Online Appendix
"School Boards and Education Production: Evidence from Randomized Ballot Order"

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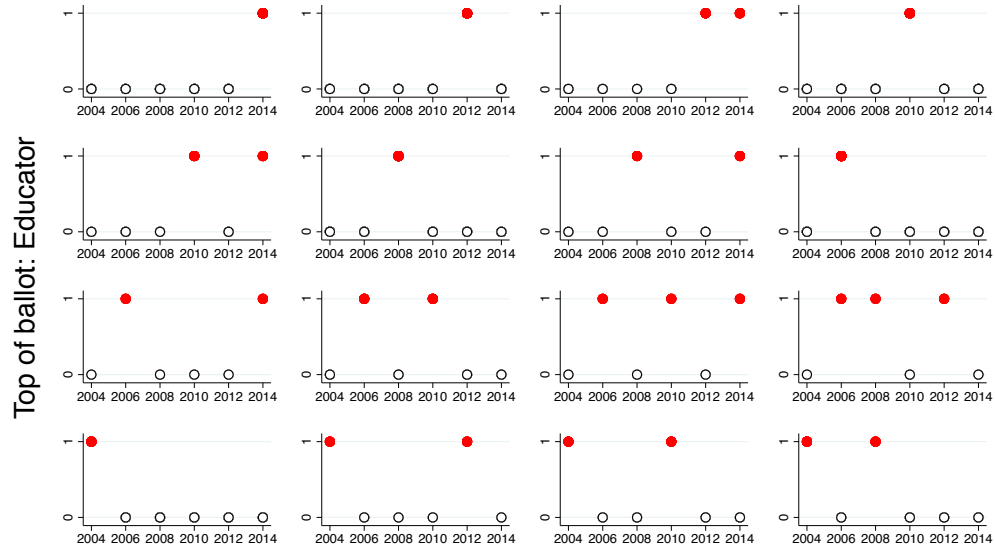
I. Tables and Figures

Figure A1. : Within-District Variation in Having Educator at Top of Ballot, 2004-2014 Elections

Note: The graph shows the sixteen most common patterns for even-year elections in 2004-2014. Red dots denote having an educator candidate at the top of the ballot in the district for a given year, while white dots denote having a non-educator candidate at the top.
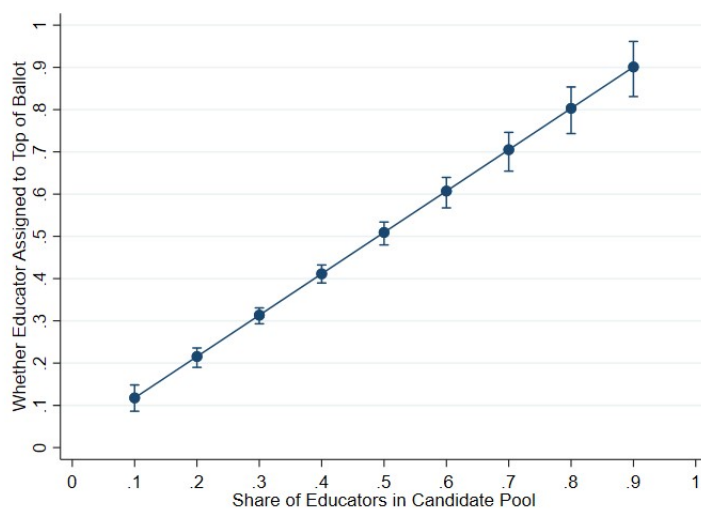
Figure A2. : Test of Randomized Assignment to Top of Ballot

Note: Figure reports empirical means for whether an educator is assigned to the top of the ballot (and associated confidence intervals) by share of educators in the candidate pool across election contests. Predictions are obtained from a non-parametric regression with Epanechnikov kernel and bandwidth chosen by cross-validation. Confidence intervals are calculated by bootstrap (200 draws).
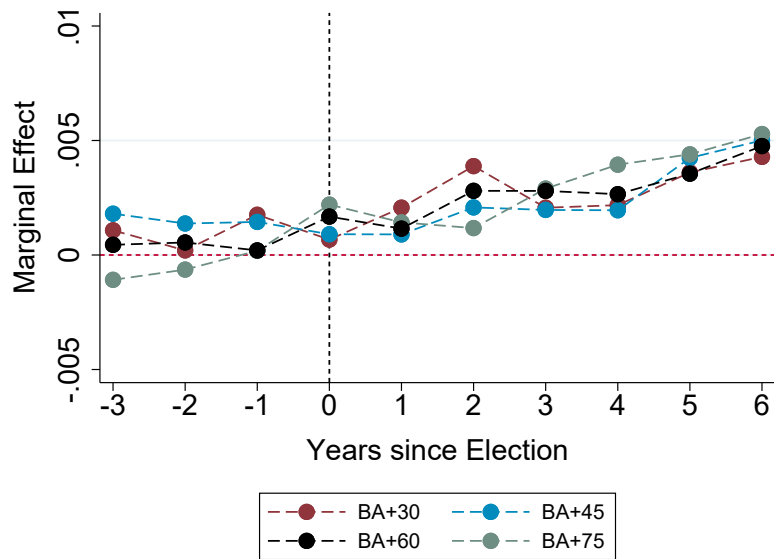
Figure A3. :   Event-Study Causal Estimates - Log Salary by Column

Note: The dataset is stacked across six experience levels (1, 5, 10, 15, 20, and 25 years) for each education level. Coefficients correspond to interactions between the instrument and the number of years since the election. Covariates include the number of open seats, share of educators in the candidate pool, their interaction, indicators for having no educators or all educators in the candidate pool, and indicators for the number of contests per district-year. The models furthermore include district, election year, years elapsed, and year fixed effects.

Table A1—: Characteristics of Full Sample and Randomized Assignment Sample

	Full Sample	Subsample	
	Mean	Mean	SE
Panel A. School District Characteristcs			
Total Enrollment	9736	12041	(1005)
Share White	0.41	0.38	(0.01)
Share Black or Hispanic	0.47	0.49	(0.01)
Share Asian	0.08	0.09	(0.01)
Share FRP Lunch	0.51	0.52	(0.01)
Urban	0.59	0.68	(0.02)
Panel B. Charter Schooling			
Share of Enrollment	0.04	0.04	(0.00)
No. of Charters	1.00	1.17	(0.19)
Panel C. Teacher Working Conditions			
Service Days	184	184	(0.08)
MA Bonus Offered	0.58	0.52	(0.02)
Max Health Contribution	9149	9609	(164)
Pupils per Teacher	27.46	27.78	(0.23)
BA+60 Teacher Salary	59063	60530	(344)
Panel D. School District Expenditures			
Certified Salaries	0.47	0.47	(0.00)
Classified Salaries	0.15	0.15	(0.00)
Benefits	0.18	0.18	(0.00)
Services & Other Exp.	0.10	0.10	(0.00)
Capital Outlay	0.01	0.01	(0.00)
Superintendent Salary	142648	153316	(2095)
Panel E. Student Outcomes			
Reading Scores	0.07	0.06	(0.03)
Math Scores	-0.01	-0.02	(0.03)
HS Graduation	0.79	0.79	(0.01)
Panel F. Election and Board Characteristics			
No. of Open Seats in Contest	2.12	2.28	(0.03)
No. of Candidates in Contest	4.10	4.67	(0.07)
Share of Candidates: Educators	0.17	0.34	(0.00)
Share of Board: Educators	0.19	0.30	(0.01)
No. of Contests	4550	2165	
No. of School Districts	859	652	

Note: Table reports averages for sample of all electoral contests and for randomized assignment subsample (contests in which at least one educator is an educator but not all candidates are educators). Third column reports district clustered standard errors of the subsample means.

Table A2—: Within-District Variation in Ballot Order Instrument

No. of Election Years With First-Listed Educator	No. of districts (1)	Pct. (2)	Cum. Pct. (3)
0	431	50.17	50.17
1	240	27.94	78.11
2	107	12.46	90.57
3	43	5.01	95.58
4 or more	38	4.42	100.00
Total	859	100.00	

Note: Table shows the number of election years in which each of the 859 districts in our sample had an educator at the top of their electoral ballot. Election years span 1998-2015.

Table A3—: Validity: Prior Events

	Top of Ballot Educator (current contest)				
	(1)	(2)	(3)	(4)	(5)
Share of Educators in Candidate Pool	0.977 (0.062)	1.041 (0.073)	1.051 (0.073)	0.998 (0.085)	1.012 (0.090)
Top of Ballot Educator, t-2		-0.039 (0.026)	-0.027 (0.027)	-0.009 (0.031)	0.010 (0.034)
Share of Educators in Candidate Pool, t-2			-0.063 (0.061)		-0.099 (0.074)
Top of Ballot Educator, t-4				0.048 (0.030)	0.047 (0.030)
Share of Educators in Candidate Pool, t-4					0.014 (0.076)
Observations	2,165	1,522	1,522	1,075	1,075

Note: Robust standard errors are clustered at the district level. Sample in column (1) includes all contests in which the candidate pool is neither only educators or without any educators. Columns (2) and (3) are contests in which an election two years prior is also observed; (4) and (5) contests in which elections two and four years prior are observed.

Table A4—: Evidence of Treatment: Down-Ballot Effects

	No. of Winners Who are Educators		Share of Board: Educators	
	(1)	(2)	(3)	(4)
Top of Ballot Educator	0.141	0.139	0.023	0.023
	(0.029)	(0.031)	(0.008)	(0.009)
Other Top Tier Educator		-0.007		-0.003
		(0.029)		(0.007)
Observations	4448	4448	4448	4448
F-statistics	24.21	12.50	7.895	4.191

Note: Robust standard errors are clustered at the district level. Other top tier educators are defined as educators who occupy a ballot position that is 1) not at the top and 2) at or below the number of open seats. For instance, an educator who is second on the ballot in an electoral contest with two open seats would fall into this category, but an educator at the top or third on the ballot would not. All specifications include separate district, election year, and year fixed effects. Covariates include the number of open seats, share of educators in the candidate pool, their interaction, indicators for having no educators or all educators in the candidate pool, and indicators for the number of contests per district-year.

Table A5—: Robustness: Causal Estimates - Charter Schools

Top of Ballot Educator	Share of Enrollment (1)	No. of Charters (2)
Main Model		
Effect 4-Years Post-Election	-0.005	-0.200
	(0.003)	(0.110)
Effect Slope	-0.001	-0.069
	(0.001)	(0.041)
Observations	40,975	40,975
Flexible Model		
Effect 4-Years Post-Election	-0.005	-0.200
	(0.003)	(0.110)
Effect Slope	-0.001	-0.069
	(0.001)	(0.041)
Observations	40,975	40,975
Main Model - Random Assignment Sample		
Effect 4-Years Post-Election	-0.006	-0.222
	(0.003)	(0.122)
Effect Slope	-0.001	-0.071
	(0.001)	(0.042)
Observations	19,478	19,478
Parsimonious Model		
Effect 4-Years Post-Election	-0.005	-0.193
	(0.003)	(0.105)
Effect Slope	-0.001	-0.062
	(0.001)	(0.040)
Observations	40,975	40,975
Main Model - Quadratic Controls for No. of Candidates and Educator Candidates		
Effect 4-Years Post-Election	-0.005	-0.178
	(0.003)	(0.098)
Effect Slope	-0.001	-0.059
	(0.001)	(0.036)
Observations	40,975	40,975
Main Model - Cubic Controls for No. of Candidates and Educator Candidates		
Effect 4-Years Post-Election	-0.005	-0.189
	(0.003)	(0.104)
Effect Slope	-0.001	-0.064
	(0.001)	(0.039)
Observations	40,975	40,975
Main Model - Controls for Lags of Events		
Effect 4-Years Post-Election	-0.005	-0.211
	(0.003)	(0.121)
Effect Slope	-0.001	-0.074
	(0.001)	(0.042)

Table A5—: Robustness: Causal Estimates - Charter Schools

	Share of Enrollment	No. of Charters
Top of Ballot Educator	(1)	(2)
Observations	40,975	40,975
Main Model - Excludes Boards with Recent Top-Listed Educator		
Effect 4-Years Post-Election	-0.006	-0.166
	(0.004)	(0.143)
Effect Slope	-0.001	-0.053
	(0.001)	(0.059)
Observations	31,224	31,224

Note: Robust standard errors are clustered at the district level. The sample is a stacked dataset of periods -3 through 6 for each school board. Covariates in the main specification include the number of open seats, share of educators in the candidate pool, their interaction, indicators for having no educators or all educators in the candidate pool, and indicators for the number of contests per district-year. For each control variable we estimate a level effect, an interaction with a post-election indicator, and an interaction with both the post-election indicator and the period (linear trend). The flexible model interacts all control variables listed above with post-election period intercepts. The parsimonious model restricts the set of control variables to the share of educators in the candidate pool, indicators for having no educators or all educators in the candidate pool. The random assignment sample excludes electoral contests that have no educator candidates or all educator candidates. The next two specifications control for the quadratics (cubics) of the number of candidates and candidates who are educators, and their interaction, instead of a linear share of educators. The next specification controls for lags of the instrument and share of educators in the candidate pool going back five years. The final specification restricts to school boards that have not had a top-of-the-ballot educator in the previous five years. All models include district, period, election year, and calendar year fixed effects.

Table A6—: Robustness: Causal Estimates - Teacher Working Conditions

Top of Ballot Educator	Service Days (1)	M.A. Bonus Offered (2)	Log Max Health Benefit (3)	Class Size (4)	Log Salary: BA+60 (5)
Main Model					
Effect 4-Years Post-Election	-0.017	-0.005	-0.020	0.035	0.003
	(0.046)	(0.005)	(0.030)	(0.195)	(0.001)
Effect Slope	0.002	-0.000	-0.003	-0.091	0.001
	(0.025)	(0.002)	(0.015)	(0.072)	(0.000)
Observations	37,380	37,380	37,380	38,997	227,795
Flexible Model					
Effect 4-Years Post-Election	-0.016	-0.005	-0.019	0.031	0.003
	(0.046)	(0.005)	(0.030)	(0.195)	(0.001)
Effect Slope	0.002	-0.000	-0.003	-0.094	0.001
	(0.025)	(0.002)	(0.015)	(0.072)	(0.000)
Observations	37,380	37,380	37,380	38,997	227,795
Main Model - Random Assignment Sample					
Effect 4-Years Post-Election	-0.040	-0.006	-0.015	0.051	0.003
	(0.049)	(0.005)	(0.031)	(0.191)	(0.001)
Effect Slope	0.003	-0.000	-0.004	-0.093	0.000
	(0.024)	(0.002)	(0.015)	(0.070)	(0.000)
Observations	18,448	18,448	18,448	18,866	112,149
Parsimonious Model					
Effect 4-Years Post-Election	-0.018	-0.005	-0.019	0.034	0.003
	(0.047)	(0.005)	(0.030)	(0.196)	(0.001)
Effect Slope	-0.001	-0.000	-0.002	-0.093	0.001
	(0.025)	(0.002)	(0.015)	(0.072)	(0.000)
Observations	37,380	37,380	37,380	38,997	227,795
Main Model - Quadratic Controls for No. of Candidates and Educator Candidates					
Effect 4-Years Post-Election	-0.018	-0.005	-0.014	0.065	0.003
	(0.045)	(0.005)	(0.030)	(0.196)	(0.001)
Effect Slope	-0.001	-0.000	0.001	-0.095	0.001
	(0.025)	(0.002)	(0.015)	(0.072)	(0.000)
Observations	37,380	37,380	37,380	38,997	227,795
Main Model - Cubic Controls for No. of Candidates and Educator Candidates					
Effect 4-Years Post-Election	-0.018	-0.005	-0.012	0.049	0.003
	(0.046)	(0.005)	(0.030)	(0.194)	(0.001)
Effect Slope	-0.001	-0.000	-0.000	-0.094	0.001
	(0.024)	(0.002)	(0.015)	(0.071)	(0.000)
Observations	37,380	37,380	37,380	38,997	227,795
Main Model - Controls for Lags of Events					
Effect 4-Years Post-Election	-0.011	-0.006	-0.017	-0.005	0.004
	(0.050)	(0.006)	(0.033)	(0.211)	(0.001)
Effect Slope	0.007	-0.000	-0.003	-0.094	0.001

Table A6—: Robustness: Causal Estimates - Teacher Working Conditions

	Service Days	M.A. Bonus Offered	Log Max Health Benefit	Class Size	Log Salary: BA+60
Top of Ballot Educator	(1)	(2)	(3)	(4)	(5)
	(0.025)	(0.002)	(0.016)	(0.073)	(0.000)
Observations	37,380	37,380	37,380	38,997	227,795
Main Model - Excludes Boards with Recent Top-Listed Educator					
Effect 4-Years Post-Election	-0.073	-0.006	-0.000	-0.100	0.004
	(0.058)	(0.007)	(0.048)	(0.247)	(0.002)
Effect Slope	0.001	0.000	0.015	-0.105	0.000
	(0.032)	(0.002)	(0.020)	(0.084)	(0.001)
Observations	27,897	27,897	27,897	29,473	170,080

Note: Robust standard errors are clustered at the district level. The sample is a stacked dataset of periods -3 through 6 for each school board. Covariates for the main specification include the number of open seats, share of educators in the candidate pool, their interaction, indicators for having no educators or all educators in the candidate pool, and indicators for the number of contests per district-year. The random assignment sample excludes electoral contests that have no educator candidates or all educator candidates. The flexible model interacts all control variables listed above with post-election period intercepts. The parsimonious model controls for the share of educators in the candidate pool, indicators for having no educators or all educators in the candidate pool. The next two specifications control for the quadratics (cubics) of the number of candidates and candidates who are educators, and their interaction, instead of a linear share of educators. The next specification controls for lags of the instrument and share of educators in the candidate pool going back five years. The final specification restricts to school boards that have not had a top-of-the-ballot educator in the previous five years. All models include district, period, election year, and calendar year fixed effects.

Table A7—: Robustness: Causal Estimates - Expenditures

	Certified Staff	Classified Staff	Benefits	Services & Other Exp.	Capital Outlays	Log Supt. Salary
				Share of Expenditures On:		
Top of Ballot Educator	(1)	(2)	(3)	(4)	(5)	(6)
Main Model						
Effect 4-Years Post-Election	0.002	0.000	0.001	-0.001	-0.001	0.002
	(0.001)	(0.000)	(0.001)	(0.001)	(0.000)	(0.003)
Effect Slope	0.001	-0.000	0.000	-0.000	-0.000	0.001
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.002)
Observations	43,569	43,569	43,569	43,569	43,569	36,791
Flexible Model						
Effect 4-Years Post-Election	0.002	0.000	0.001	-0.001	-0.001	0.002
	(0.001)	(0.000)	(0.001)	(0.001)	(0.000)	(0.003)
Effect Slope	0.001	-0.000	0.000	-0.000	-0.000	0.001
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.002)
Observations	43,569	43,569	43,569	43,569	43,569	36,791
Main Model - Random Assignment Sample						
Effect 4-Years Post-Election	0.002	0.000	0.001	-0.001	-0.001	0.001
	(0.001)	(0.000)	(0.001)	(0.001)	(0.000)	(0.003)
Effect Slope	0.001	-0.000	0.000	-0.000	-0.000	0.001
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.002)
Observations	20,742	20,742	20,742	20,742	20,742	18,384
Parsimonious Model						
Effect 4-Years Post-Election	0.002	0.000	0.001	-0.001	-0.001	0.002
	(0.001)	(0.000)	(0.001)	(0.001)	(0.000)	(0.003)
Effect Slope	0.001	-0.000	0.000	-0.000	-0.000	0.001
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.002)
Observations	43,569	43,569	43,569	43,569	43,569	36,791
Main Model - Quadratic Controls for No. of Candidates and Educator Candidates						
Effect 4-Years Post-Election	0.002	0.000	0.001	-0.001	-0.001	0.002
	(0.001)	(0.000)	(0.001)	(0.001)	(0.000)	(0.003)
Effect Slope	0.001	-0.000	0.000	-0.000	-0.000	0.001
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.002)
Observations	43,569	43,569	43,569	43,569	43,569	36,791
Main Model - Cubic Controls for No. of Candidates and Educator Candidates						
Effect 4-Years Post-Election	0.002	0.000	0.001	-0.001	-0.001	0.002
	(0.001)	(0.000)	(0.001)	(0.001)	(0.000)	(0.003)
Effect Slope	0.001	-0.000	0.000	-0.000	-0.000	0.001
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.002)
Observations	43,569	43,569	43,569	43,569	43,569	36,791
Main Model - Controls for Lags of Events						
Effect 4-Years Post-Election	0.002	0.000	0.001	-0.001	-0.001	0.003
	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.004)

Table A7—: Robustness: Causal Estimates - Expenditures

| | Share of Expenditures On: | | | | | Log Supt. Salary |
| | Certified Staff | Classified Staff | Benefits | Services & Other Exp. | Capital Outlays | |
Top of Ballot Educator	(1)	(2)	(3)	(4)	(5)	(6)
Effect Slope	0.001	-0.000	0.000	-0.000	-0.000	0.001
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.002)
Observations	43,569	43,569	43,569	43,569	43,569	36,791
Main Model - Excludes Boards with Recent Top-Listed Educator						
Effect 4-Years Post-Election	0.003	0.000	0.002	-0.002	-0.001	0.005
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.004)
Effect Slope	0.001	0.000	0.001	-0.000	-0.000	0.003
	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.002)
Observations	33,128	33,128	33,128	33,128	33,128	27,242

Note: Robust standard errors are clustered at the district level. The sample is a stacked dataset of periods -3 through 6 for each school board. Covariates for the main specification include the number of open seats, share of educators in the candidate pool, their interaction, indicators for having no educators or all educators in the candidate pool, and indicators for the number of contests per district-year. The random assignment sample excludes electoral contests that have no educator candidates or all educator candidates. The flexible model interacts all control variables listed above with post-election period intercepts. The parsimonious model controls for the share of educators in the candidate pool, indicators for having no educators or all educators in the candidate pool. The next two specifications control for the quadratics (cubics) of the number of candidates and candidates who are educators, and their interaction, instead of a linear share of educators. The next specification controls for lags of the instrument and share of educators in the candidate pool going back five years. The final specification restricts to school boards that have not had a top-of-the-ballot educator in the previous five years. All models include district, period, election year, and calendar year fixed effects.

Table A8—: Robustness: Causal Estimates - Student Outcomes

| | Elementary | | Middle | | |
| | Math | Reading | Math | Reading | HS Graduation |
Top of Ballot Educator	(1)	(2)	(3)	(4)	(5)
Main Model					
Effect 4-Years Post-Election	-0.011	-0.020	-0.014	-0.014	-0.001
	(0.012)	(0.010)	(0.010)	(0.008)	(0.003)
Effect Slope	-0.007	-0.003	-0.001	-0.001	0.001
	(0.005)	(0.003)	(0.004)	(0.003)	(0.001)
Observations	1,263,925	1,263,574	488,559	503,140	25,934
Flexible Model					
Effect 4-Years Post-Election	-0.010	-0.020	-0.013	-0.013	-0.001
	(0.012)	(0.009)	(0.010)	(0.008)	(0.003)
Effect Slope	-0.004	-0.001	0.000	0.001	0.001
	(0.004)	(0.004)	(0.004)	(0.003)	(0.001)
Observations	1,263,925	1,263,574	488,559	503,140	25,934
Main Model - Random Assignment Sample					
Effect 4-Years Post-Election	-0.014	-0.023	-0.018	-0.018	-0.002
	(0.013)	(0.010)	(0.010)	(0.009)	(0.003)
Effect Slope	-0.004	-0.001	0.001	0.001	0.001
	(0.004)	(0.003)	(0.004)	(0.003)	(0.001)
Observations	710,366	710,224	271,134	278,245	13,188
Parsimonious Model					
Effect 4-Years Post-Election	-0.007	-0.019	-0.013	-0.014	-0.001
	(0.013)	(0.010)	(0.010)	(0.008)	(0.003)
Effect Slope	-0.004	-0.002	-0.001	0.000	0.001
	(0.004)	(0.004)	(0.004)	(0.003)	(0.001)
Observations	1,263,925	1,263,574	488,559	503,140	25,934
Main Model - Quadratic Controls for No. of Candidates and Educator Candidates					
Effect 4-Years Post-Election	-0.012	-0.021	-0.013	-0.014	-0.001
	(0.012)	(0.009)	(0.010)	(0.008)	(0.003)
Effect Slope	-0.005	-0.001	0.000	0.001	0.001
	(0.004)	(0.004)	(0.004)	(0.003)	(0.001)
Observations	1,263,925	1,263,574	488,559	503,140	25,934
Main Model - Cubic Controls for No. of Candidates and Educator Candidates					
Effect 4-Years Post-Election	-0.011	-0.020	-0.013	-0.014	-0.001
	(0.012)	(0.010)	(0.010)	(0.008)	(0.003)
Effect Slope	-0.005	-0.001	-0.000	0.000	0.001
	(0.004)	(0.004)	(0.004)	(0.003)	(0.001)
Observations	1,263,925	1,263,574	488,559	503,140	25,934
Main Model - Controls for Lags of Events					
Effect 4-Years Post-Election	-0.011	-0.022	-0.014	-0.014	-0.001
	(0.014)	(0.010)	(0.011)	(0.008)	(0.003)
Effect Slope	-0.005	-0.002	0.000	0.000	0.001

Table A8—: Robustness: Causal Estimates - Student Outcomes

	Elementary		Middle		
	Math	Reading	Math	Reading	HS Graduation
Top of Ballot Educator	(1)	(2)	(3)	(4)	(5)
	(0.005)	(0.003)	(0.005)	(0.003)	(0.001)
Observations	1,263,925	1,263,574	488,559	503,140	25,934
Main Model - Excludes Boards with Recent Top-Listed Educator					
Effect 4-Years Post-Election	-0.008	-0.018	-0.014	-0.012	-0.006
	(0.014)	(0.014)	(0.013)	(0.011)	(0.005)
Effect Slope	0.002	0.003	0.008	0.003	0.002
	(0.005)	(0.004)	(0.006)	(0.004)	(0.002)
Observations	746,800	746,550	278,201	286,876	13,188

Note: Robust standard errors are clustered at the district level. The sample is a stacked dataset of periods -3 through 6 for each school board. Covariates for the main specification include the number of open seats, share of educators in the candidate pool, their interaction, indicators for having no educators or all educators in the candidate pool, and indicators for the number of contests per district-year. The random assignment sample excludes electoral contests that have no educator candidates or all educator candidates. The flexible model interacts all control variables listed above with post-election period intercepts. The parsimonious model controls for the share of educators in the candidate pool, indicators for having no educators or all educators in the candidate pool. The next two specifications control for the quadratics (cubics) of the number of candidates and candidates who are educators, and their interaction, instead of a linear share of educators. The next specification controls for lags of the instrument and share of educators in the candidate pool going back five years. The final specification restricts to school boards that have not had a top-of-the-ballot educator in the previous five years. All models include district, period, election year, and calendar year fixed effects.

Table A9—: Treatment Effects Estimates - Teacher Employment

	Log FTE Teachers (1)
Additional Educator on School Board	
Effect 4-Years Post-Election	-0.015
	(0.055)
Effect Slope	0.049
	(0.025)
Observations	40,983

Note: Robust standard errors are clustered at the district level. The sample is a stacked dataset of periods -3 through 6 for each school board. Coefficients show the causal effect of the instrument four years post-election, as well as the slope of the causal effect post-election. Covariates include the number of open seats, share of educators in the candidate pool, their interaction, indicators for having no educators or all educators in the candidate pool, and indicators for the number of contests per district-year. The models furthermore include district, period, election year, and calendar year fixed effects.

Table A10—: Treatment Effect Estimates - Student Demographic Composition

	Share of Non-White Students:		Share of FRL Students:
	Elementary (1)	Middle (2)	(3)
Additional Educator on School Board			
Effect 4-Years Post-Election	0.067	0.046	0.021
	(0.051)	(0.030)	(0.028)
Effect Slope	0.008	0.011	-0.002
	(0.010)	(0.009)	(0.006)
Observations	2,130,574	564,729	628,372

Note: Robust standard errors are clustered at the district level. The sample is a stacked dataset of periods -3 through 6 for each school board. Models use an indicator for being a first-listed educator to instrument for the number of educators newly elected to the school board, with the intercept coefficient showing the causal effect of an additional educator four years post-election, and the slope coefficient showing the trend of effects post-election. Covariates include the number of open seats, share of educators in the candidate pool, their interaction, indicators for having no educators or all educators in the candidate pool, and indicators for the number of contests per district-year. The models also include district, election year, period, and year fixed effects.

Table A11—: Treatment Effect Heterogeneity - Charter Schools

	Share of Enrollment (1)	No. of Charters (2)
Additional Educator on School Board		
Effect 4-Years Post-Election	-0.029	-1.299
	(0.020)	(0.793)
$\times \geq 1$ Curr. Educator	-0.009	0.007
	(0.007)	(0.248)
Observations	40,975	40,975

Note: Robust standard errors are clustered at the district level. The sample is a stacked dataset of periods -3 through 6 for each school board. $\times \geq 1$ Curr. Educator equals 1 if a seat not up for election in the current cycle is occupied by an educator (and 0 otherwise). The first coefficient shows the causal effect of the instrument four years post-election for a board without any current educators. The second coefficient captures the differential treatment effect four years post-election for a board with at least one current educator. Covariates include the number of open seats, share of educators in the candidate pool, their interaction, indicators for having no educators or all educators in the candidate pool, and indicators for the number of contests per district-year. The models furthermore include district, election year, period, and year fixed effects.

Table A12—: Treatment Effect Heterogeneity - Teacher Working Conditions

	Service Days (1)	M.A. Bonus Offered (2)	Log Max Health Benefit (3)	Class Size (4)	Log Salary: BA+60 (5)
Additional Educator					
Effect 4-Years Post-Election	-0.110	-0.030	-0.189	0.540	0.027
	(0.383)	(0.046)	(0.270)	(1.399)	(0.012)
$\times \geq 1$ Curr. Educator	-0.071	-0.018	0.087	-0.577	-0.006
	(0.130)	(0.015)	(0.110)	(0.564)	(0.004)
Observations	37,380	37,380	37,380	38,997	227,795

Note: Robust standard errors are clustered at the district level. The sample is a stacked dataset of periods -3 through 6 for each school board. Column 6 further stacks the dataset across six experience levels (1, 5, 10, 15, 20, and 25 years). Coefficients show the causal effect of the instrument four years post-election, as well as the slope of the causal effect post-election. Covariates include the number of open seats, share of educators in the candidate pool, their interaction, indicators for having no educators or all educators in the candidate pool, and indicators for the number of contests per district-year. The model furthermore includes district, election year, period, and year fixed effects.

Table A13—: Treatment Effect Heterogeneity - Expenditures

| | Share of Expenditures On: | | | | | |
	Certified Salaries (1)	Classified Salaries (2)	Benefits (3)	Services & Other Exp. (4)	Capital Outlays (5)	Log Supt. Salary (6)
Additional Educator						
Effect 4-Years Post-Election	0.012	0.002	0.004	-0.009	-0.007	0.011
	(0.008)	(0.004)	(0.005)	(0.005)	(0.003)	(0.028)
$\times \geq 1$ Curr. Educator	0.003	0.001	0.000	0.003	0.002	0.004
	(0.003)	(0.001)	(0.002)	(0.002)	(0.001)	(0.011)
Observations	43,569	43,569	43,569	43,569	43,569	36,791

Note: Robust standard errors are clustered at the district level. The sample is a stacked dataset of periods -3 through 6 for each school board. Coefficients show the causal effect of the instrument four years post-election, as well as the slope of the causal effect post-election. Covariates include the number of open seats, share of educators in the candidate pool, their interaction, indicators for having no educators or all educators in the candidate pool, and indicators for the number of contests per district-year. The models furthermore include district, election year, period, and year fixed effects.

Table A14—: Treatment Effect Heterogeneity - Student Outcomes

| | Elementary | | Middle | | |
	Math (1)	Reading (2)	Math (3)	Reading (4)	HS Graduation (5)
Additional Educator					
Effect 4-Years Post-Election	-0.073	-0.166	-0.103	-0.097	-0.011
	(1.000)	(0.107)	(0.092)	(0.071)	(0.023)
$\times \geq 1$ Curr. Educator	-0.009	-0.009	-0.017	-0.022	0.008
	(0.053)	(0.052)	(0.043)	(0.035)	(0.010)
Observations	1,263,925	1,263,574	488,559	503,140	25,934

Note: Robust standard errors are clustered at the district level. The sample is a stacked dataset of periods -3 through 6 for each school board. Coefficients show the causal effect of the instrument four years post-election, as well as the slope of the causal effect post-election. Covariates include the number of open seats, share of educators in the candidate pool, their interaction, indicators for having no educators or all educators in the candidate pool, and indicators for the number of contests per district-year. The models furthermore include district, election year, period, and year fixed effects.

II.   Overlapping Elections, Causal Effects, and Electoral Dynamics

Our research design focuses on using the ballot order instrument to estimate the causal effects of an additional educator elected to the school board over time. Drawing on the framework of Cellini, Ferreira and Rothstein (2010), this section expands on the interpretation of these effects in recognition that 1) outcomes are likely to depend on current and prior boards' actions; and 2) current board composition will also depend on results of prior elections (e.g. because of staggered terms).

To assist the exposition, we use separate district j and election year t indices here in lieu of school board identifiers (b). τ indexes periods relative to election year t as before. An outcome Y_{jt} for a given school board can be expressed as a function of the composition of the current board as well as of those boards that preceded it:

$$
\text{(A.1)} \qquad\qquad Y_{jt} = \sum_{\tau=0}^{\infty} \theta_\tau T_{j,t-\tau} + u_{jt}
$$

T_{jt} is the number of educators elected to the district j school board in year t. For the modal school district, elections are held every two years with members serving term lengths of four years. For non-election years, $T_{jt} = 0$ by definition. This equation in principle allows the decisions of all previous school boards to influence the outcome. This setup accommodates staggered elections: the school board immediately prior is likely to share members in common with the board elected at t. However, the setup also allows that the decisions of boards for which all members' terms have expired by t may continue to matter (e.g. because of path-dependence in collective bargaining or because education input changes may not immediately translate into effects on learning).

The causal effects we estimate correspond to the thought experiment of randomly assigning an educator to the board at time t and tracing out its consequences for outcomes. These effects are represented in equation (1) (re-written without the b notation this time):

$$
\text{(A.2)} \qquad\qquad Y_{j,t+\tau} = \beta_\tau T_{jt} + u_{j,t+\tau}
$$

Note that equations (A.1) and (A.2) are linked via the following identity:

$$
\beta_\tau = \frac{dY_{jt}}{dT_{j,t-\tau}}
$$
$$
= \theta_\tau + \sum_{h=1}^{\tau} \theta_{\tau-h} \frac{dT_{j,t-\tau+h}}{dT_{j,t-\tau}}
$$

where $(dT_{j,t-\tau+h})/(dT_{j,t-\tau})$ represents the effect of a change in the number of educators elected in a given year on the number who are elected h periods subsequent.

This equation formalizes that the causal effects represented by β_τ include both the "partial" effect of an additional educator as well as the cumulative impact of intermediate changes in the school board's composition. In Cellini, Ferreira and Rothstein (2010)'s framework, the β_τ parameters are "intent to treat" causal effects. θ_τ, in contrast, corresponds to the effect of exogenously changing the board composition on the outcome in period τ, holding the board's composition in the years between t and τ fixed. These notions of causal effect are thus by definition the same in post-election periods prior to the next election year (typically $\tau = 1$ and 2 in our setting), but diverge when electoral dynamics are present (i.e. when $(dT_{j,t-\tau+h})/(dT_{j,t-\tau}) \neq 0$). We examine these electoral dynamics directly and discuss their implications for interpreting

our findings in Section IV.B.

REFERENCES

Cellini, Stephanie Riegg, Fernando Ferreira, and Jesse Rothstein. 2010. "The Value of School Facility Investments: Evidence from a Dynamic Regression Discontinuity Design." *The Quarterly Journal of Economics*, 125(1): 215–261.