Supplementary Information for "The Effect of Television Advertising in United States Elections"

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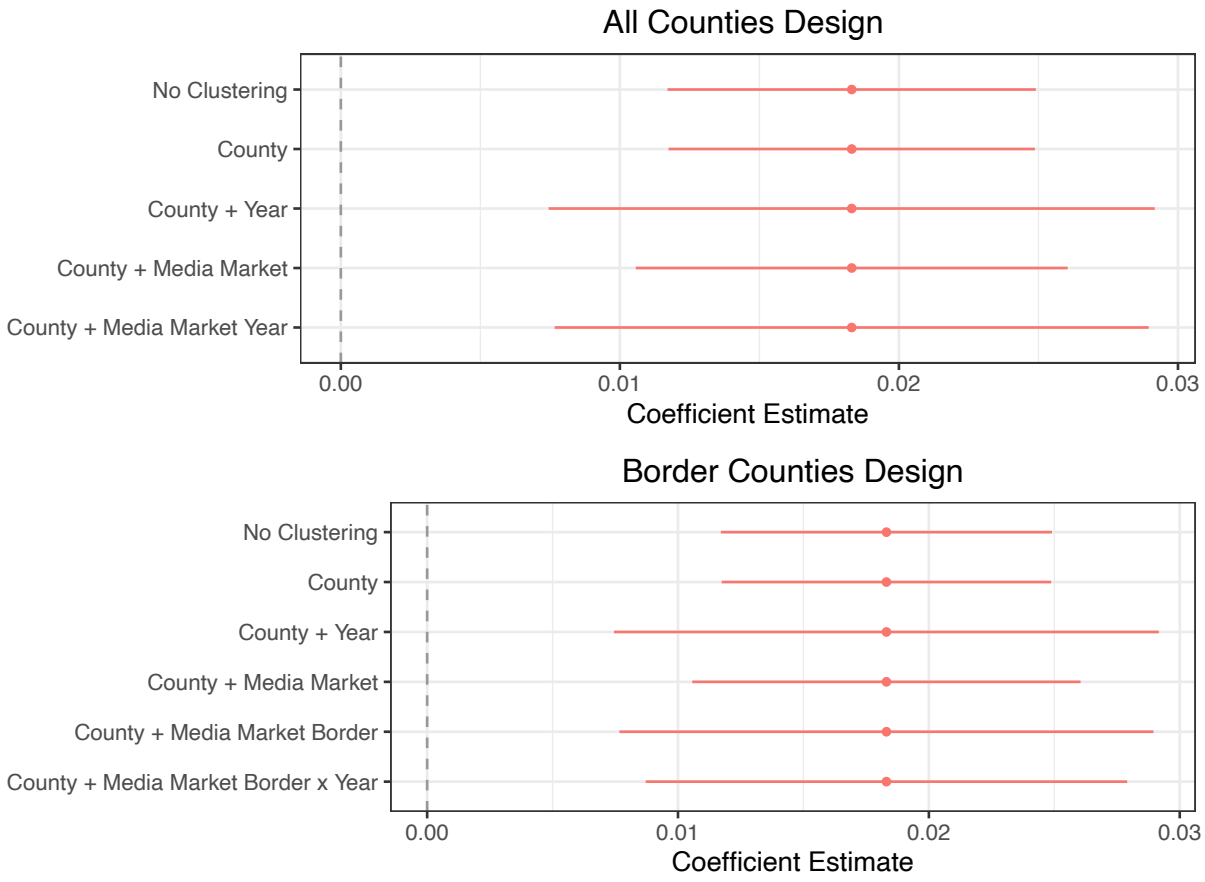
A Clustering Strategies

In this appendix, we compare the approach we use to cluster our standard errors with other plausible approaches. For simplicity, we focus on our main results for presidential elections. Figure A1 shows that the standard errors are much smaller in a naive model that does not cluster standard errors at all. But the standard errors are similar using a variety of other clustering strategies for both the all counties and border counties designs. Moreover, the results are statistically significant using all plausible clustering strategies.

Figure A1: Comparing strategies for clustering standard errors in models of effect of advertising in presidential elections. The top plot shows the all counties design and the second plot shows the border counties design.



B Placebo Checks

The identification strategy for our research design relies on the assumption that there are no time-varying confounders, typically called the parallel trends assumption. To demonstrate that this assumption is likely to be valid, researchers commonly demonstrate that there are parallel trends in pre-treatment outcomes. In the panel framework that we employ, we can demonstrate parallel trends by looking at the effects of future values of our main independent variable on contemporaneous outcomes. If future "treatments" (differing advertising advantages) affected voting in previous elections, ad placement could be affected by other factors that also affect voting, invalidating our assumptions about time-varying confounders.

Table A1: Placebo Tests: Effect of Aggregate Television Advertising in Last Two Months of the Next Election Cycle

	Dependent variable: Dem. Vote Share					
	President	Senate	Governor	House	Attorney Gen.	Treasurer
	(1)	(2)	(3)	(4)	(5)	(6)
All Counties						
Dem. Ad. Adv. (100 ads)$_{t+1}$	−0.001	−0.012	−0.008	0.012	0.059	−0.212
	(0.008)	(0.011)	(0.013)	(0.028)	(0.046)	(0.113)
County FE	X	X	X	X	X	X
State-year FE	X	X	X	X	X	X
Observations	12,693	17,118	11,997	23,344	8,685	5,868
R^2	0.959	0.961	0.939	0.959	0.963	0.965
Adjusted R^2	0.945	0.951	0.922	0.943	0.944	0.950
Border Counties						
Dem. Ad. Adv. (100 ads)$_{t+1}$	−0.002	0.0001	0.005	0.028	−0.039	−0.161*
	(0.004)	(0.007)	(0.011)	(0.038)	(0.043)	(0.069)
County FE	X	X	X	X	X	X
Border-Pair-Year FE	X	X	X	X	X	X
Observations	17,753	25,529	12,707	27,717	9,102	6,305
R^2	0.993	0.989	0.989	0.992	0.991	0.992
Adjusted R^2	0.978	0.972	0.963	0.964	0.970	0.978

Standard errors clustered by county and DMA-year in top panel; county and DMA border-year in bottom.
*p<0.05; **p<0.01

Table A1 shows placebo tests that validate the plausibility of the parallel trends assumption in difference-in-difference models for the border counties sample. There are almost no significant effects of future advertising on contemporaneous election outcomes. Moreover,

the point estimates of the effects are all very small.

We also examined models that included both future advertising and contemporaneous advertising. And we examined models of the effect of contemporaneous advertising on future election outcomes. These models all indicated no effect of past or future advertising on elections.

This evidence suggests that time-varying confounders do not bias our estimates of advertising effects in elections (see also Spenkuch and Toniatti 2018).

C Assessing Whether Field Offices Confound Advertising Effects

In this appendix, we examine the concern that field offices could confound advertising effects. We have data on Democratic presidential candidates' field offices in the 2004-2016 presidential elections (Darr and Levendusky 2014; Sides and Vavreck 2013; Sides, Tesler, and Vavreck 2018). Unfortunately, we lack consistent data on Republican presidential candidates' field offices. We also lack field office data for other races. For some of these years, we have detailed data on the number of Democratic field offices in each county, while for other years we just have an indicator for whether the Democratic presidential campaign had an office in a county. Thus, we rely on a dichotomous indicator for whether each Democratic presidential campaign had offices in each county.

To begin, we examine whether Democratic advertising advantage is correlated with the presence of Democratic field offices in presidential elections (Table A2). In both the all counties and border counties designs, we find no relationship between Democratic field offices and advertising advantage. That field offices seem to be approximately orthogonal to television advertising suggests that field activities are not likely to confound the effects of advertising.

Table A2: Relationship between Democratic Ad Advantage and Democratic Field Offices

	Dependent variable: Dem. Field Offices	
	All counties	*Border counties*
	(1)	(2)
Dem. Ad. Adv. (100 ads)	0.00002	−0.0003
	(0.0004)	(0.001)
Observations	11,194	15,809
R^2	0.736	0.868
Note:		*p<0.1; **p<0.05; ***p<0.01

In Table A3, we examine whether field offices could be confounding the effects of advertising by estimating regression models of presidential election outcomes that include both

Democratic advertising advantage and Democratic field offices. The left panel shows the all county design, while the right panel shows the border counties design. (Note that the results here slightly vary from those in the main paper because they only include counties and elections where we have data on field offices.) Including the measure of field offices does not affect the point estimates for the effect of advertising.[1]

Table A3: Models of the Effect of TV Advertising in Presidential Elections from 2004-16 with and without Controlling for Field Offices

	Dependent variable: Dem. Vote Share			
	All counties		*Border counties*	
	(1)	(2)	(3)	(4)
Dem. Ad. Adv. (100 ads)	0.022**	0.022**	0.016**	0.016**
	(0.008)	(0.008)	(0.005)	(0.005)
Dem. Field Offices		0.690**		0.051
		(0.225)		(0.211)
Observations	11,135	11,135	15,754	15,754
R^2	0.971	0.971	0.993	0.993
Note:				*p<0.05; **p<0.01

1. One reason for the null effect of field offices in column 4 could be that field offices conduct electioneering in both counties of a border pair.

D Detailed Results

This appendix shows detailed results analogous to those in Table 2 for Senate, Governor, House, Attorney General, and Treasurer elections.

Table A4: Effects of Aggregate Television Advertising in Last Two Months of Presidential Elections (2000-2016)

	Dependent variable: Dem. Vote Share						
	All counties				*Border counties*		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dem. Ad. Adv. (100 ads)	0.158**	0.043**	0.037**	0.027**	0.027**	0.020**	0.018**
	(0.036)	(0.013)	(0.007)	(0.008)	(0.005)	(0.006)	(0.005)
Year FE	X	X					
State-year FE			X	X	X	X	
County FE		X		X		X	X
Lagged Outcome			X		X		
Border-Pair-Year FE							X
Observations	12,652	12,652	12,650	12,652	17,652	17,689	17,689
R^2	0.076	0.930	0.953	0.962	0.956	0.968	0.993

Standard errors clustered by county and DMA-year in top panel; county and DMA border-year in bottom.
*p<0.05; **p<0.01

Table A5: Effects of Aggregate Television Advertising in Last Two Months of Senate Elections (2000-2018)

	Dependent variable: Dem. Vote Share						
	All counties				*Border counties*		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dem. Ad. Adv. (100 ads)	0.383**	0.189**	0.031**	0.055**	0.035**	0.053**	0.038**
	(0.044)	(0.042)	(0.011)	(0.010)	(0.009)	(0.009)	(0.007)
Year FE	X	X					
State-year FE			X	X	X	X	
County FE		X		X		X	X
Lagged Outcome			X		X		
Border-Pair-Year FE							X
Observations	17,133	17,133	17,128	17,133	23,847	23,910	23,910
R^2	0.114	0.696	0.919	0.960	0.922	0.964	0.990

Standard errors clustered by county and DMA-year in top panel; county and DMA border-year in bottom.
*p<0.05; **p<0.01

Table A6: Effects of Aggregate Television Advertising in Last Two Months of Governor Elections (2000-2018)

	Dependent variable: Dem. Vote Share						
	All counties				*Border counties*		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dem. Ad. Adv. (100 ads)	0.265**	0.249**	0.081**	0.087**	0.067**	0.073**	0.055**
	(0.039)	(0.031)	(0.016)	(0.014)	(0.012)	(0.012)	(0.010)
Year FE	X	X					
State-year FE			X	X	X	X	
County FE		X		X		X	X
Lagged Outcome			X		X		
Border-Pair-Year FE							X
Observations	11,373	11,373	11,332	11,373	15,784	15,880	15,880
R^2	0.156	0.773	0.890	0.941	0.897	0.949	0.986

Standard errors clustered by county and DMA-year in top panel; county and DMA border-year in bottom.
*p<0.05; **p<0.01

Table A7: Effects of Aggregate Television Advertising in Last Two Months of House Elections (2000-2018)

	Dependent variable: Dem. Vote Share						
	All counties				*Border counties*		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dem. Ad. Adv. (100 ads)	0.534**	0.325**	0.069**	0.088**	0.069**	0.078**	0.084**
	(0.050)	(0.033)	(0.017)	(0.019)	(0.014)	(0.024)	(0.022)
Year FE	X	X					
CD-year FE			X	X	X	X	
County FE		X		X		X	X
Lagged Outcome			X		X		
Border-Pair-Year FE							X
Observations	28,642	28,642	24,004	28,642	31,719	38,138	38,138
R^2	0.061	0.690	0.963	0.953	0.963	0.962	0.991

Standard errors clustered by county and DMA-year in top panel; county and DMA border-year in bottom.
*p<0.05; **p<0.01

Table A8: Effects of Aggregate Television Advertising in Last Two Months of Attorney General Elections (2006-2018)

	Dependent variable: Dem. Vote Share						
	All counties				*Border counties*		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dem. Ad. Adv. (100 ads)	0.992**	0.612**	0.208**	0.260**	0.193**	0.230**	0.192**
	(0.181)	(0.127)	(0.049)	(0.046)	(0.035)	(0.032)	(0.031)
Year FE	X	X					
State-year FE			X	X	X	X	
County FE		X		X		X	X
Lagged Outcome			X		X		
Border-Pair-Year FE							X
Observations	7,984	7,984	7,453	7,984	10,848	11,557	11,557
R^2	0.123	0.758	0.925	0.967	0.928	0.971	0.991

Standard errors clustered by county and DMA-year in top panel; county and DMA border-year in bottom.
*p<0.05; **p<0.01

Table A9: Effects of Aggregate Television Advertising in Last Two Months of Treasurer Elections (2006-2018)

	Dependent variable: Dem. Vote Share						
	All counties				*Border counties*		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dem. Ad. Adv. (100 ads)	1.772**	1.415**	0.366**	0.337**	0.391**	0.421**	0.352**
	(0.346)	(0.315)	(0.113)	(0.087)	(0.081)	(0.058)	(0.056)
Year FE	X	X					
State-year FE			X	X	X	X	
County FE		X		X		X	X
Lagged Outcome			X		X		
Border-Pair-Year FE							X
Observations	5,331	5,331	4,601	5,331	6,478	7,520	7,520
R^2	0.124	0.695	0.912	0.971	0.922	0.975	0.993

Standard errors clustered by county and DMA-year in top panel; county and DMA border-year in bottom.
*p<0.05; **p<0.01

E Marginal Returns to Advertising

In this appendix, we examine more closely the degree to which advertising has diminishing marginal effects. We use three different analyses to probe different elements of diminishing returns.

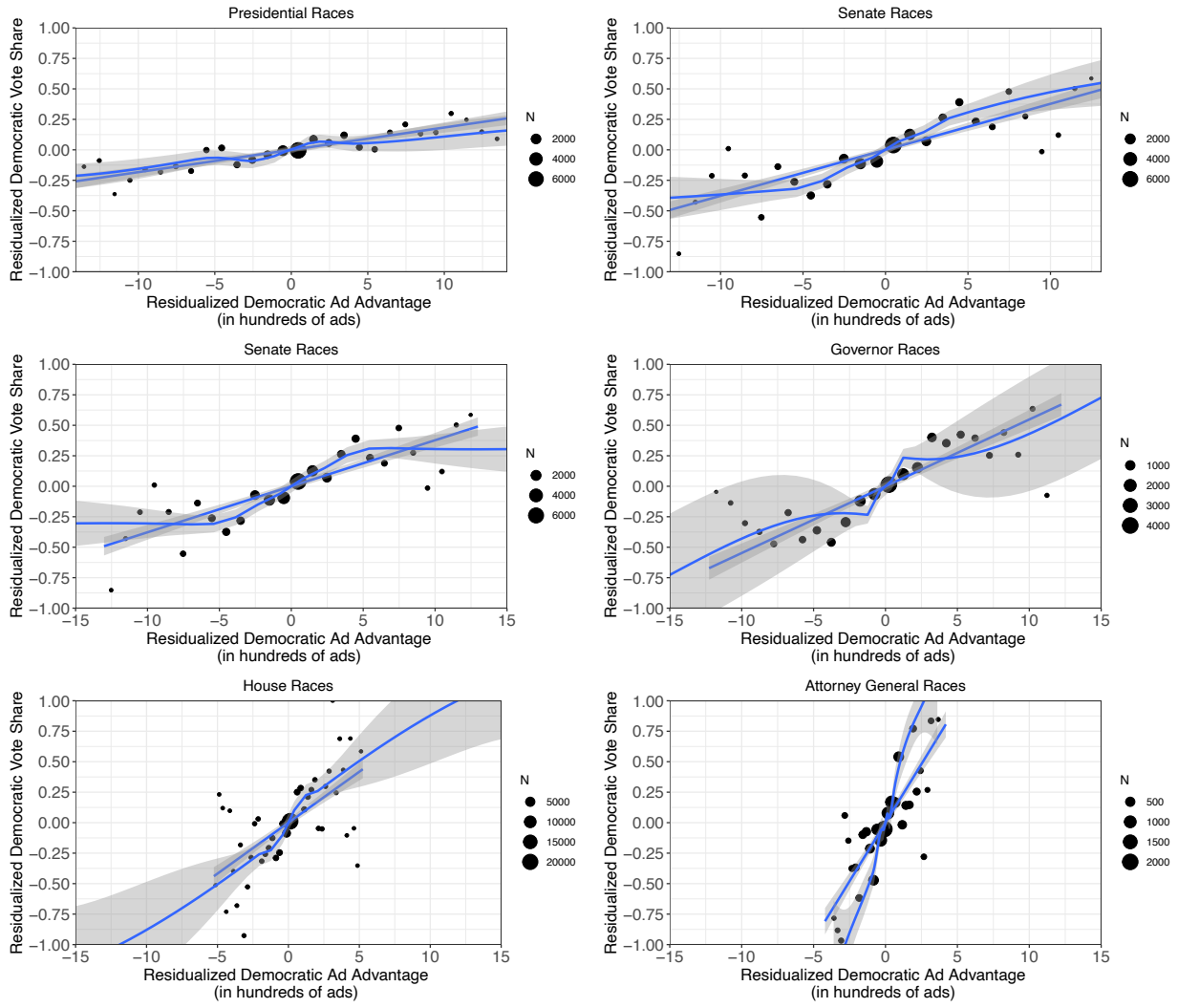
One way to conceptualize diminishing returns is based on the scale of one candidates' advertising advantage in a particular race. Figure 3 in the main body of the paper provided an initial visual evaluation of returns to scale for advertising advantage. It indicated that there is little apparent evidence of diminishing returns. For many types of offices, the relationship between advertising advantage and vote share is reasonably linear. Only at extreme levels of advertising advantage, where there are very few cases, do the points deviate much from the linear regression line. Moreover, a non-parametric loess curve is generally close to the linear regression line for each type of office for levels of advertising advantage within about two standard deviations of the mean (see Figure A2 below). This suggests that advertising has approximately constant returns to scale across the range of plausible variation in advertising advantage for either party.

Another way to conceptualize diminishing returns is based on the volume of each candidate's advertising in a race. To assess this, Table A10 disaggregates the advertising advantage measure and examines the effects of Democratic advertising and Republican advertising separately. We allow for non-linearity by including both linear and quadratic terms for each party's advertising. The quadratic terms should capture any decreasing (or increasing) returns to scale. Overall, we find that the quadratic terms are sometimes statistically significant and in the expected direction, but are nearly always very small in size.

Figure A3 provides a graphical illustration of the results from these regression out to the 99th percentile of observed advertising for each office. In general, each party's ads have their expected effect: increasing the vote share for that party.[2] More importantly, that

2. The apparent null effect of Republican advertising in presidential elections (top left-hand panel) is in part due to the 2016 election, in which Donald Trump's advertising had little relationship to the outcome (Sides, Tesler, and Vavreck 2018). In the 2000-2012 elections, the relationship between Republican

Figure A2: Effect of Democratic Advertising Advantage on Democratic Vote Share. These graphs show the implied effects of a ±3 standard deviation shift in Democratic ad advantage for each office. They are based on the residuals from the border counties models in Table 4.



effect is approximately linear. Only at very high levels of advertising do there appear to be diminishing returns. But even at these high levels, vote share is almost always increasing at the margins, suggesting that candidates are still getting something for their dollar. Moreover, these high levels of advertising rarely translate into an advertising advantage for either candidate because the two sides typically match each other's advertising. Given that advertising advantage also has a largely linear relationship with vote share (Figure 3), there is little reason for candidates to cease advertising, especially if their opponent continues to

advertising and Democratic vote share is negative and statistically significant.

Table A10: Models Including Separate Measures of Each Party's Advertising (all counties)

	Dependent variable: Dem. Vote Share					
	President	Senate	Governor	House	Attorney Gen.	Treasurer
	(1)	(2)	(3)	(4)	(5)	(6)
All Counties						
Democrats	0.040*	0.094**	0.190**	0.163**	0.283**	0.495
	(0.016)	(0.015)	(0.028)	(0.028)	(0.083)	(0.308)
Republicans	0.003	−0.073**	−0.067**	−0.160**	−0.246**	−0.349
	(0.024)	(0.020)	(0.024)	(0.030)	(0.077)	(0.273)
Democrats squared	−0.0001	−0.0003**	−0.001*	−0.001**	0.002	−0.041
	(0.0001)	(0.0001)	(0.0004)	(0.0003)	(0.003)	(0.034)
Republicans squared	−0.0001	0.0003*	0.0004	0.002**	0.002	−0.013
	(0.0002)	(0.0001)	(0.0002)	(0.0005)	(0.002)	(0.017)
Observations	12,652	17,133	11,373	28,642	7,984	5,331
R^2	0.962	0.960	0.942	0.953	0.967	0.971
Border Counties						
Democrats	0.016	0.060**	0.124**	0.140**	0.167**	0.605**
	(0.009)	(0.011)	(0.021)	(0.032)	(0.064)	(0.198)
Republicans	0.030*	−0.079**	−0.090**	−0.176**	−0.242**	−0.343*
	(0.014)	(0.016)	(0.020)	(0.032)	(0.056)	(0.158)
Democrats squared	0.00002	−0.0002**	−0.001**	−0.001**	0.001	−0.033
	(0.0001)	(0.00005)	(0.0003)	(0.0002)	(0.003)	(0.023)
Republicans squared	−0.0003*	0.0003*	0.001**	0.002**	0.002	−0.0003
	(0.0001)	(0.0001)	(0.0002)	(0.0005)	(0.002)	(0.011)
Observations	17,689	23,910	15,880	38,142	11,557	7,520
R^2	0.993	0.990	0.986	0.991	0.991	0.993

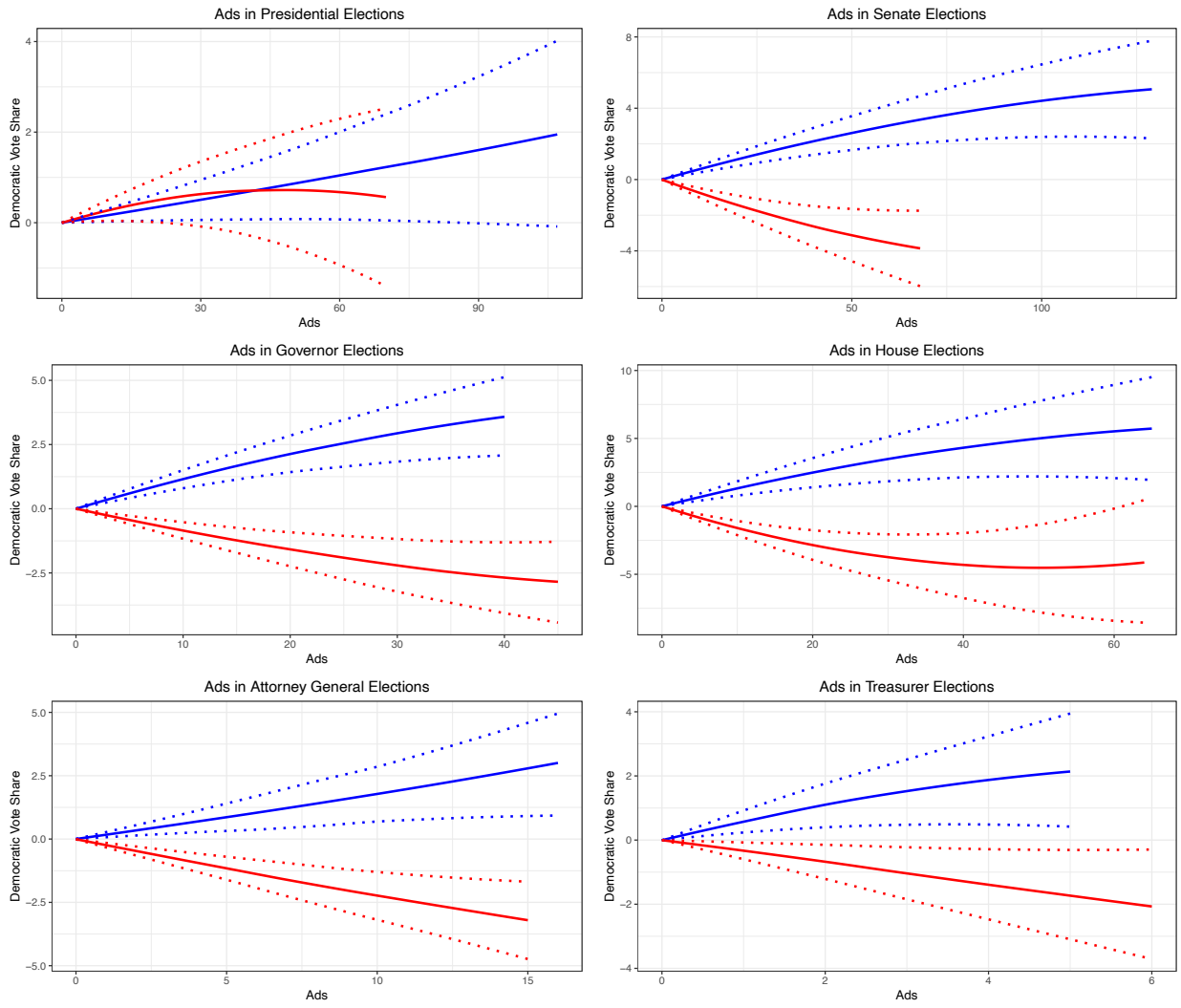
Standard errors clustered by county and DMA-year in top panel; county and DMA border-year in bottom.
*p<0.05; **p<0.01

stay on the air.[3]

A third way to conceptualize diminishing returns is based on the total volume of ads. To assess this, the models using our border-counties design in Table A11 interact the Democratic advertising advantage with a standardized measure of the total number of ads across all races

3. Our results for presidential races are similar to those of Spenkuch and Toniatti (2018, Appendix C), who also show that ads have approximately linear effects.

Figure A3: Effect of Democratic and Republican Advertising on Democratic Vote Share. These graphs show the implied effects of each party's spending from 0 to the 99th percentile of the within-county variation in observed ads (in hundreds of ads) for each office (Democrats in blue and Republicans in red). They are based on the border counties models in Table A9.



in a county. These regressions show tentative, modest evidence of diminishing returns for ads for some offices. For instance, in the border design, the apparent effect of ads in Senate races is about 10% higher when the volume of advertising is one standard deviation ads below the mean. But there is little evidence of diminishing effects due to airwave saturation for other offices (e.g., governor races). Moreover, ads continue to have positive marginal effects out to very high advertising levels for all offices.

Table A11: Diminishing Returns

	Dependent variable:					
	Dem. Vote Share					
	President	Senate	Governor	House	Attorney Gen.	Treasurer
	(1)	(2)	(3)	(4)	(5)	(6)
Dem. Ad. Adv. (100 ads)	0.017**	0.056**	0.058**	0.098**	0.286**	0.470**
	(0.006)	(0.010)	(0.013)	(0.019)	(0.054)	(0.119)
Std(Total Ads (100 ads))	0.135	−0.076	−0.035	0.128	0.026	0.056
	(0.110)	(0.115)	(0.130)	(0.102)	(0.214)	(0.207)
Dem. Ad. Adv. x Std(Total Ads)	−0.001	−0.006**	−0.002	−0.012	−0.073**	0.002
	(0.003)	(0.002)	(0.004)	(0.014)	(0.024)	(0.048)
Observations	17,689	23,910	15,880	37,933	10,848	6,478
R^2	0.993	0.990	0.986	0.991	0.978	0.984

Note: *p<0.05; **p<0.01

F Does Accounting for Partisan Turnout Affect the Main Results?

This appendix examines whether our main results are attenuated when we control for the Democratic turnout advantage. This would indicate that differential turnout could be an important mechanism underlying the relationship between advertising and election outcomes. Overall, the effect of advertising is virtually identical in a model that does not control for turnout (column 1) as in a model where we do (column 2).[4] This implies that partisan turnout is unlikely to be the main mechanism of our findings.

Table A12: Effect of Ads on Presidential Results After Controlling for Differential Turnout

	Dependent variable:	
	Dem. Vote Share	
	(1)	(2)
Dem. Ad. Adv. (100 ads)	0.017**	0.016**
	(0.005)	(0.005)
Dem. Turnout Adv.		0.102**
		(0.015)
Years	2008-16	2008-16
Observations	12,938	12,938
R^2	0.994	0.994
Note:	*p<0.05; **p<0.01; ***p<[0.***]	

4. Note the results here slightly vary from those in the main paper because they only include counties and elections where we have data on partisan turnout from 2008-2018.

G Decay of Ad Effects

To estimate the potential decay of advertising effects, we estimate a model that divided the advertising advantage variable into three time periods: 1) ads aired between 0 and 36 days from election day ("October/November"), 2) ads aired between 37 and 69 days from election day ("September"), and 3) ads aired between 70 and 129 days before election day ("July-August"). To reduce the noise in the estimates, we combine different levels of office, in this case presidential, governor, and Senate. This allows us to more precisely estimate the effects of the ads that air closest to Election Day, which some research has found are most important, at least in presidential elections. It also allows us to determine whether there is a decline in the effect of ads as they are aired earlier and earlier, stretching back into the summer before the general election.

Table A13: Decay of Advertising Effects. This table shows the effects of advertising aired at different points during the campaign season, combining presidential, Senate, and gubernatorial elections.

	Dependent variable:	
	Dem Vote Share	
	All Counties	Border Counties
	(1)	(2)
October/November	0.061**	0.038**
	(0.014)	(0.007)
September	0.039	0.033**
	(0.022)	(0.011)
July/August	0.018	0.010
	(0.014)	(0.008)
County FE	X	X
State-Year-Office FE	X	
Border-Pair-Year-Office FE		X
Observations	41,199	57,543
R^2	0.947	0.987

Standard errors clustered by county & DMA-year-office in left panel; county & DMA border-office-year in right panel.

Note: *p<0.05; **p<0.01

As Table A13 shows, ads aired in October and November have the largest effect on election outcomes, although ads aired in September also matter. By contrast, advertising before Labor Day does not appear to affect election outcomes. These results confirm previous studies showing that advertising effects decay, although our results do not necessarily show the rapid decay evident in several studies (e.g., Gerber et al. 2011; Hill et al. 2013; Kalla and Broockman 2018; Sides and Vavreck 2013). However, it may require more sensitive data, especially surveys conducted consistently over the days and weeks before elections, to more clearly identify the exact pattern of decay. For example, our data do not give us effective purchase on the effects of advertising within October and November. That said, we can confirm the finding that ads closer to Election Day are more strongly related to election outcomes than earlier ads.

H Are Advertising Effects Different in Midterm Elections?

In this appendix, we examine whether advertising effects are different in midterm elections (Table A14). Overall, we find no clear evidence of differences between advertising effects in midterm and presidential election years.

Table A14: Are Advertising Effects Different in Midterm Elections?

	Dependent variable:		
	Dem. Vote Share		
	Senate	Governor	House
	(1)	(2)	(3)
All Counties			
Dem. Ad. Adv. (100 ads)	0.034**	0.139**	0.100**
	(0.011)	(0.032)	(0.027)
Ad Adv x Midterm	0.041*	−0.064	−0.019
	(0.016)	(0.036)	(0.029)
Observations	17,133	11,373	28,642
R^2	0.960	0.941	0.953
Border Counties			
Dem. Ad. Adv. (100 ads)	0.032**	0.102**	0.105**
	(0.008)	(0.026)	(0.033)
Ad Adv x Midterm	0.011	−0.056*	−0.032
	(0.013)	(0.028)	(0.032)
Observations	23,910	15,880	38,142
R^2	0.990	0.986	0.991
Note:	*p<0.05; **p<0.01; ***p<[0.***]		

I Have Ad Effects Declined in Recent Years?

In this appendix, we examine whether ad effects have declined in recent years. To do so, we replicate our analysis in Table 3 but allow the effects of advertising to vary across two time periods: 2000-2008 and 2010-2018. To be sure, this is a simple periodization, but given that we do not have a long time-series of election years, it provides at least some purchase on whether the effects are smaller in more recent elections.

Table A15: Time Trends in Effects of Aggregate Television Advertising

	Dependent variable: Dem. Vote Share			
	President	Senate	Governor	House
	(1)	(2)	(3)	(4)
All Counties				
Dem. Ad. Adv. (100 ads) (2000-2008)	0.022*	−0.007	0.046	0.107**
	(0.011)	(0.027)	(0.034)	(0.034)
Dem. Ad. Adv. (100 ads) (2009-2018)	0.029**	0.063**	0.095**	0.083**
	(0.009)	(0.010)	(0.015)	(0.020)
County FE	X	X	X	X
State-Year FE	X	X	X	X
Observations	12,652	17,133	11,373	28,653
R^2	0.962	0.960	0.941	0.953
Border Counties				
Dem. Ad. Adv. (100 ads) (2000-2008)	0.021**	0.003	0.119**	0.045
	(0.007)	(0.021)	(0.030)	(0.036)
Dem. Ad. Adv. (100 ads) (2009-2018)	0.017**	0.041**	0.047**	0.093**
	(0.006)	(0.008)	(0.010)	(0.025)
County FE	X	X	X	X
Border-Pair-Year FE	X	X	X	X
Observations	17,689	23,910	15,880	38,138
R^2	0.993	0.990	0.986	0.991

Standard errors clustered by county and DMA-year in top panel, and county and DMA border-year in bottom panel.
*p<0.05; **p<0.01

However, we find no consistent evidence of any decrease in advertising effects (Table A15). In fact, in many cases—depending on the level of office and the modeling strategy—the effects are larger in 2010-2018 than in 2000-2008. Televised advertising appears to remain an effective strategy for winning votes.

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