Ballot design, voter intentions, and representation: A study of the 2018 midterm election in Florida[1]

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Abstract

Confusing ballots muddle the connection between voter intentions and votes, diminishing the ability of elections to facilitate representation in political institutions. This motivates our examination of the 2018 midterm election in Florida, where the ballot used in Broward County yielded an abnormally high number of undervotes in Florida's United States Senate race. We offer cross-sectional and temporal analyses that eliminate explanations for Broward's Senate undervote that do not turn on ballot design. Respectively, these analyses compare Broward County and its precincts to other counties and their precincts and compare elections in 2016 with those in 2018. Our purview also extends beyond Florida to states that had Senate and gubernatorial elections in 2018. We generate counterfactual estimates of Senate vote totals had Broward County used a conventional ballot in 2018, and our counterfactual results lie in statistical purgatory. They show neither that the Broward County ballot was pivotal to the Senate election outcome nor rule out this possibility.

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Introduction

Regular and fair elections are key features of modern democracy (Katz 1997), and for an election to be fair, its vote tallies must reflect the intentions of eligible participants (Grofman and Lijphart 1986). A voter who intends to support a particular candidate in an election, but whose vote is not counted for that candidate due to an administrative failure, cannot be said to have been treated fairly. Moreover, if the intentions of a sufficiently large number of voters are not reflected in an election's vote tabulations, the election can return an outcome contrary to what voters *writ large* wanted, diminishing the extent to which the election provides representation.

This concern is not merely hypothetical. In the 2000 general election, the Palm Beach County, Florida, "butterfly ballot" cost Democratic presidential candidate Al Gore the presidency (Wand et al. 2001). Similarly, a confusing two-page presidential ballot in Florida's Duval County produced a 50-fold increase in presidential *overvotes* (votes cast for more than one presidential candidate) in the 2000 election. In Florida's 13th Congressional District in 2006, a ballot layout on Sarasota County's electronic voting machines lead supporters of Democratic candidate Christine Jennings to ignore her race entirely, costing her a seat in the United States House of Representatives (Frisina et al. 2008). Beyond Florida, ballot structure has impacted North Carolina statewide elections (Hamilton and Ladd 1996), the rates at which voters cast votes for unintended candidates (Herrnson, Hanmer and Niemi 2012), and minor candidate vote shares (Ho and Imai 2006).

Here we show that a confusing ballot in Broward County, Florida, led to an unusually high number of *undervotes* in Florida's 2018 United States Senate election, diminishing the ability of that county's voters to act on their intentions in what turned out to be the closest United States Senate race in the 2018 midterm election. This race was contested by now-Senator Rick Scott (Republican) and then-incumbent Bill Nelson (Democrat), the

former of whom won by 10,033 votes out of 8,305,929 ballots cast, and for some perspective we note that Broward County contributed approximately 8.8 percent of Florida voters in the 2018 midterm election but over 30 percent of the state's Senate undervotes.

In what follows we describe literature on ballot formats and the extent to which ballot design can confound the ability of voters to express themselves in elections. Then, after offering a backdrop to the 2018 United States Senate race in Florida, we present statistical analyses that highlight the extensive Senate undervote in Broward County. As part of this exercise, we offer a set of cross-sectional and temporal analyses of Broward County and other Florida counties, in both 2016 and 2018, that rule out explanations for Broward's Senate undervote other than a confusing ballot design. These analyses constitute a forensics exercise in the sense of Mebane (2004). Lastly, leveraging voting patterns in Florida precincts beyond Broward County, we counterfactually estimate the consequences of the Broward ballot for the outcome of the Scott-Nelson Senate race. Our final section concludes with final thoughts about representation and equal protection.

Ballot formats and representation

Elections map voter intentions into representation in political institutions (McDonald and Budge 2005). Ballots are the medium used by voters to express intentions, and there is considerable variance across United States in ballot design practices (Niemi and Herrnson 2003; Kropf 2014). Confusing ballots attenuate the connection between elections and representation and can result not only in the unequal treatment of voters but also the election of candidates who might otherwise have lost at the ballot box.

Well before "hanging chads" entered the American vernacular thanks to Florida's meltdown in the 2000 presidential election (Posner 2001; Hasen 2012), researchers had long probed the causes and consequences of votes cast that do not contribute toward final tal-

lies of contested races. These *residual votes* (Ansolabehere and Stewart III 2005; Alvarez, Beckett and Stewart III 2013) are comprised of undervotes (votes that do not count because of abstention or improper voting) and overvotes (votes that do not count because a voter cast multiple votes in a race that allows only one). Residual votes are commonplace in nearly all elections, even top-of-the-ticket contests, although nationally residual vote rates have steadily declined over the past three decades (Stewart III 2014). Election outcomes occasionally hang in the balance due to residual votes, as was the case in the 2000 presidential election in Florida, the 2004 Washington gubernatorial race (Avila 2005), and the 2008 United States Senate race in Minnesota (Foley 2011).

As to the myriad causes of undervotes (Menger, Stein and Vonnahme 2018), one explanation focuses on down-ballot rolloff where a voter is said to roll-off on a given race on a ballot if she stops voting from that point onward (Magleby 1984; Mueller 1969; Feig 2007; Bonneau and Loepp 2014; Garlick 2015). Research on rolloff has drawn attention to ballot complexity (Reilly and Richey 2011), ballot length (Walker 1966; Matson and Fine 2006; Meredith and Salant 2013; Augenblick and Nicholson 2015), the availability of like-race candidates (Herron and Sekhon 2005; Herron 2013), and candidate visibility/salience (Bullock, III and Dunn 1996; Streb and Frederick 2011).

In contrast to studies concluding that undervoting is largely a function of choice, Carman, Mitchell and Johns's (2008) study of the 2007 Scottish parliamentary elections considers the role of technology in undervoting. Research in this vein has shown that higher roll-off rates occur with lever machines than paper ballots (Mather 1964), on the back sides of two-sided optical scan ballots (Darcy and Schneider 1989), on punch cards or optical scan ballots more than electronic voting machines (Tomz and Houweling 2003; Sinclair and Alvarez 2004), on poorly designed ballots (Kimball and Kropf 2005), and on mailed ballots as opposed to ballots cast in person Alvarez, Beckett and Stewart III (2013) (but see Hanmer and Traugott (2004) for a contrary finding). Moreover, the effects of technology

on roll-off are usually exacerbated in among minority and poorer populations.

Finally, and consistent with the aforementioned butterfly ballot (Wand et al. 2001; Lausen 2008; Norden and Kimball 2012), scholars have considered the extent to which ballot simplicity affects residual vote rates. In an experiment manipulating colors and symbols, Reynolds and Steenbergen (2006) find that ballot design can affect the salience of ethnic identities. And, Norden and Kimball's (2012) study of Ohio counties in the 2008 presidential election finds that paper ballots listing candidates for the same office across more than one column or page had higher residual votes. Despite accumulated examples of ballot effects, Kropf (2014) notes that many states devote little attention to ballot design.

We are interested in one type of residual vote, the undervote, in the 2018 United States Senate race in Florida. Except for a minuscule fraction of voters who utilize Americans with Disability Act accommodations, Floridians across the state's 67 counties cast ballots with optical scan technology, regardless of whether voting by mail, early in-person, or on election day. Our analysis thus holds constant voting technology.[1] Although tabulating technology is constant across Florida, the physical layout of ballot designs varies across counties. This provides us with a natural experiment on the role of ballot design on undervote rates.

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[1]Details on Florida's vote tabulating machines is at `https://dos.myflorida.com/media/695246/voting-systems-in-use-by-county.pdf` (last accessed March 8, 2019). The Florida Department of State reports 83 votes cast statewide on electronic voting machines in 2018. See p. 5 of "Analysis and Report of Overvotes and Undervotes in the 2018 General Election," available at `https://dos.myflorida.com/media/700609/overvote_undervote_report_2018.pdf` (last accessed March 31, 2019).

Context and hypotheses

In November 2018, Florida's two-term Republican Governor, Rick Scott, challenged three-term Democratic incumbent United States Senator Bill Nelson. Despite narrow victories in previous gubernatorial elections, Scott was regarded as the most formidable Republican opponent that Nelson had faced since first winning a Senate seat in 2000. Polls varied throughout late 2018 yet most forecasted a close election.[2]

Beyond the United States Senate race, on the Broward County ballot in November 2018 were contests for Florida Governor/Lieutenant Governor and three cabinet offices, Attorney General, Chief Financial Officer, and Commissioner of Agriculture. We refer to these contests collectively as top statewide races. As shown in Figure 1, Broward County intersects four congressional districts. Florida's 22nd and the 23rd congressional districts featured competitive races with more than one non-write-in candidate. In the 20th, there was only one official non-write-in candidate, and the 24th Congressional District race did not appear on any Florida ballots, this district's incumbent being unopposed.

The 2018 midterm election took place on November 6, and after a mandatory machine recount Scott defeated Nelson by 10,033 votes (approximately 0.12 percent) out of 8,305,929 votes cast.[3] The Scott-Nelson race, whose margin was 4,099,505 to 4,089,472,

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[2]See https://www.realclearpolitics.com/epolls/2018/Senate/fl/florida_Senate_scott_vs_nelson-6246.html (last accessed March 7, 2019). For the October 26, 2018, Cook Political Report report on the 2018 Florida Senate race, see https://cookpolitical.com/ratings/Senate-race-ratings/187540 (last accessed March 11, 2019).

[3]This margin is based on certified vote totals from the statewide recount of the Scott-Nelson race, available at https://results.elections.myflorida.com/Index.asp?ElectionDate=11/6/2018 (last accessed March 4, 2019).

was one of 35 United States Senate contests in the 2018 midterm election, and in percentage terms this race was the closest Senate contest that year. Mississippi's race had a smaller vote margin (3,253), but percentage-wise this figure is greater than Florida's.[4]

Figure 1: Map of Broward and surrounding counties
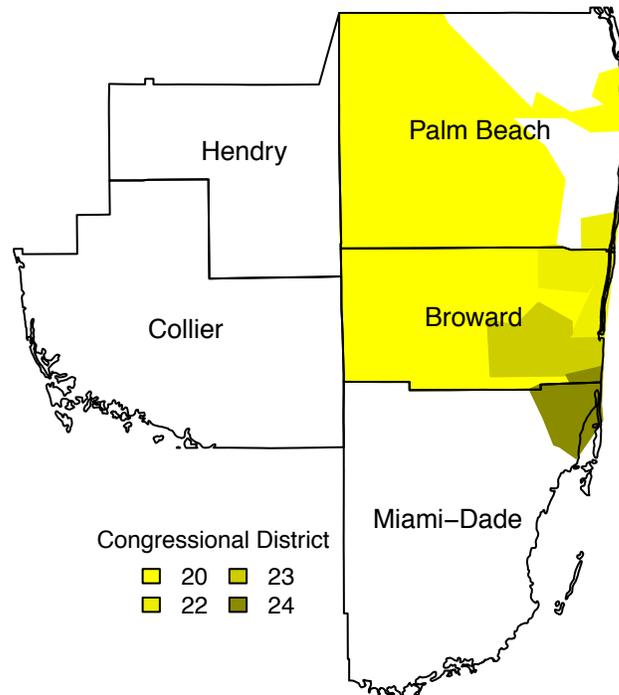
Figure 2 displays a version of the first page of a 2018 Broward County ballot from Congressional District 24. Instructions in English, Spanish, and Haitian Creole appear in the ballot's first column, and the Scott-Nelson contest lies under those instructions. There is ample white space beneath the Senate race, reflecting the fact that the ballot is from Florida's 24th Congressional District. Following federal races, the Florida Governor/Lieutenant Governor race appears at the top of the middle column of Broward

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[4]Statewide margins from 2018 Senate races are available from Dave Leip's Atlas of U.S. Presidential Elections. See `https://uselectionatlas.org` (last accessed March 4, 2019).

County's ballot followed by races for other top statewide officers.

Figure 2: Broward County ballot from Congressional District 24

Like Miami-Dade County, Broward is mandated by the amended Voting Rights Act to

print ballots in three languages (Newman 2006). The Broward ballot contradicts recommendations promulgated in 2007 by the U.S. Election Assistant Commission, that ballot instructions in multiple languages not be co-mingled with races in a single column.[5]

Figure 3a displays a 2018 Hendry County ballot, on which the United States Senate race is displayed at the top.[6] The Hendry ballot contains only two languages, as opposed to three, and features essentially no white space at all.

Finally, Figure 3b shows a version of the 2018 Miami-Dade ballot, which reflects a compromise between Broward and Hendry ballots.[7] Like the former, the Miami-Dade ballots displays the United States Senate race in its leftmost column, underneath voting instructions (that are not as long as Broward County's). Like the latter, the Miami-Dade ballot features multiple races in its leftmost column, both federal and state races. There is whitespace in the Miami-Dade ballot but in the right-most column only.

To the best of our knowledge, the location of the United States Senate race on the Broward County ballot was unique among Florida ballots insofar as this race was either the only race listed below instructions in the leftmost column of a first page (Congres-

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[5]See U.S. Election Assistance Commission, "Effective Designs for the Administration of Federal Elections," Section 3: Optical scan ballots, Washington, D.C. June 2007, page 3.39. "Vertical instruction treatments *cannot* share column space with contests–test voters often overlooked races located immediately beneath vertical instructions." See `https://www.eac.gov/assets/1/6/Optical_Scan_Ballots.pdf` (accessed March 7, 2019).

[6]The source of the Hendry County ballot is a March 8, 2019, email received from Brenda Hoots, Supervisor of Elections in Hendry County.

[7]Source of the Miami-Dade County ballot is "al karajo jr," who uploaded a picture of it to `https://www.slideshare.net/alkarajo/fl-election-sample-ballot-november-2018-miami-beach` (last accessed March 17, 2019).

Figure 3: Sample ballots from Hendry and Miami-Dade Counties

(a) Hendry County

(b) Miami-Dade County

sional District 24) or one of only two races (in Congressional Districts 20, 22, and 23). Both Hendry and Miami-Dade Counties used three-column ballot designs, but these counties placed multiple races below their instructions, to the extent that races were under instructions at all.

Our hypothesis is as follows: in Broward County, the isolation of federal races caused a disproportionate number of voters in the county to undervote in the Senate race. We expect this problem to be exaggerated in the 24th Congressional District. We further hypothesize that undervote rates in Florida's gubernatorial contest will be normal in Broward County given the placement of this race at the top of the second of three columns, adjacent to English language instructions.

Results

We present results in three sections. First, we provide evidence about undervoting in top statewide races in Florida in the 2018 midterm, highlighting an excessive undervote in the Broward County Senate race. Second, we consider potential confounding of this undervote. Third, we present estimates of counterfactual Scott-Nelson margins had the ballot format in Broward County not led to an excessive undervote there.

The Broward County undervote in the Senate race was extensive

Table 1 reports undervote rates across top statewide races contested in the 2018 midterm. The order of the races reflects Florida state law and was used on all ballots in 2018.[8]

As shown in Table 1, the Scott-Nelson United States Senate contest had an elevated undervote rate (approximately 1.1 percent) compared to the Florida governor contest that followed it (approximately 0.64 percent). The Senate undervote cannot be attributed to this

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[8] See 2018 Florida Statutes 101.151, "Specifications for ballots," available at `http://www.leg.state.fl.us/Statutes/index.cfm?App_mode=Display_Statute&Search_String=&URL=0100-0199/0101/Sections/0101.151.html` (last accessed March 16, 2019).

Table 1: Undervotes across Florida in the 2018 midterm election

Race	Undervotes	Undervote rate	Broward share
United States Senator	91,657	1.10	33.24
Governor	53,456	0.64	6.62
Attorney General	180,568	2.17	9.28
Chief Financial Officer	269,795	3.25	11.97
Commissioner of Agriculture	245,805	2.96	8.96

race being uncompetitive. In fact, three of five statewide races in Table 1—Senate, Governor, and Commissioner of Agriculture—went to automatic recounts after initial results had differences between candidates within a half-percentage point. The Senate race was ultimately decided by a margin of 0.12 percent and the Democratic candidate for Commissioner of Agriculture won by 0.08 percent. Republican Ron DeSantis defeated Democrat Andrew Gillum in the Florida gubernatorial race by a scant 0.40 percent. Of the two non-recount races in Table 1, Republican candidates won the Florida Attorney General and Chief Financial Officer contests by 6.0 and 3.48 percent, respectively.

The small changes in undervote rates across top statewide races in Table 1 mask the contribution of Broward County to these rates. The rightmost column of the table shows that the Broward share of the overall United States Senate undervote is approximately four times the share of the county's contribution to undervotes in other top statewide races. Broward County's 715,519 voters in 2018 constituted approximately 8.8 percent of Florida turnout yet approximately 33 percent of the statewide Senate undervote.

Precinct analysis of undervoting in top statewide races

Our hypothesis about ballot format operates below the state level and thus we disaggregate Table 1's results to the greatest extent possible. Figure 4 plots, for 4,881 Florida precincts,

Senate and governor undervote rates against each other.[9] Precincts are the smallest geographical units for which election returns are tabulated in Florida, and Figure 4, like all precinct-level figures in this paper, plots only those Florida precincts that had voter turnout in the 2018 midterm of at least five voters.

Figure 4 considers two undervote rates because a given undervote rate of interest—here, the Senate undervote rate—can only be assessed with respect to other rates. Literature on American elections does not specify what the correct rate of Senate race undervoting should be in the absence of a potentially confusing ballot. Thus, to evaluate our hypotheses about the Broward County ballot, we make comparisons of Broward County Senate undervote rates to undervote rates in other races.

In Figure 4, precincts in Broward County are colored black and non-Broward precincts, grey. All the precincts in the former lie above the figure's 45-degree line, showing that Broward precincts had greater Senate undervote rates than Florida governor undervote rates. Of the 577 Broward precincts in the figure, not a single one had a greater number of governor undervotes than Senate undervotes. Non-Broward precincts in Florida, however, do not follow this pattern, as the cluster of grey points are dispersed both above and below Figure 4's 45-degree line.[10]

The inset in Figure 4 depicts the relationship between undervote rates in the attorney general and gubernatorial races, and this relationship serves as a placebo test of our hypothesis that ballot position was responsible for the excessive Senate undervote in Broward

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[9]Precinct data for the 2018 midterm were downloaded from https://dos.myflorida.com/elections/data-statistics/elections-data/precinct-level-election-results (last accessed January 22, 2019). One precinct is covered by the inset in Figure 4.

[10]We drop split precincts in precinct plots and calculations that do not disaggregate by congressional district.

Figure 4: Undervote rates across Florida precincts
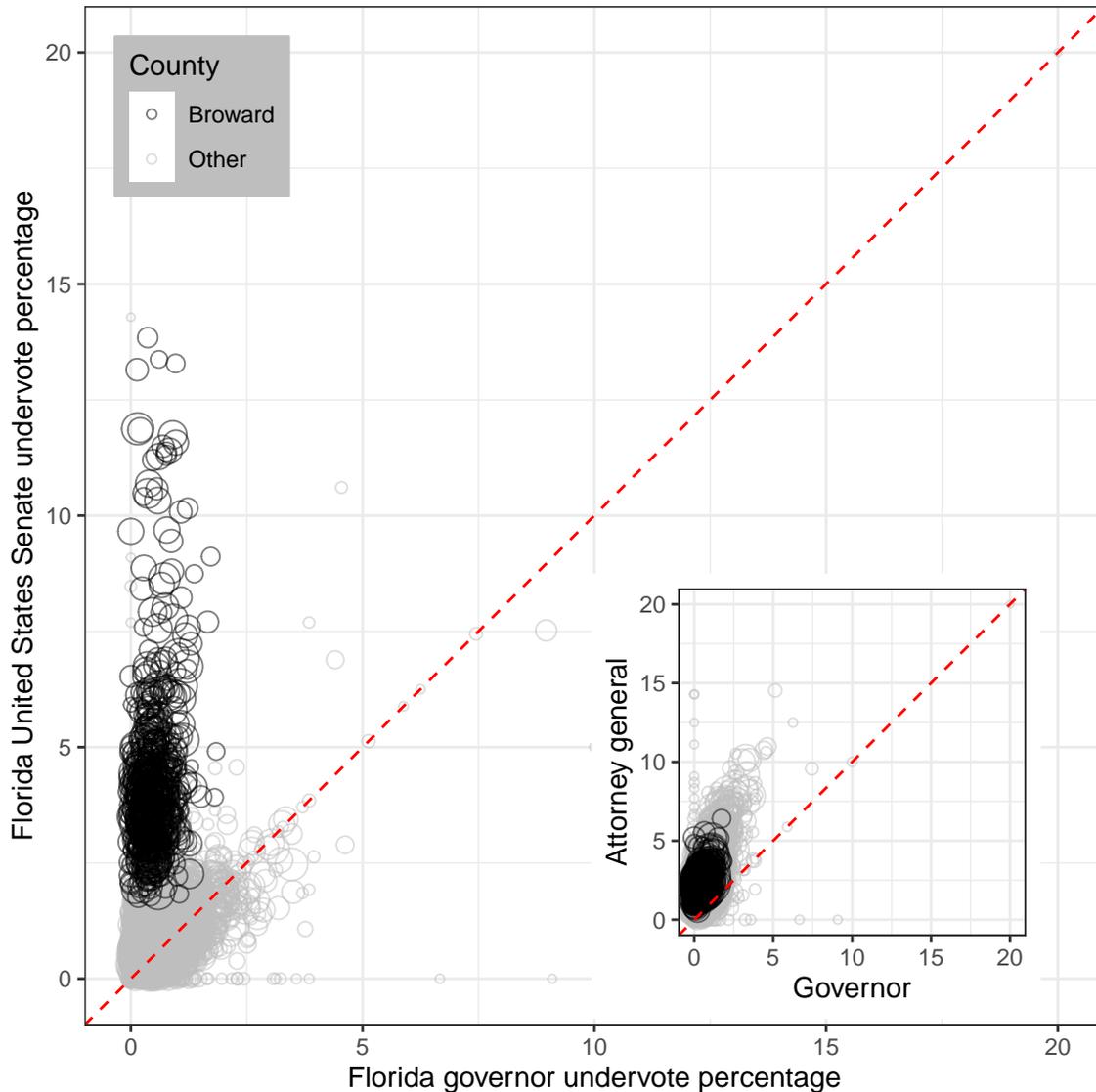
Note: each circle represents one Florida precinct with sizes proportional to 2018 turnout.

County. The inset shows that undervotes for attorney general in Broward County precincts are similar to those in the rest of the state, as the black circles (representing Broward precincts) are contained within the mass of grey circles (precincts from the rest of Florida). Statewide, there were approximately 3.4 times as many undervotes for attorney general as

for governor (180,568 to 53,456), while in Broward the ratio was *lower* (2.9, or 16,993 to 5,943). This pattern hold for the other top statewide contests listed in Table 1 (plots available from the authors), and from this it follows that Broward voters do not have a general proclivity to undervote in statewide contests.

Congressional Districts in Broward County

Our hypothesis about Broward County turns on the isolated location of the United States Senate race on the county's ballot, and our discussion of the map in Figure 1 noted that Broward County intersects four congressional districts. If the isolation of the Senate race under the column of voting instructions was responsible for the undervotes in this race, we should see a disproportionately greater share of undervotes in Congressional District 24.

Such a pattern appears in Figure 5, which compares Broward County precinct-level undervote rates in the United States Senate race with undervote rates in the governor race. We already have seen that the Senate undervote rate is higher throughout Broward County relative to the rest of the state, but Figure 5 adds nuance to this result. Namely, Senate undervote rates in Broward County were sometimes twice as high in precincts that are part of Congressional District 24. In contrast, the inset in Figure 5 shows that attorney general undervotes rates in precincts in Congressional District 24 are similar to those in the other congressional districts in Broward County.

Modeling Senate and governor undervote rates

We now present a more formal argument that Broward County Senate undervote rates are distinct from attorney general undervote rates. Consider the following linear regression:

Figure 5: Undervote rates in Broward County precincts and Congressional District 24
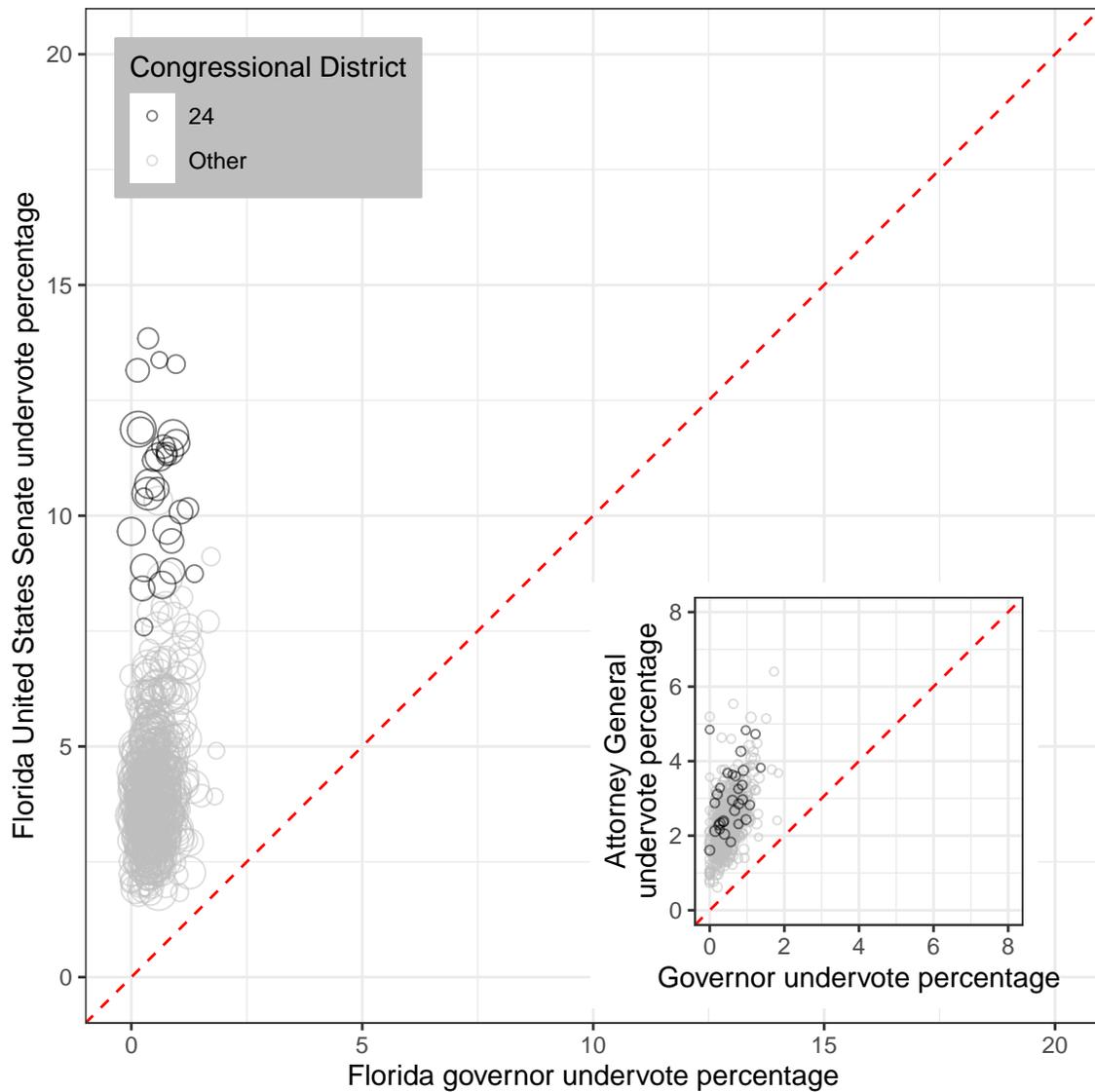
Note: each circle represents one precinct with sizes proportional to 2018 turnout.

$$\text{UndervoteSenate}_i = \beta_0 + \beta_1\,\text{UndervoteGovernor}_i +$$
$$\beta_2 + \beta_1\,\text{Female}_i + \beta_3\,\text{Democratic}_i + \beta_4\,\text{Republican}_i +$$
$$\beta_5\,\text{Black}_i + \beta_6\,\text{Hispanic}_i + \beta_7\,\text{White}_i + \qquad (1)$$
$$\beta_8\,\text{AgeYoung}_i + \beta_9\,\text{AgeMedium}_i + \beta_{10}\,\text{AgeOlder}_i +$$
$$\gamma_{\text{County–CD}(i)} + \epsilon_i$$

where, for precinct i, UndervoteSenate_i is the 2018 Senate undervote rate, $\text{UndervoteGovernor}_i$ is the 2018 Florida governor undervote rate, and demographics are defined with respect to 2018 voter pools.[11] For example, Female_i denotes the fraction of the 2018 voter pool in precinct i that was female. In terms of age variables, AgeYoung includes voters between 18 and 29, AgeMedium between 30 and 44, and AgeOlder includes voters between 45 and 66. The two partisan affiliation variables in Equation (1) refer to fractions of voters registered with the two major parties, the residual category being registrants with minor parties or with "No Party Affiliation."

The estimates of the various β parameters in Equation (1) are not of particular interest. Rather, what is of interest are the γ fixed effects, one per each county/congressional district intersection, of which there are four in Broward County. These fixed effects reflect Senate undervote rates not explained by precinct demographics or contemporaneous governor undervote rates.

We estimate Equation (1) (weighted by 2018 turnout) and then a second version of

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[11]We calculated demographics of registered voters who cast ballots in Florida's 67 counties in 2018 using the January 2019 statewide voter file. For a similar exercise, see Herron and Smith (2014). Voter registration information in Florida is maintained by the state's Division of Elections.

this equation, this time using a precinct's attorney general undervote rate as the dependent variable. Thus, for each county/congressional district intersection in Florida, we have two fixed effects, one from a Senate undervote regression and one from am attorney general regression. The fixed effects are plotted against each other in Figure 6.

Figure 6: Senate and attorney general fixed effects
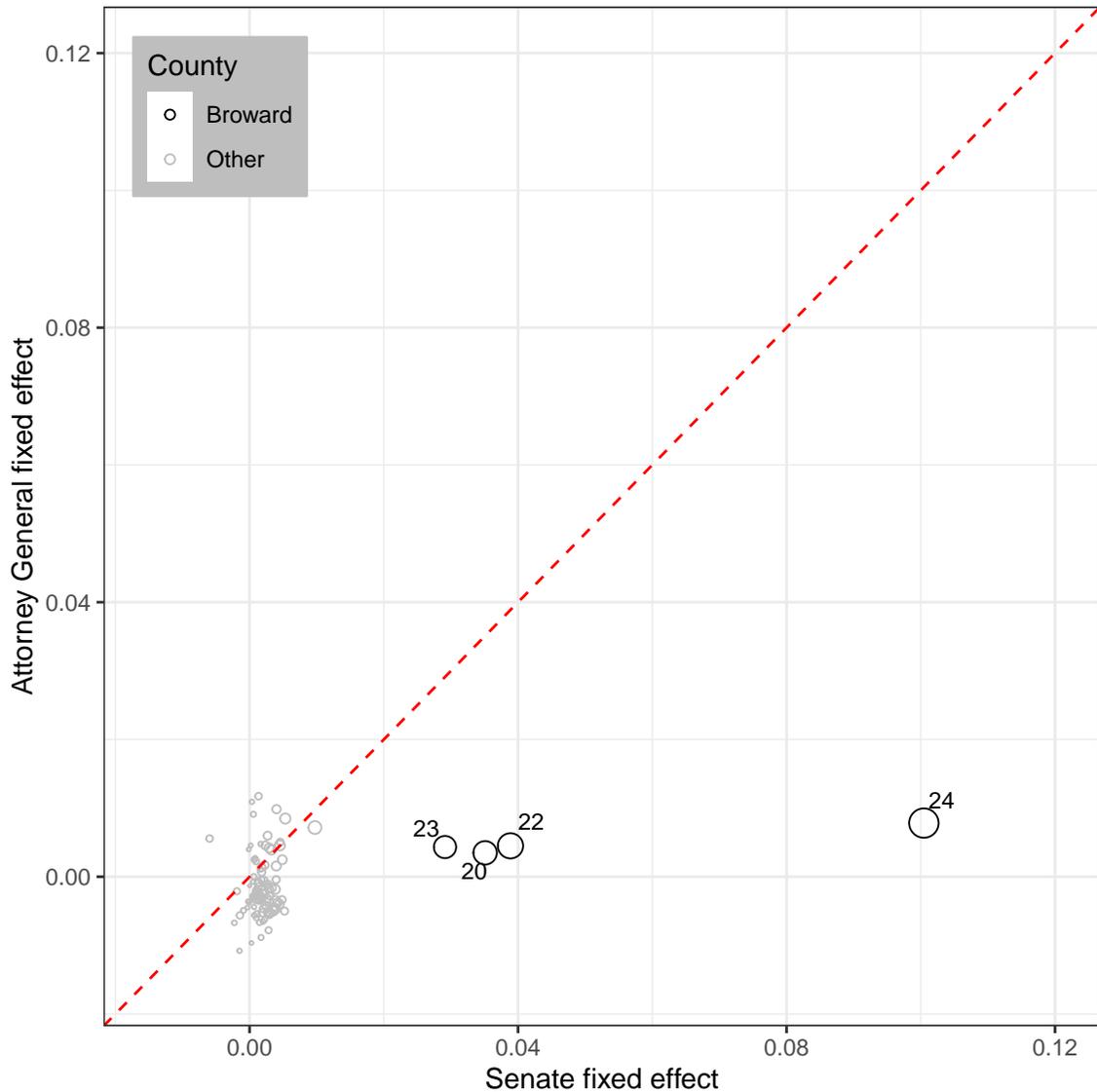
Note: each circle represents one county/congressional district intersection, and circles are weighted by magnitude of Senate race t-statistic.

Figure 6 highlights several results. First, outside of Broward County, fixed effects are clustered around the figure's 45 degree line. This means that, beyond Broward, the processes driving precinct-level Senate and attorney general undervoting were similar, conditional on precinct demographics and governor undervoting rates. Second, fixed effects outside of Broward were statistically not large in the Senate race. This is evident in the fact that the sizes of the grey circles in Figure 6 are relatively small. Third, neither of these conclusions holds with respect to the four Broward circles in the figure, all of which are large statistically and far from the figure's 45-degree line. Even controlling for voter demographics and governor undervoting, the part of Broward County in Congressional District 24 had an extremely high Senate undervote rate, and in fact all four areas in Broward had elevated Senate undervote rates holding fixed voter demographics and governor undervote rates.

Alternative explanations

The 2018 United States Senate undervote in Broward County was elevated and the part of Broward with the greatest undervote was Congressional District 24. These conclusions, which are consistent with our hypothesis, hold conditional on voter demographics. Consistency does not imply causality, however, and it is also possible that our analysis is risking selecting on the dependent variable, i.e., that Broward in 2018 was unusual regarding its Senate undervote rate but that every election cycle in Florida features a county with an excessive undervote rate. To address these possibilities, we now consider three alternative explanations for our findings, none of which have anything to do with ballot formats.

Do Broward County voters eschew United States Senate contests?

Our first alternative explanation for the 2018 Broward Senate undervote is the possibility that voters in this county have a proclivity for undervoting in Senate contests. Any analysis of undervoting in Florida in 2018 would be remiss in not considering this possibility.

Figure 7: Undervote rates in Florida counties, 2016 and 2018 United State Senate races
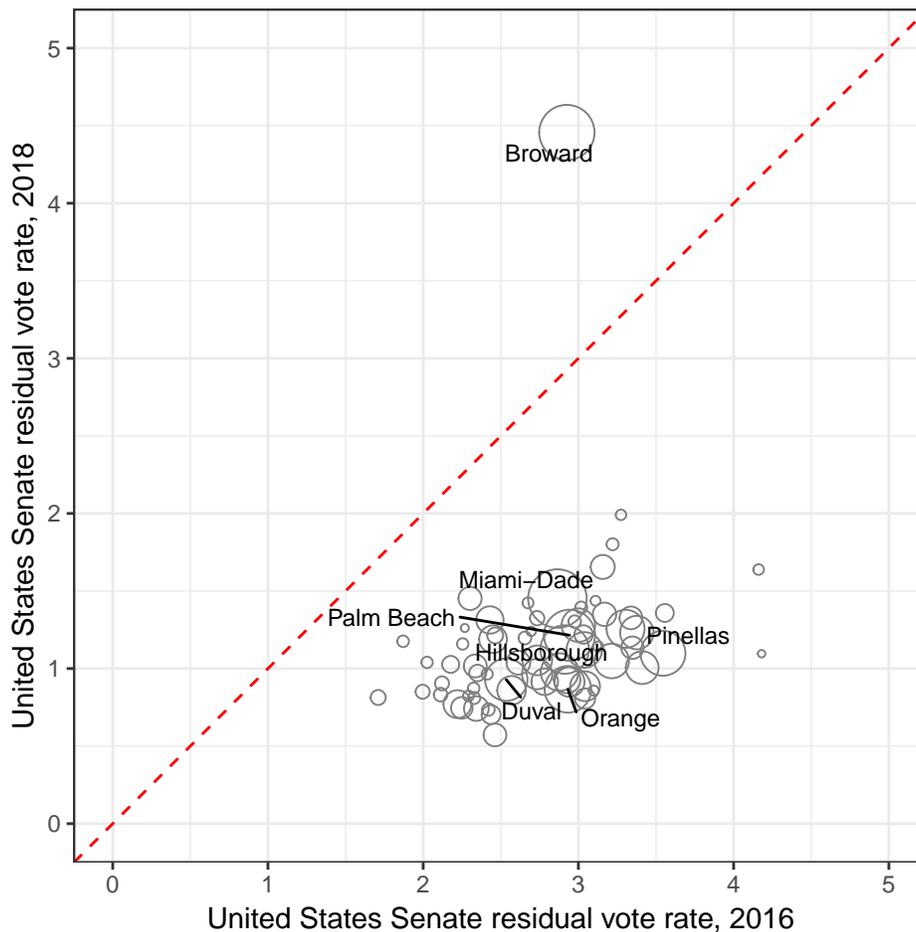
Note: each circle represents one Florida county with sizes proportional to 2018 turnout. Counties with at least 300,000 voters in 2018 are labeled.

Prior to 2018, the most recent Florida United States Senate race took place in 2016, when Republican incumbent Marco Rubio defeated his Democratic challenger, then-

United States Representative Patrick Murphy. Figure 7 displays county-level Senate undervote rates for these two election years. Broward is clearly an anomaly: it is the only county of Florida's 67 that had a Senate undervote rate in the 2018 midterm greater than the corresponding undervote rate in the 2016 general election.

Figure 7 is at the county level, which is a departure from our previous precinct-level figures. Constant boundaries in geographic units facilitate temporal comparisons like those in this figure, and but replication of Figure 7 at the precinct level is complicated by the fact that some precinct boundaries in Florida changed between 2016 and 2018. We thus adopt the following procedure.

We first identify all counties—there are 49—in Florida that had the same number of precincts in 2016 and in 2018. Among these, if a 2018 precinct has the same name as a 2016 precinct, we assume it is the same precinct. For the remaining 18 counties whose precinct counts changed between 2016 and 2018, we determine which 2018 precincts correspond with 2016 precincts by overlaying electronic maps of 2016 and 2018 precincts.[12] We can link 4,606 precincts with usable data from 2018 to 2016, and these are shown in Figure 8. The scale of this precinct-level figure differs from the previous county-level figure, and this reflects greater variance in precinct undervote rates than in county rates.

With some exceptions, the vast majority of Broward precincts had higher Senate un-

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[12]For a given county, we determine the centroid of each 2018 precinct based on shapefiles acquired from the Florida Division of Elections. We then intersect these centroids with 2016 precincts based on shapefiles acquired from the Florida Division of Elections. For a given 2018 centroid that intersects a 2016 precinct, we say that the corresponding precincts are identical if their areas in square miles differ by at most one percent. This is conservative. Shapefiles re-digitized between 2016 and 2018 could produce precincts that are equivalent yet have area changes beyond our one percent threshold.

Figure 8: Undervote rates in Florida precincts, 2016 and 2018 United State Senate races
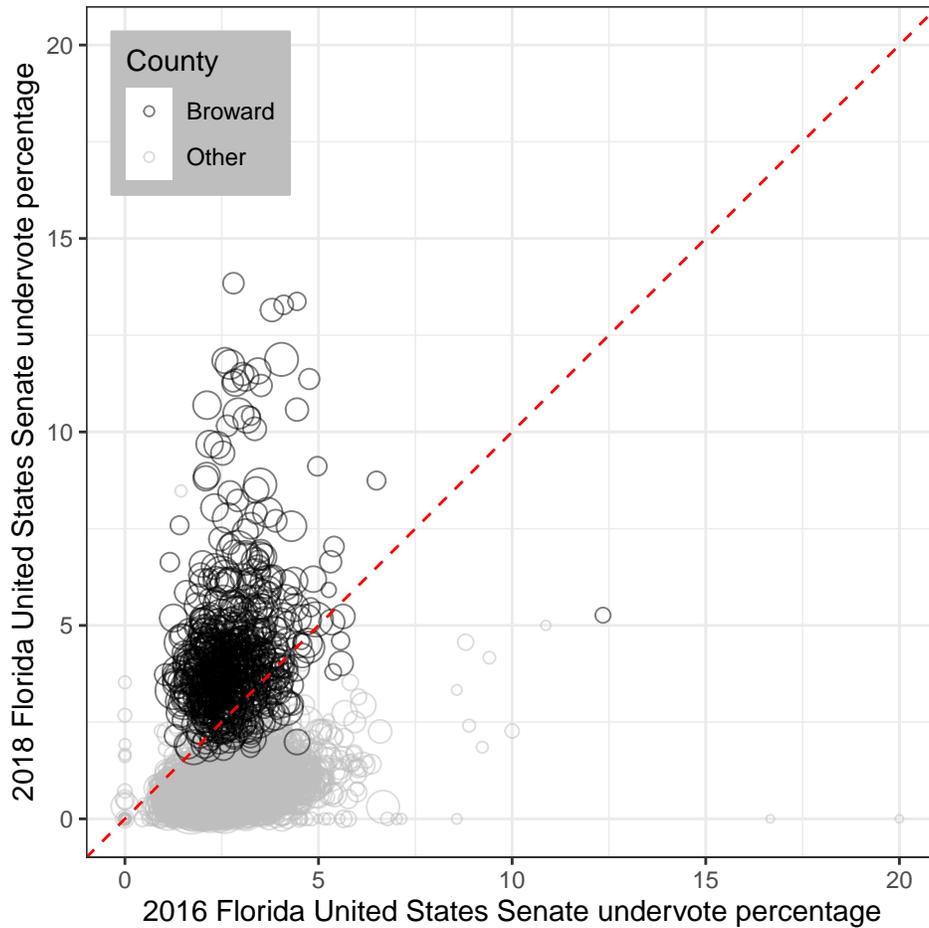
Note: each circle represents one Florida precinct with sizes proportional to 2018 turnout. Includes only precincts with unchanged boundaries between 2016 and 2018. See fn. 12.

dervote rates in 2018 than in 2016. Among precincts in Florida counties, however, the vast majority had greater undervote rates in 2016 than in 2018. These findings echo those from our county-level Figure 7, which covers all of Florida. Based on both figures, there is no evidence that Broward County voters eschew United States Senate races, allowing us to reject our first alternative explanation for the 2018 Broward Senate race undervote.

Did Broward County's demographics change?

Our second explanation for the 2018 Broward Senate undervote is that Broward County changed between 2016 and 2018. We thus consider a precinct-level regression of the following form:

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\begin{aligned}
\Delta\text{Undervote}_i =& \beta_0 + \beta_1\,\Delta\text{Female}_i + \beta_2\,\Delta\text{Democratic}_i + \beta_3\,\Delta\text{Republican}_i + \\
& \beta_4\,\Delta\text{Black}_i + \beta_5\,\Delta\text{Hispanic}_i + \beta_6\,\Delta\text{White}_i + \\
& \beta_7\,\Delta\text{AgeYoung}_i + \beta_8\,\Delta\text{AgeMedium}_i + \beta_9\,\Delta\text{AgeOlder}_i + \\
& \gamma_{\text{County–CD}(i)} + \epsilon_i
\end{aligned}
\tag{2}
$$

where, for precinct i, $\Delta\text{Undervote}_i$ is the 2018-2016 change in Senate undervote rate and demographics are defined with respect to 2018 and 2016 voter pools.[13] Equation (2) is similar to the cross-sectional regression in Equation (1) except that the former uses demographic changes as opposed to levels. As before, we focus attention not on estimates of β parameters in Equation (2) but rather on γ fixed effects, which reflect 2018-2016 changes in Senate undervote rates not explained by the evolution of precinct demographics.

We estimate the regression in Equation (2) (weighted by 2018 turnout) using 2018 precincts that could be matched to 2016 precincts, and Figure 9 plots estimated fixed effects along with 95 percent confidence intervals. The figure shows that there are four county/congressional district fixed effects that depart from the pattern of fixed effects across Florida. These four, all of which are positive and precisely estimated, are from Broward County. Mirroring patterns seen earlier, the most extreme fixed effect corresponds to the part of Broward County intersecting Florida's 24th Congressional District.

Our analysis of changes in precinct demographics across Florida was motivated by a

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[13]We calculated 2016 voter demographics using the January 2017 Florida statewide voter file. On 2018 voter demographics, see fn. 11

Figure 9: County/congressional district fixed effects, 2018-2016 Senate undervote rate differences
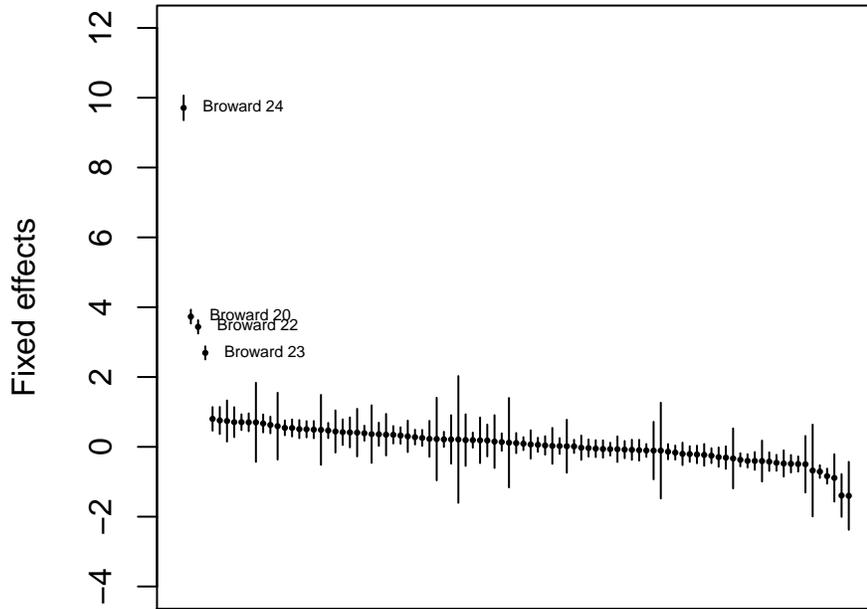
Note: fixed effects ordered by magnitude with vertical lines depicting 95 percent confidence intervals.

concern that changes in Broward County's demographics may have produced the extensive Senate race undervote in 2018. We have now ruled out this possibility. Even allowing for changes in demographics, Broward County's undervote in the 2018 Senate rate was extensive compared to the rest of Florida, and the portion of Broward in Congressional District 24 is the most extensive.

How unusual was Broward County's undervote?

A third alternative explanation for the Broward Senate undervote is sampling variance. It is possible that many states in the 2018 midterm election cycle contained a county as anomalous as Broward, and we now extend our purview beyond Florida.

There were 22 states in the 2018 midterm election that had both United States Senate and gubernatorial elections, and for 18 of them we have been able to assemble data on election returns and voter turnout by county. Unlike Florida, not all of these states separate undervotes from overvotes. The analysis here thus combines undervotes and overvotes into residual votes, and it compares residual vote rates in Senate and governor races for 782 counties across 18 states.[14]

Figure 10 plots county-level residual vote rates for United States Senate and governor races against each other in 18 states. The structure of this figure parallels earlier plots, and three states are highlighted.

While the scope of Figure 10 is valuable, it combines residual vote rates from a variety of distinct electoral contexts, raising questions about comparability. To wit, the 2018 California (green circles) United States Senate race featured two Democratic candidates— that is, no official Republican candidates at all. This was a consequence of California's

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[14]The states are Arizona, California, Connecticut, Florida, Hawaii, Massachusetts, Maryland, Michigan, Minnesota, Nebraska, New Mexico, Nevada, New York, Ohio, Rhode Island, Tennessee, Vermont, and Wyoming. United States Senate and governor vote totals by county were purchased from Dave Leip's Atlas of U.S. Presidential Elections. See fn. 4. We assembled 2018 turnout results by county from secretary of state websites, contacting local election officials as necessary. In a very small number of cases (four), we find negative residual vote rates when comparing turnout with total votes cast either in United States Senate and governor races. Figure 10 ignores these cases.

Figure 10: Residual vote rates in counties, 2018 United States Senate and governor races
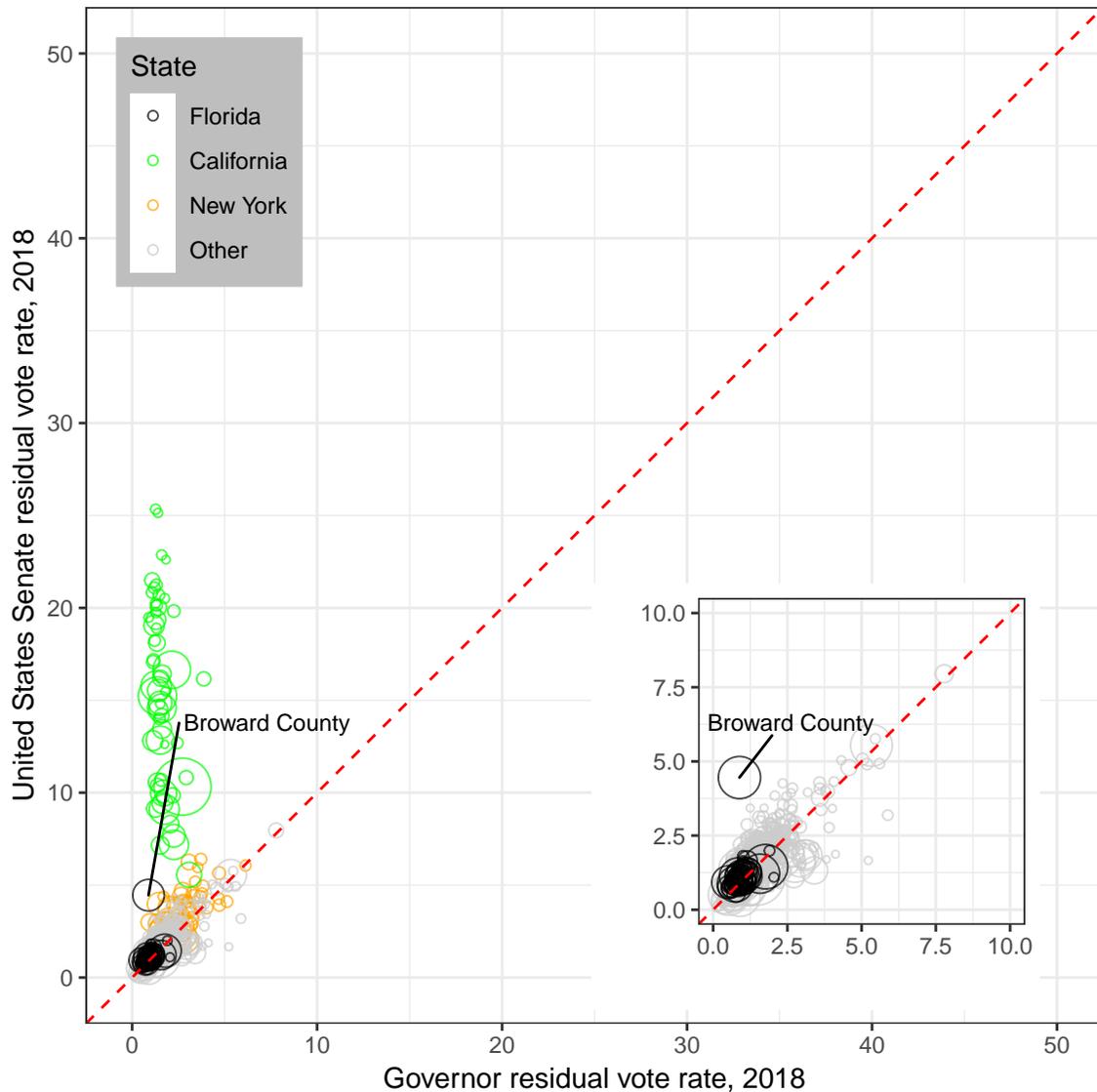
Note: each circle represents one county with sizes proportional to 2018 turnout.

blanket primary system, in which the top two candidates in the state's primary election for a given office advance regardless of partisanship. Accordingly, Republican voters in California had no chance to vote for an official Republican candidate for Senate in the 2018 midterm, and Senate residual votes in California should thus be interpreted differ-

ently than Florida residual votes. Perhaps not surprisingly, across California's 58 counties Senate race residual vote rates were higher than corresponding residual vote rates from the California governor race, which in 2018 was contested by both Democratic and Republican candidates.

The New York (orange circles) United States Senate race featured candidates of opposing parties—Democrat Kirsten Gillibrand versus Republican Chele Chiavacci Farley—but was lopsided: more than 2,000,000 votes separated Gillibrand from Farley, and the next closest Senate margin in 2018 was in Maryland (794,597 votes).[15] Given the contrast in margins between Florida's and New York's Senate races, we are skeptical that Senate race residual vote rates in these two states are comparable.

Beyond California and New York, Figure 10 presents what appears to be the standard relationship between United States Senate and governor residual vote rates—with the exception of Broward County. Ignoring California and New York, points in Figure 10 are clustered around the red 45-degree line, with about as many counties above the line (more residual votes for Senate) as below (more residual votes for governor). The inset plot in Figure 10 excludes California and New York, reinforcing how Broward County's residual vote rate in the Senate contest was not only unusual in comparison to the other 66 counties in Florida but also in comparison to counties in other states in the same electoral cycle.

We have now considered residual vote rates across multiple states in light of the possibility that our Broward County findings are not atypical beyond Florida. Notwithstanding two states with non-comparable Senate contests, we find that Broward County's 2018 Senate undervote rate is anomalous not only in Florida but beyond as well.

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[15]See fn. 4 for source of Senate margins.

Effect of the Broward undervote on the Senate race outcome

In our third results section, we assess the effect of the Broward County ballot format on the outcome of the United States Senate race in Florida. To do this, we counterfactually reallocate Broward County's Senate undervotes in a way consistent with Senate race voting beyond Broward. Because this county's ballot format was presumably confusing to both Democratic and Republican voters, both Bill Nelson and Rick Scott gain votes when we reallocate Broward's Senate undervotes.

Our reallocation exercise is conducted at the precinct level. To estimate counterfactual Nelson vote totals in Broward precincts that would have been observed in the absence of the county's confusing ballot (we address counterfactual Scott vote totals shortly), we first assume that, among Broward voters in Congressional District $\mathrm{CD} \in \{20, 22, 23, 24\}$ who intended to vote for Nelson, the fraction that accidentally undervoted was $\delta_{\mathrm{CD}}^D \in (0, 1)$.

Second, we note that there are two types of precinct-level Nelson vote shares in Florida. There are true vote shares observed in non-Broward precincts, and there are shares observed in Broward precincts adulterated by the county's ballot. For a Broward precinct i in Congressional District CD, we denote the observed fraction of Nelson voters as Nelson_i, and we assume that this fraction is a proportion $\left(1 - \delta_{\mathrm{CD}}^D\right)$ of the true fraction of voters who intended to vote for Nelson. The greater the accidental undervote rate δ_{CD}^D, the smaller is $\left(1 - \delta_{\mathrm{CD}}^D\right)$.

To estimate our four accidental undervote rates, we assume that

$$
\begin{aligned}
\mathrm{Nelson}_i =& \beta_0^D \left(1 - I_{\mathrm{Broward}_i}\right) + \beta_0^D \left(1 - \delta_{\mathrm{CD}_i}^D\right) I_{\mathrm{Broward}_i} + \\
& \beta_1^D \, \mathrm{Gillum}_i \left(1 - I_{\mathrm{Broward}_i}\right) + \beta_1^D \left(1 - \delta_{\mathrm{CD}_i}^D\right) \mathrm{Gillum}_i \, I_{\mathrm{Broward}_i} + \epsilon_i
\end{aligned}
\tag{3}
$$

where Nelson_i and Gillum_i are Nelson's and Gillum's vote shares, respectively, in precinct i; I_{Broward_i} is in indicator function that is one if and only if precinct i lies in Broward

County; and, CD_i is the congressional district of precinct i (which only matters in Broward County). We assume that ϵ_i is a normally distributed, mean zero error term with variance inversely proportional to 2018 turnout in precinct i, scaled up by $\left(1 - \delta^D_{\mathrm{CD}_i}\right)$ for Broward County precincts. Intuitively, Equation (3) states that Nelson's Senate vote share by precinct is linearly related to Gillum's gubernatorial vote share.

We create a Republican version of Equation (3) where Scott and DeSantis substitutes for Nelson and Gillum, respectively. In this latter model, our four accidental Republican undervote rates are denoted $\delta^R_{\mathrm{CD}} \in (0, 1)$ for $\mathrm{CD} \in \{20, 22, 23, 24\}$.

Third, with non-split precincts in Florida that had positive 2018 turnout, we use Equation (3) and its Republican counterpart to estimate two β^D, two β^R, four δ^D, and four δ^R parameters with maximum likelihood. While our ultimate objective is estimating our eight accidental undervote parameters, these rates cannot be identified with Broward precincts alone. Precincts outside of Broward identify the β^D and β^R parameters, and this identifies the δ^D and δ^R parameters.

Fourth, across Broward County precincts in Congressional District CD, we sum up votes cast for Nelson (call this quantity $\mathrm{NelsonTotal}_{\mathrm{CD}}$) and Scott ($\mathrm{ScottTotal}_{\mathrm{CD}}$). The counterfactual number of Nelson votes that we should have observed in Broward County absent the county's ballot is

$$\sum_{\mathrm{CD} \in \{20,22,23,24\}} \mathrm{NelsonTotal}_{\mathrm{CD}} \,/\, \left(1 - \hat{\delta}^D_{\mathrm{CD}}\right) \tag{4}$$

where $\hat{\delta}^D_{\mathrm{CD}}$ is the maximum likelihood estimate of δ^D_{CD}. We calculate the standard error of this quantity using the delta method.[16] We reallocate Broward undervotes to Scott using

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[16]For numerical reasons, our likelihood function does not directly estimate any of the δ parameters. Instead it estimates $\Phi\left(\tilde{\delta}\right)$, where $\Phi\left(\cdot\right)$ is the standard normal distribution function and $\tilde{\delta}$ is unconstrained. We incorporate the normal transformation in our delta

Table 2: Accidental undervote rates in Broward County

CD	Governor		AG		CFO		Agri	
	D	R	D	R	D	R	D	R
20	0.025	0.086	0.049	0.022	0.04	0.047	0.025	0.068
	(0.0017)	(0.0045)	(0.0022)	(0.0011)	(0.0019)	(0.0022)	(0.0017)	(0.0038)
22	0.013	0.077	0.05	0.018	0.039	0.041	0.028	0.043
	(0.002)	(0.0084)	(0.0025)	(0.0011)	(0.0022)	(0.0024)	(0.002)	(0.0028)
23	0.0067	0.072	0.039	0.0068	0.025	0.033	0.018	0.034
	(0.0019)	(0.014)	(0.0024)	(0.00055)	(0.0022)	(0.0028)	(0.0019)	(0.0032)
24	0.09	0.14	0.11	0.083	0.1	0.11	0.092	0.13
	(0.0055)	(0.0074)	(0.0072)	(0.0058)	(0.0064)	(0.0065)	(0.0056)	(0.0071)

Note: for four baseline races, accidental undervote rates for Democratic (Nelson) and Republican (Scott) voters are denoted "D" and "R," respectively.

Equation (4) albeit with $\mathrm{ScottTotal_{CD}}$ in place $\mathrm{NelsonTotal_{CD}}$ and $\hat{\delta}_{\mathrm{CD}}^{R}$ in place of $\hat{\delta}_{\mathrm{CD}}^{D}$.

Before considering results, we return to a point made earlier about Equation (3), namely, that this equation implies that Nelson's (Scott's) Senate vote share can be expressed as a function of Gillum's (DeSantis's) gubernatorial vote share. While logical, this formulation raises the question as to why we model Senate vote share based on Florida gubernatorial vote share. Given that there were four statewide races beyond the Nelson-Scott Senate contest (see Table 1), there is no theoretical reason to base our reallocation exercise on any of these races in particular.

To ensure that our reallocation results are as robust as possible, in a final modification of Equation (4) we substitute Democratic candidate vote shares from the attorney general (AG), chief financial officer (CFO), and commissioner of agriculture (Agri) races for Gillum vote share. And, we similarly substitute corresponding Republican candidate vote shares in the Republican version of Equation (4).

Table 2 contains 32 accidental undervote parameter estimates. There are eight estimates for each baseline race, and each set of eight includes four Democratic and four method calculations.

Republican estimates.

Several aspects of the accidental undervote rate estimates in Table 2 are notable. First, for each baseline and each party, the greatest accidental undervote rates can be found in Congressional District 24. Second, there is fair amount of regularity in the Democratic District 24 estimates: around ten percent of intended Scott voters cast accidental Senate race undervotes. There is less regularity among Republican District 24 estimates in the table. Third, the Republican estimates in Table 2 are usually, albeit not always, estimated less precisely than corresponding Democratic estimates. This presumably reflects the fact that Broward County is home to more registered Democrats and registered Republicans.

Ignoring split precincts (see fn. 10), Nelson received 260,568 more votes than Scott in Broward County. Table 3 contains counterfactual Nelson-Scott margins based on using estimates in Table 2 and Equation (4).

Table 3: Counterfactual Nelson-Scott margins in Broward County

Baseline	New margin	New undervote percentage
Governor	251,305	0.842
	(688)	
Attorney General	281,230	0.695
	(989)	
Chief Financial Officer	269,648	0.757
	(832)	
Commissioner of Agriculture	263,333	1.34
	(723)	

The first column in Table 3 lists one of four baseline races, the second the counterfactual Nelson-Scott margin based on the baseline, and the third the counterfactual Senate undervote rate in Broward County that results after allocating Senate undervotes to Nelson and Scott.

Regarding the last column of the table, we should not expect any race on Florida's 2018 ballot to have zero undervotes. Outside of Broward County, turnout in the 2018 midterm

was 7,590,415 with 61,187 Senate race undervotes; this corresponds to an undervote rate of approximately 0.81 percent. Depending on which baseline one consults in Table 3, our counterfactual Broward County has a Senate undervote race in the vicinity of this quantity.

To change the overall Senate result, a counterfactual result in Broward County must be at least the sum of the observed margin by which Nelson led Scott in Broward County (260,568), plus the margin by which Scott defeated Nelson statewide (10,033 votes), i.e., 270,601. As shown in Table 3, the counterfactual using the Florida governor race implies that Nelson would not have won his Senate election even with a standard Broward ballot; the Attorney General-based counterfactual implies that Nelson would have defeated Scott but for Broward's problematic ballot design; the counterfactual using the Chief Financial Officer race puts the outcome within confidence bounds, leaving us uncertain as to whether Broward's ballot design affected the statewide outcome; and, the Commissioner of Agriculture-based counterfactual implies that eliminating Broward's ballot would have increased Nelson's margin in Broward but not by enough to affect the statewide outcome.

Table 3's varied conclusions imply that the existing public data on Florida's 2018 Senate race do not allow us to determine whether Broward County's ballot was pivotal or not. While it is normatively pleasing that we cannot conclude that the ballot was pivotal, it is hardly a positive assessment of election administration in Florida that our results do not allow us to rule out such a conclusion.

Given Broward's known Democratic bent, this result might seem unintuitive. Nonetheless, a key explanation for it is apparent in Figure 11, which plots Gillum vote share against Senate undervote rates, disaggregated by congressional district.

In Congressional District 24, precincts with many Senate undervotes lean Democratic, and the more Democratic they lean, the more Senate undervotes they had in 2018. However, in other congressional districts, the 20th and 22nd in particular, the more Democratic a precinct as measured by governor vote share, the lower the Senate undervote rate. Within

Figure 11: Gubernatorial Democratic vote share and Senate undervoting in Broward County, by congressional district
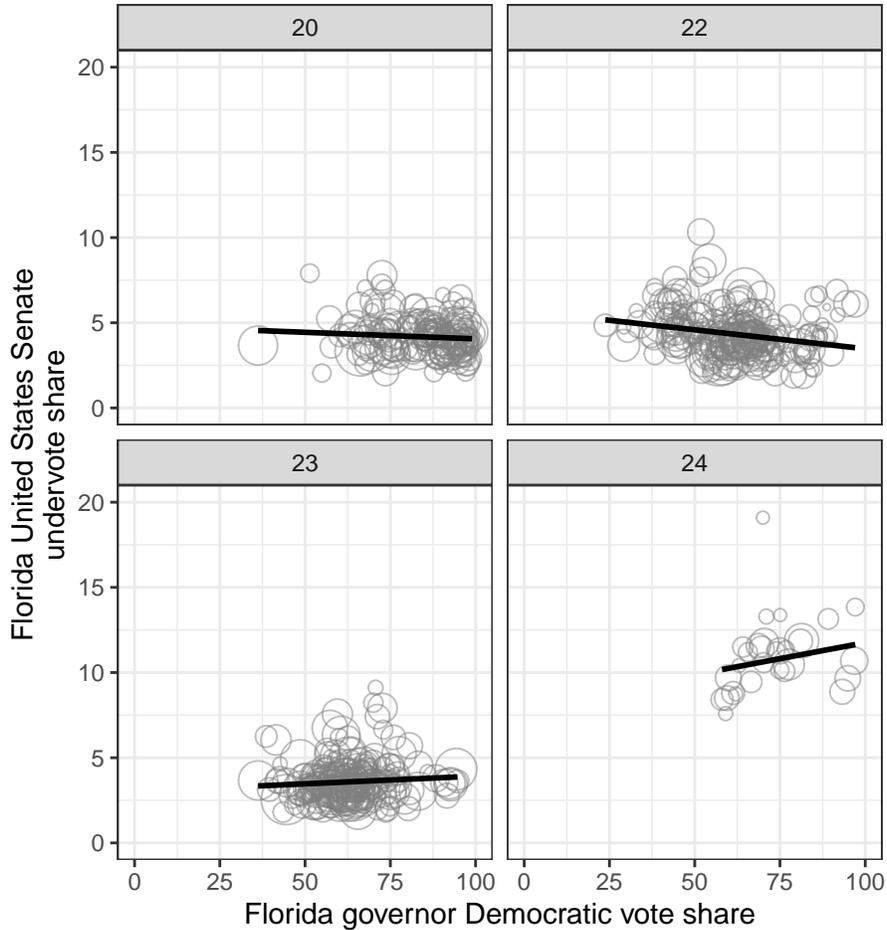
Note: each circle represents one Florida precinct with sizes proportional to 2018 turnout.

Broward County, the 20th and 22nd congressional districts had more votes than the 23rd and 24th, and the downward sloping regression lines in top two panels of Figure 11 provide intuition as to why reallocating Senate undervotes to Nelson and Scott can favor Scott.

Discussion

Elections are mechanisms, and ballots the medium, in which voter intentions are translated into representation. Nonetheless, ever since the 19th Century introduction of the secret ballot in the United States (Ware 2000), political observers have expressed concerns about ballot design and it effect on the abilities of voters to signal their intentions. Over the years and in particular post-2000, numerous administrative efforts have sought to reduce the number of residual votes—"non-votes"—cast in elections, because, presumably, this will help ensure that voter intent is captured in election results.

Nonetheless, we have in the 2018 United States Senate race in Florida another exemplar of an election marred by a sizeable undervote. The isolation of federal races below tri-lingual instructions on the Broward County ballot caused some Broward voters to undervote accidentally in the Senate race, and this undervote was exacerbated in the uncontested 24th Congressional District, where only the Senate race was listed on the bottom of the left-most column on Broward's tri-column ballot. The large number of Senate undervotes cast in Broward County may have altered the outcome of the Senate contest there—though the data cannot decisively pin down whether this happened.

We arrived at our conclusions after considering a variety of alternative explanations for the Broward Senate race undervote that do not turn on the county's ballot, only to find them all wanting. Distinctive undervote patterns in Broward County were limited to the 2018 United States Senate race, and beyond Broward we find no evidence of anomalous undervotes in top statewide races. Compared to residual votes on United States Senate races in other states in the 2018 midterm, we find Broward to be an outlier, on par only with the uncompetitive Senate races in California (which featured no official Republican candidates) and New York (where an incumbent had a landslide victory).

One of the basic tasks of an electoral system is to translate votes into seats. As such,

democratic elections are predicated on equity and fairness—which means allowing all voters to have the same opportunity to have their preferences translated via a secret ballot into representation. If a sufficiently large number of voters are precluded from being able to have their intentions reflected in vote tabulations, it not only raises equal protection concerns but can also, if pivotal, undermine representation.

Our results indicate that the 2018 Broward Senate case lies in the statistical purgatory between pivotality and inconsequential, as the estimated number of undervotes in Broward County that were actually intended for each candidate depends on modeling assumptions. While there is no doubt that the ballot design in Broward County inflated the number of undervotes in this election, the ambiguity about whether it also affected the outcome may undermine the legitimacy of the election among Nelsons supporters. Democracy depends, in part, on the consent of the losers, and, as Floridians know all too well, losers' suspicions are heightened when they believe that administrative procedures may have obscured their preferences.

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