Ranked Choice Voting with Different Elimination Procedures

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Abstract

Ranked choice voting (RCV) is one of the fastest-growing electoral reforms in the United States, yet few have considered whether RCV could be improved with a different elimination procedure. This paper examines RCV with three different elimination procedures: Fewest First Place votes, Most Last Place votes, and Least Borda Count. We examine how often RCV with each of these procedures violates four criteria: the Condorcet winner criterion, reversal symmetry, independence of eliminated alternatives, and monotonicity using data from RCV elections in the United States as well as simulated data from the Impartial Culture condition – both with complete and partial rankings. Our results show that eliminating candidates with the least Borda count, rather than the traditional fewest first place votes, can help RCV adhere to the Condorcet Winner criterion, the IEA criterion, and monotonicity. Results from reversal symmetry are more mixed. Discovering that another elimination procedure is at least as likely to adhere to three of four normative criteria may help improve RCV as a voting rule and boost its success as an electoral reform.

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Introduction

Ranked Choice Voting (RCV), also known as Instant Runoff Voting, is one of the most broadly endorsed electoral reforms in the United States today. Republicans, like Mitt Romney, and Democrats, like Elizabeth Warren, have endorsed it, claiming it tempers political polarization and strengthens "the principle of majority rule while … including those in the minority."[1] RCV has become so popular that a member of the US House of Representatives introduced a bill in Congress which required RCV for all primary and general elections for both the House and Senate.[2]

RCV is a preferential voting method that allows voters to rank candidates in order of their preference. If a candidate receives more than half of the first ranked votes, that candidate wins. If no candidate receives a majority, a candidate is eliminated, and lower-ranked candidates are moved up to fill the missing ranks. The process repeats until one candidate obtains a majority among the non-eliminated candidates.

Traditionally, the candidate with the Fewest First Place votes (FFP) is eliminated. However, other elimination procedures could be used. The candidate with the Most Last Place votes (MLP) could be eliminated, as suggested by Coombs (1964),[3] or the candidate with the Least Borda Count (LBC) could be eliminated as advocated by Foley and Maskin (2022).[4] Foley

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[1] Wilburn (2023). Quote from Warren and Raskin (2020).

[2] Congress.gov. "Text - H.R.9578 - 118th Congress (2023-2024): Ranked Choice Voting Act." September 12, 2024. https://www.congress.gov/bill/118th-congress/house-bill/9578/text, Accessed October 15, 2025.

[3] Unlike traditional RCV, RCV with MLP guarantees that if there are less than five voters a Condorcet winner will be selected in a single dimensional model with single-peaked preferences (Grofman and Feld 2004).

[4] Foley (2023) calls this the "fewest total votes."

(2023) recommends the latter because it uses all information in a ranked-choice ballot, not just the first-rank information. Each elimination procedure represents a distinct implementation of RCV, yet the effects of those procedures on RCV remain largely unexplored.

This study evaluates how three elimination procedures, FFP, MLP, and LBC, affect RCV's compliance with four normative criteria: the Condorcet winner criterion, reversal symmetry, independence of eliminated alternatives, and monotonicity. Rather than treating a voting rule that violates a criterion in a single ballot profile the same as a voting rule that violates a criterion in every possible ballot profile, as done in the axiomatic approach (e.g., Arrow 1951), we determine the frequency of violations among the profiles examined. We use two types of data, ballots from RCV elections in the United States and simulated ballots generated from the Impartial Culture condition – both for complete and partial rankings.

We find that the traditional method of eliminating candidates with the fewest first place votes is not the best way to comply with these democratic principles. Specifically, eliminating the candidate with the least Borda count improves RCV adherence to the Condorcet Winner criterion, the IEA criterion, and the monotonicity criterion. Results from the reversal symmetry criterion are more mixed.

By demonstrating that the most commonly used elimination procedure violates three of the four normative criteria more frequently than one of the alternatives, we identify a clear path for improving RCV. Modifying the elimination procedure makes RCV a more normatively appealing voting rule, thereby advancing it as a legitimate electoral reform.

Literature Review

Traditional RCV, which eliminates the candidate with the fewest first place votes (FFP), can violate the Condorcet winner criterion, IEA, monotonicity, and reversal symmetry over an unrestricted domain. In practice, however, RCV rarely violates the first three criteria.

The Condorcet Winner Criterion requires a voting rule to select the candidate that beats every other candidate in pairwise contests if such a candidate exists (Condorcet 1785). Condorcet believed that if a candidate could defeat every other candidate in pairwise comparisons, that candidate should be declared the winner. To see his reasoning, consider a sports competition such as boxing. If a boxer defeats all contenders in their weight class, that boxer ought to be crowned champion of the weight class. Similarly, if a candidate beats all other candidates, Condorcet reasoned that candidate ought to win.

It is widely known that even though RCV will never select a Condorcet loser, that is a candidate that loses to every other candidate pairwise, it can fail to select a Condorcet winner (Nurmi and Palha 2021). Miller (2017) shows that in three candidate elections, RCV fails to select the Condorcet winner if and only if the Condorcet winner has the fewest plurality votes. Such a candidate would be eliminated in the first round and not have an opportunity to go head-to-head with another candidate in the second round. Plassmann and Tideman (2014) suggest that the rate of violation should be small and increase as the number of voters increases. Despite these theoretical failures, in real-world elections, RCV almost always selects the Condorcet winner under FFP (Graham-Squire and McCune 2023; McCune et al. 2025). The two cases cited in the US include progressive Bob Kiss's victory in the 2009 Burlington, Vermont mayoral election over the Condorcet winner Andy Montroll, and Mary Peltola's victory over Condorcet winner Nick Begich in the 2022 US House election in Alaska (Ornstein and Norman 2014; Graham-Squire and McCune 2023; McCune et al. 2025).

Reversal symmetry requires that if candidate *A* is the unique winner of an election, then *A* must not be elected if every voter's preference ranking is completely inverted, i.e., their least preferred alternative becomes their most preferred, and so on (Saari 1995; Saari and Barney 2003). To understand this criterion, imagine what would happen if the NCAA coaches poll asked coaches to rank football teams from most preferred at the top to least preferred at the bottom, but the computer program used to access the rankings had a glitch and considered the rankings in reverse order. Fans might be angered by the glitch, but they would be stunned if they discovered the voting rule ranked the same team first in both profiles. Such a voting rule would violate reversal symmetry.

RCV can violate reversal symmetry. However, based on simulations using a single-dimensional spatial voting model with various numbers of candidates, RCV violates reversal symmetry at most 70 out of one million trials -- roughly the same rate as Borda Count, which never violates reversal symmetry (Dougherty and Edward 2011). This suggests that RCV with FFP is particularly good at reversal symmetry in a single dimensional context, even though to the best of our knowledge it has not been evaluated in real-word elections.

Independence of Eliminated Alternatives (IEA), also called the spoiler effect, stipulates that a candidate who wins an election should not lose the election if one or more of the non-winning candidates are removed. This differs from Arrow’s independence of irrelevant alternatives. The former requires independence across sets of available candidates for a fixed set of preferences. The latter requires independence across “irrelevant” preferences for a fixed set of candidates (Nurmi and Palha 2021; Dougherty and Heckelman 2020).

Simulations based on a single dimensional voting model with only one candidate eliminated at a time suggest that RCV with FFP adheres to IEA in roughly 48-64% of elections, and it is less likely to adhere to IEA as the number of candidates increases (Dougherty and Edward 2011). In real-world data, violations have been found in the 2009 Mayoral election in Burlington; the 2021 City Council, Ward 2 election in Minneapolis, Minnesota; and the 2022 House election in Alaska (Graham-Squire and McCune 2023; McCune and Wilson 2023).[5]

Monotonicity, sometimes called upward monotonicity, dictates that if a candidate is winning an election, and one or more voters rank that candidate higher on their ballot(s) while all other rankings remain the same, then that candidate should not lose the election. Monotonicity requires that a candidate not be harmed by gaining more support. If a voting rule violates monotonicity, a voter's sincere attempt to support the leading candidate by moving them up in their ballot can actually result in the candidate losing the election.

RCV is susceptible to monotonicity failures because increasing the ranking of the winning candidate among a subset of voters can cause a different candidate to be eliminated in an early round, allowing a spoiler candidate to persist in later rounds. Mathematical analysis shows that susceptibility to monotonicity failure is hardly a rare event. With FFP the rate of violation increases as the number of candidates increases (Quas 2004) and it increases quite substantially as three-candidate elections become more competitive (Miller 2017). Using a two-dimensional spatial voting model, Ornstein and Norman (2014) show that in three candidate elections a substantial proportion of competitive RCV ballot profiles are vulnerable to monotonicity failure with FFP, including upwards of 50% in closely contested profiles. In

[5] The additional violations found by McCune and Wilson (2023) come from bootstrapping actual elections.

practice, however, monotonicity failures have been rarely observed. In a database of 182 RCV elections in the US, monotonicity violations occurred in only three elections: the 2009 Burlington Mayoral; the 2021 Minneapolis Ward 2; and the 2022 Alaska House (Graham-Squire and McCune 2023).

Our study differs from the literature in three important ways. First, we employ a more elaborate algorithm for detecting monotonicity violations than previously used and find two more US elections that violate monotonicity under FFP. Second, we examine the reversal symmetry criterion which has been under-studied. Third, and most importantly, we compare variations within a family of voting rules, namely RCV with three different elimination procedures. We do this for both US Elections, IC-complete, and IC-partial data. This allows us to isolate the effect of the elimination mechanism itself and the degree to which differences are due to skewed distributions or non-ranking behavior.

Definitions

Let C be the number of balloted candidates, R be the number of possible ranks, and N be the number of voters. In the United States, RCV elections require a strict ranking of candidates but do not require ballots to be complete. For example, Minneapolis allows three ranks. A ballot would be complete in Minneapolis only if there were less than four candidates and voter ranked all candidates. If three candidates run but a Minneapolis voter ranks only two of the three candidates, their ballot would be partial. If five candidates run, all ballots would be partial.

We assume voters prefer the candidates they rank higher more than the candidates they rank lower, they prefer ranked candidates to candidates they leave unranked, and they are indifferent among their unranked candidates.[6] For LBC this means that the candidate with the highest ranking receives R points, the second highest ranking receives R-1 points, …, the candidate with the lowest ranking receives 1 point, and unranked candidates receive 0 points.

If two or more candidates are tied for elimination in any round, we eliminate a single candidate randomly. Random elimination of a single candidate appears to be the most common method for breaking ties in the United States.[7]

Data

We examine three types of election data: RCV elections from the United States, simulated elections from the impartial culture condition, and simulated elections from the impartial culture condition with partial ballots.

[6] Another possible assumption is that voters have no preferences between ranked and unranked candidates. The problem with this assumption is that it is inconsistent with the treatment of RCV elections with two candidates. In those cases, voters frequently rank only one candidate, and electioneers assume that candidate is preferred to the unranked candidate. If they considered unranked candidates non-comparable, a very large proportion of the ballots would have to be dropped.

[7] Ties are broken by random elimination in Alaska; Portland, Oregon; Maine; the District of Columbia; San Francisco; Oakland, San Leandro, and Berkeley, California; Minneapolis, Minnesota; and Ft. Collins, Colorado; to name a few. Two other methods for breaking ties include eliminating all tied candidates at once (as applied in Boulder, Colorado) and the backward tie-breaking method (as applied in Northhampton and Easthampton, Massachusetts; Tacoma Park, Maryland; and Santa Fe, New Mexico). Under the backward tie-breaking method, if two or more candidates are tied, the candidate with the fewest votes in the previous round is eliminated. If the tie persists, the candidate with the fewest votes in the round before that is eliminated. The process continues until the tie is broken.

U. S. Election Data

Fair Vote provides ballot data on almost every single-winner RCV election in the United States from 2004 to 2025 (Otis 2025). We examine all 362 of those elections that have at least three candidates. They include local, state, and federal elections conducted in various jurisdictions in Alaska, California, Colorado, Massachusetts, Maine, Maryland, Minnesota, New Mexico, New York, Oregon, Utah, and Vermont. The number of balloted candidates range from 138 elections with 3 candidates to the single Minneapolis Mayoral Election of 2013 with 35 candidates.[8] Among the elections, 39 have five balloted candidates and 8 have nine balloted candidates. The average election contains roughly 44,000 valid ballots, 3.9 marked ranks, and 5.2 candidates.

Voters make three common mistakes when they rank candidates. They overrank, overvote, and skip ranks. For each, we apply the most common treatment in the United States.

An overrank occurs when a voter ranks a single candidate multiple times. For example, they select Anne as both their first choice and second choice. In such cases, we accept the highest ranking, then ignore each lower rankings for the same candidate and move the remaining candidates up the voter's ballot.[9]

An overvote occurs when a voter casts more than one vote for the same rank. For example, when they mark both Anne and Bob as their first preference. In these cases, we treat the ballot as exhausted as soon as an overvote is encountered. Ranks above the overvote are

[8] An election with *C* balloted candidates may also contain additional write-in candidates, which we treat as a single person, which does not affect the results.

[9] The second most frequent method for addressing overranks appears to be exhausting the ballot upon over ranking. In other words, election officials would treat the ballot as "exhausted" or invalid from the point of an over rank onward.

included in the ballot profile, but overvoted candidates and candidates ranked beneath those overvoted are dropped from the voter's ballot.[10]

A skip occurs when a voter leaves a column blank, i.e., they skip one or more rankings. In such cases, we ignore the blank and elevate the voter's remaining rankings into the missing columns.[11] The only time that an unranked candidate becomes ranked are cases in which the lowest ranked position is blank and there is a single unranked candidate.

After processing, RCV elections in the US have three noticeable characteristics. First, ballot profiles are typically skewed toward one (or two) candidates. For example, with three candidates, roughly 53% of the elections have a majority winner in the first round, with an average vote share of 59%. With five candidates, roughly 39% of the elections have a first-round majority winner with an average vote share of 61%. With nine candidates, roughly 36% of the voters rank the same candidate first.

Second, there are many partial ballots in actual RCV elections – that is rankings with at least one missing value. These are produced whenever a voter ranks fewer candidates than allowed or the number of candidates in the election exceeds the number of ranks on the ballot (Kilgour et al. 2020). After processing, all blanks trail the set of ranked candidates. In elections with three candidates and three ranks, an average of 0.156 of the ballots had a single trailing

[10] Another approach to overvotes is to skip the overvotes and continue counting. That means election officials would eliminate the overvoted candidates but keep the rest of the ballot intact (as done in Burlington, Vermont; Minneapolis, Minnesota; and Portland, Oregon). Surprisingly, exhausting the ballot upon overvote is much more common.

[11] There are at least two other approaches to skipped ranks. First, a ballot continues after a single skipped ranking, but the ballot becomes inactive after two or more consecutive skips (as done in Alaska and Maine). Second, the ballot is treated as exhausted as soon as a skipped rank is encountered (as done in Salt Lake City, Utah and Boulder, Colorado).

blank, while 0.302 of the ballots had two trailing blanks. In the elections with five candidates and five ranks there were 0.263, 0.102, 0.201, and 0.384 trailing blanks for one missing, two missing, three missing, and four missing, respectively.

Third, candidates with the most votes are disproportionately the candidate with the most trailing blanks. Put differently, if a voter ranks only one candidate, they often rank the plurality winner. For example, in three candidate elections, a little less than a third of the ballots cast for the plurality winner contain only one ranked candidate. In five candidate elections, roughly 41% of the ballots cast for the plurality winner contained only one ranked candidate. In nine candidate elections the number was roughly 36%. This observation helps explain our reversal symmetry results.

IC-Complete Distribution

To compare the performance of the three elimination procedures in more competitive elections, we also simulated 1,000 elections using the Impartial Culture distribution (IC) with $N = 10,000$, and $C = \{3, 5, 9\}$. IC draws each voter's ballot rankings assuming each *permutation* of the $C!$ strict preference orders are equally likely. For our simulated data, we set $R = C$.

IC-Partial Distribution

Finally, we simulate 1,000 elections with partial IC rankings, $N = 10,000$, and $C = \{3, 5, 9\}$. These ballots are exactly the same as the ballots generated under IC-complete, except we replace the last r ranks with blanks, where r is a proportion derived from RCV elections in the US. For example, because the average number of trailing blanks in 3 candidate elections with 3 ranks were 0.156 for a single trailing blank and 0.302 for two trailing blanks, we eliminated the last ranked candidate in the first 1,560 of the 10,000 rows of the IC distributed preferences and the last two ranked candidates for the next 3,020 rows. The remaining rows maintained complete ballots.[12] Data from US Elections differs from data generated by the IC distribution in two important ways: the IC data is less skewed, and it is complete. We study IC-partial data because it varies from US election data only in terms of skew, not in terms of completeness.

Computer Script

To determine the frequency of violations under each elimination procedure, we wrote an R script which utilized functions in Rcpp to increase processing speed. The script starts by opening the ballots for a single election, either actual or simulated. It determines the winner of the election using each elimination procedure separately then determines whether selecting that winner leads to a violation of any of the four criteria separately. We repeat the process for the 362 actual elections, or the 1,000 simulated elections, and report the frequency of violations in each respective category.

The script identifies violations of the Condorcet winner and reversal symmetry criteria in the usual fashion.[13] Functions for identifying IEA and monotonicity violations are more complex.

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[12] There were few elections with 9 candidates and 9 ranks, so the proportions applied to $C = 9$ had to be calculated more elaborately using elections with the same number of ranks for $C \in [7, 10]$.

[13] For reversal symmetry we invert the preferences of the ranked candidates and leave the unranked candidates unranked.

IEA

To determine whether RCV with each elimination procedure violates IEA, each subset S of the $C - 1$ candidates who lost the race are identified. Voting is then reconducted on the set $S \cup W$, where W is the winner of the election with C candidates. If a candidate other than W wins in any of the subsequent elections, the elimination procedure is marked as violating IEA for that election. An elimination procedure adheres to IEA in an election only if it selects W for any combination of losing candidates removed.

Monotonicity

Our approach for detecting monotonicity violations proceeds in two stages. First, the script determines whether ties arise during the elimination process, and whether resolving those ties in different ways could yield different winners. Because such outcomes make the winner depend on arbitrary tie-breaking, rather than on ballot preferences, we classify these cases as monotonicity violations but record them separately.

Second, if no tie-induced violation is found, we test whether the winner of the initial election W could be forced to lose if W is moved up on some ballots, while other rankings remain fixed.[14] The key to our approach is recognizing that any candidate capable of defeating W after such modifications must already defeat W head-to-head in the original profile. Denote the set of

[14] At the core of the evaluation is the MoveW() function, which implements counterfactual movements of W in the ballots. MoveW() computes the smallest feasible movement of W up the fewest ballots and fewest possible ranks to eliminate the targeted candidate. That movement varies by FFP, MLP, and LBC and often causes groups of ballots to split.

such candidates F. To avoid examining all possible elimination orders, whose number increases factorially ($O(n!)$) as the number of candidates increases, we generate all subsets $S \subseteq C$, such that $W \in S$ and $S \cap F \neq \emptyset$. Among these, we identify what we call minimal "G-subsets," that is the subsets in which a candidate other than W emerges as the winner. For each G-subset, we construct compatible elimination orders by concatenating all permutations of the complement set $C \backslash S$ with the elements of S. In other words, candidates outside S must be eliminated before the G-subset is reached, with natural elimination always tested before W is moved. This subset-based search ($O(n^2)$) drastically reduces the computational burden of the procedure.

After the set of viable elimination orders have been generated, each elimination order is evaluated round by round. In each round, we attempt to move W up in the fewest possible ballots to assure the targeted candidate's elimination. The process continues through the elimination order until either the first element of the G-subset is reached, at which point the modified profile is checked for whether it produces a winner other than W. If it does, the election is classified as violating monotonicity; otherwise, the search proceeds to the next elimination order.[15]

[15] Graham-Squire and Zayatz (2021) approach the problem differently. Following an insight by Miller (2017) for elections with three and four candidates, their script runs RCV with FFP on the original ballot profile to determine W and the four candidates that reach the final rounds. The script then targets a monotonicity violation by moving W up only after the field is reduced to four candidates (or three if C = 3). The success of their algorithm depends on an assumption that any ballot modification in an earlier round that leads to a violation must also contain a more minimal violation detectable among the final four candidates in the original ballots. Our script does not require that assumption. It attempts movements in every period that a targeted candidate cannot be eliminated naturally, and it can be applied to MLP and LBC, as well as to FFP. Interestingly, we identify only two more monotonicity violations in US elections using FFP.

Results

This section presents a separate table of results for each criterion. The top section of each table shows results from US elections, with combined results for all *C* in the left-most column and results broken out for *C* = 3, 5, 9 in the remaining columns. The middle section presents results for complete voter rankings from the IC-complete distribution for *C* = 3, 5, 9. The bottom section presents results from the IC-partial distribution. Recall that our IC-partial ballots are identical to our IC-complete ballots except the number of empty-trailing ranks are set in proportion to the number of empty-trailing ranks from the US data.

Condorcet Winner

Table 1: Condorcet Winner Violations

Voting rule	$C \in [3, 35]$	$C = 3$	$C = 5$	$C = 9$
<u>US Elections</u>				
Fewest First Place	0.006	0.007	0.026	0.000
Most Last Place	0.003	0.000	0.000	0.000
Least Borda Count	0.000	0.000	0.000	0.000
# CW	359			
<u>IC Complete</u>				
Fewest First Place		0.026	0.095	0.169
Most Last Place		0.038	0.073	0.183
Least Borda Count		0.000	0.000	0.000
# CW		890	735	540
<u>IC Partial</u>				
Fewest First Place		0.017	0.066	0.136
Most Last Place		0.024	0.053	0.067
Least Borda Count		0.008	0.036	0.031
# CW		915	815	699

Notes: The figures reported are the frequency of Condorcet winner violations given the existence of a Condorcet winner and the ballot type indicated in the section. #CW indicates the number of Condorcet winners. For the 362 US Elections, $N \in [112,\ 942{,}031]$. For the 1,000 ICC complete and partial elections, N=10,000.

The rate at which Ranked Choice Voting violates the Condorcet winner criterion with each of the three elimination procedures is presented in Table 1.

Because the distribution of preferences RCV in US elections are skewed, all but three of the US elections have a Condorcet winner (2021 Minneapolis Ward 2; 2022 Oakland School

Board, District 4; and 2021 Portland, ME City Council). This is indicated by #CW = 359 at the bottom of the top section. Interestingly, RCV almost always selects the Condorcet winner regardless of the elimination procedure. FFP only fails to select a Condorcet winner twice (2009 Burlington Mayoral; and 2022 Alaska House) out of the 359 elections where a Condorcet winner exists, both of which correspond to what is found in the existing literature. MLP has one violation (2008 election for Assessor/Treasurer in Pierce County, Washington), and LBC has zero violations. No difference in violation rate is statistically significant. Part of the reason that all three elimination procedures are so successful at finding Condorcet winners is that many RCV elections have a first-round majority winner in the US.

In contrast, consider the results for IC-complete ballots in the middle section of the table. The proportion of Condorcet winners in the IC-complete simulations ranged from 0.540 for C = 9 to 0.890 for C = 3. In those cases, each combination of the strict linear orders is equally likely, the number of candidates equals the number of ranks on the ballot, and every ballot contains a complete ranking of the candidates. With complete ballots, LBC never violates Condorcet winner criteria, while FFP and MLP violate the criterion at low rates. The difference between the LBC violations and either FFP or MLP violations are statistically significant for each C considered. Rates of violation increase as the number of candidates increases.

The bottom section of the table presents the IC-partial results. The proportion of Condorcet winners in the IC-partial simulations ranged from 0.699 for C = 9 to 0.915 for C = 3. Among the partial ballots, the number of LBC violations is significantly less than FFP for each value of C examined. For C = 3 and 9, LBC also has statistically fewer violation than MLP at the .05 level. One might conclude that LBC performs at least as well as FFP in terms of the procedure's ability to select Condorcet winners.

Reversal Symmetry

Table 2: Reversal Symmetry Violations

Voting rule	$C \in [3, 35]$	$C = 3$	$C = 5$	$C = 9$
US Elections				
Fewest First Place	0.583	0.528	0.615	0.500
Most Last Place	0.583	0.514	0.564	0.625
Least Borda Count	0.610	0.565	0.590	0.500
IC Complete				
Fewest First Place		0.031	0.015	0.001
Most Last Place		0.026	0.014	0.000
Least Borda Count		0.059	0.013	0.000
IC Partial				
Fewest First Place		0.296	0.326	0.183
Most Last Place		0.287	0.369	0.216
Least Borda Count		0.288	0.364	0.206

Notes: The figures reported are the frequency of reversal symmetry violations given the ballot type indicated in the section. For the 362 US Elections, $N \in [112,\ 942{,}031]$. For the 1,000 ICC complete and partial elections, N=10,000. For IC-complete and C = 9, the observed number of violations are eight for FFP, four for MLP, and two for LBC.

The rate at which each elimination procedure violates reversal symmetry is presented in Table 2.

The three elimination procedures violate reversal symmetry quite often in the naturally occurring data because the preference distributions are skewed in favor of one candidate and voters who rank only one or two candidates often rank the plurality winner. Hence, when a preference profile is reversed, the same candidate is frequently ranked first or second by these voters again. In this setting, the pairwise differences between FFP, MLP, and LBC are insignificant at traditional levels. Based on actual RCV election data we would have no reason to favor one elimination procedure over the others in terms of reversal symmetry.

Complete ballots drawn from the IC distribution produce substantially fewer reversal symmetry violations because preferences are more uniform and diagnostics show that these elections *never* produce a majority winner. Hence, when the preference profile is flipped different candidates appear at the top of the preference profile and RCV often selects a different winner. Interestingly, for $C = 3$, MLP outperforms LBC at the 0.001 level of significance, but it does not outperform FFP at traditional levels. For $C = 5, 9$, the rates of violation are even smaller than for $C = 3$ and the pairwise differences remain insignificant.

As shown on the bottom of the table, there are substantially more reversal symmetry violations from the IC-partial data than the IC-complete data. The reason is clear. Consider $C = 3$. With 30% of the second and third ranked candidates marked as missing, reversing the preference profile produces the exact same first ranked candidate for 30% of the ballots. With 16% of only the third ranked candidates missing, reversing the preference profile moves a first ranked candidate down only one rank. Hence, the same candidate tends to win a reversed IC-partial election, causing greater reversal symmetry violations than IC-complete. The rate is lower than US elections because the IC-partial distribution is not also skewed.

Again, in terms of the best elimination procedure the results are mixed. MLP has the smallest violation rate for $C = 3$ and FFP has the smallest violation rate for $C = 5, 9$. However, none of the pairwise differences are statistically significant at the .05 level, except the difference between FFP and MLP for $C = 5$.[16] One might conclude that the three elimination procedures perform fairly similarly in terms of reversal symmetry.

Independence of Eliminated Alternatives

Table 3: IEA Violations

Voting rule	$C \in [3, 35]$	$C = 3$	$C = 5$	$C = 9$
US Elections				
Fewest First Place	0.011	0.015	0.051	0.000
Most Last Place	0.011	0.007	0.026	0.000
Least Borda Count	0.008	0.007	0.026	0.000
IC Complete				
Fewest First Place		0.121	0.374	0.678
Most Last Place		0.135	0.364	0.686
Least Borda Count		0.102	0.263	0.460
IC Partial				
Fewest First Place		0.095	0.265	0.493
Most Last Place		0.103	0.241	0.400
Least Borda Count		0.085	0.223	0.347

Notes: The figures reported are the frequency of IEA violations given the ballot type indicated in the section. For the 362 US Elections, $N \in [112,\ 942{,}031]$. For the 1,000 ICC complete and partial elections, N=10,000.

[16] For $C = 9$, the difference between FFP and MLP just misses the .05 level of significance with a two-sided p-value = 0.065.

The top section of Table 3 shows that RCV rarely violates IEA in the US. FFP violates IEA in four elections (2009 Burlington Mayoral; 2021 Minneapolis Ward 2; 2022 Alaska House; and 2022 Oakland School Board District 4). The first three have been noted in the literature, but the last is new. MLP also violates IEA in four elections (2008 Pierce County; 2021 Portland City Council; 2021 Minneapolis Ward 2; and 2022 Oakland School Board), which differ from FFP. LBC violates IEA in three elections (2021 Minneapolis Ward 2; 2021 Portland City Council; and 2022 Oakland School Board).

The low number of violations makes sense for two reasons. First, there are candidates with outright majorities in many of these elections that are difficult to displace when other candidates are eliminated. Second, because ballots are partial, removing combinations of unranked candidates rarely displaces the winner.

The IC-complete results produce substantially greater rates of violation because those ballots are not skewed in favor of a single candidate, and all candidates are ranked. Hence, removing various combinations of other candidates is more likely to lead to a different winner in the IC-complete data than in the US data. With this distribution, LBC is less likely to violate IEA than the other two elimination procedures for $C = 3, 5, 9$. The pairwise difference is statistically significant in all cases except $C = 3$, for which the difference between LBC and FFP is insignificant at traditional levels.

The violation rates for IC-partial are between the violation rates from the US and IC-complete. The partial data is less skewed than the US data, leading to more violations, and the partial data has more lower ranks than the IC-complete data, leading to fewer violations from the removal of unranked candidates. For IC-partial, LBC continues to have a lower rate of violation than the other two procedures. However, there is no statistically significant difference between it and either of the other two elimination procedures for $C = 3$. For $C = 5$, LBC outperforms FFP at the .05 level of significance. For $C = 9$, LBC outperforms both FFP and MLP at the same level of significance. Similar to our conclusion for Condorcet winners, one might conclude that LBC performs at least as well as the other two elimination procedures on the IEA criterion.

Monotonicity

Table 4: Monotonicity Violations

Voting rule	$C \in [3, 35]$	$C = 3$	$C = 5$	$C = 9$
US Elections				
Fewest First Place	0.014	0.014	0.051	0.000
Most Last Place	0.011	0.007	0.026	0.000
Least Borda Count	0.008	0.007	0.026	0.000
IC Complete				
Fewest First Place		0.129	0.318	0.544
Most Last Place		0.138	0.307	0.548
Least Borda Count		0.107	0.248	0.443
IC Partial				
Fewest First Place		0.099	0.236	0.380
Most Last Place		0.103	0.215	0.338
Least Borda Count		0.087	0.207	0.311

Notes: The figures reported are the frequency of monotonicity violations given the ballot type indicated in the section. For the 362 US Elections, $N \in [112,\ 942{,}031]$. For the 1,000 ICC complete and partial elections, N=10,000.

The rate at which RCV violates monotonicity with each of the three elimination procedures is presented in Table 4. In the actual voting data, FFP, MLP, and LBC all violate monotonicity in the 2021 Portland City Council election due to the random elimination of a candidate. FFP violates monotonicity in an additional four elections, two of which have three candidates (2022 Alaska House; and 2022 Oakland School Board) and two of which have five candidates (2009 Burlington Mayoral; and 2021 Minneapolis Ward 2). The Portland and Oakland results are new. In addition to the random elimination election, MLP violates monotonicity in the Minneapolis and Portland elections, as well as the 2008 Pierce County. The latter election had six candidates. FFP violates monotonicity in the random elimination election, Oakland, and Minneapolis. Differences in performance are not statistically significant at traditional levels.

No movement of *W* would create a monotonicity violation in the remaining cases, largely because 99% of the elections did not have a candidate that beat the winner *W* in head-to-head contest -- a necessary condition for a monotonicity violation without random elimination. Ironically, *all* of the elections in which a candidate *could* beat *W* head-to-head under an elimination procedure produced a monotonicity violation, suggesting that lacking pairwise challengers explains the result.

With the IC-complete data, the three elimination procedures violate monotonicity at a much greater rate. For each C examined, LBC violates monotonicity less often than FFP and MLP. For $C = 3, 9$, the difference between FFP and LBC is statistically significant at the .001 level.[17] Even though the rate of monotonicity violations is much larger than in real-world elections, the rate continues to be muted because few candidates beat *W* head-to-head.

[17] For $C = 3$, the difference between FFP and LBC has a p-value = 0.127.

As was the case for IEA, the violation rates for the IC-partial distribution are between the violation rates from the actual elections and IC-complete. Part of the reason it is lower than IC-complete is that the number of elections with at least one candidate who can beat W head-to-head is smaller in the partial data than in the complete data.

In addition, for FFP -- a procedure that focuses entirely on first-place votes -- a candidate targeted for elimination may be unranked in many partial ballots. In such ballots, it is impossible for a candidate to receive fewer first ranked votes by moving W into a higher position, because a candidate must have some first ranks to get fewer first ranks by the movement of W. Furthermore, moving W up in a ballot with only a couple ranked candidates can easily give W a majority and an early win, rather than eliminate a targeted candidate.

For MLP there are fewer violations from IC-partial than from IC-complete because with many unranked candidates, MLP largely focuses on eliminating unranked candidates. Raising W cannot manufacture a targeted elimination in those cases if moving W from unranked to ranked does not differentiate among the unranked candidates. Of course, the second explanation for FFP applies to MLP as well. Hence, it is more difficult for movements in W to flip the winning candidate.

Similarly, when several rivals are unranked together under LBC, moving W from unranked to ranked does not uniquely damage any one of them. Instead, it can eliminate other candidates that do not lead to a different winner at the end of the order. Of course there is still room for inversions, but there is less room than expected with the complete ballots.

With the partial ballots, LBC has the lowest rate of violation regardless of the number of candidates. However, the only statistically significant difference between FFP and LBC is for C

= 9, which is significant at the .01 level. We conclude that LBC performs at least as well as FFP on the monotonicity criterion.

Conclusion

The principal contribution of this research is to demonstrate that the normative performance of Ranked Choice Voting (RCV) is not only defined by ranked voting itself but also by the choice of the elimination procedure. By systematically comparing the traditional Fewest First Place procedure against Most Last Place and Least Borda Count, our study provides a novel, data-driven framework for evaluating RCV variants. We have shown that adopting a procedure sensitive to the entire ballot, such as Least Borda Count, reduces violations of key criteria, including the Condorcet Winner Criterion, Independence of Eliminated Alternatives, and Monotonicity. This challenges the common assumption that RCV is a singular electoral system with fixed normative properties.

The most profound differences in adhering to a criterion were found in the simulated Impartial Culture (IC) data, not in the current set of real-world RCV election data. The disparity is revealing. RCV elections, particularly in their nascent stages in the US, are frequently so skewed by decades of plurality voting and high levels of party polarization that RCV often yields the same result as plurality rule. If RCV advocates want the system to actually make a meaningful difference, they must prepare for conditions in which procedural rules matter -- namely, competitive multi-candidate elections that are not skewed. The IC-complete and IC-partial distributions, which model such highly competitive environments, serve as a critical proxy for the future state of RCV, when differences in procedural rules matter, including the voting rule itself.

Ultimately, this paper shifts the debate from simply asking, “Should we use RCV?” to meticulously defining, “How should RCV be implemented?” The evidence suggests that RCV’s failures, which critics often cite as definitive flaws, may not be inherent to preferential voting. Instead, they may be artifacts of the specific, commonly adopted elimination procedure. By providing a clear, empirically supported recommendation -- eliminating the candidate with the least Borda count -- we offer jurisdictions a practical path to more criterion-compliant elections. True commitment to fairer elections requires not just adopting a ranked system but designing its administrative rules with enough precision to realize a voting rule’s full potential.

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