Free riding

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1 Introduction

The fact that more and more communities that use proportional representation by the single transferable vote (STV) change from manual count to computer count gives us today the possibility to check hypotheses that have been made in the past about possible voting behaviours. In this paper, I use the ballot data of the 1999 and the 2001 City Council elections and School Committee elections in Cambridge, Massachusetts, to estimate the number of voters who use a voting behaviour that has been predicted e.g. by Woodall [1] and Tideman [2].

2 Woodall Free Riding

Woodall free riding is a useful strategy only for those STV methods where votes of eliminated candidates cannot be transferred to already elected candidates and therefore jump directly to the next highest ranked *hopeful* (i.e. neither yet elected nor yet eliminated) candidate. A *Woodall free rider* is a voter who gives his first preference to a candidate who is believed by this voter to be eliminated early in the count even with this voter's first preference. With this strategy this voter assures that he does not waste his vote for a candidate who is elected already during the transfer of the initial surpluses.

Woodall writes [1]:

> "The biggest anomaly is caused by the decision, always made, not to transfer votes to candidates who have already reached the quota of votes necessary for election. This means that the way in which a given voter's vote will be assigned may depend on the order in which candidates are declared elected or eliminated during the counting, and it can lead to the following form of tactical voting by those who understand the system. If it is possible to identify a candidate W who is sure to be eliminated early (say, the Cambridge University Raving Loony Party candidate), then a voter can increase the effect of his genuine second choice by putting W first. For example, if two voters both want A as first choice and B as second, and A happens to be declared elected on the first count, then the voter who lists his choices as 'A B...' will have (say) one third of his vote transferred to B, whereas the one who lists his choices as 'W A B...' will have all of his vote transferred to B, since A will already have been declared elected by the time W is eliminated. Since one aim of an electoral system should be to discourage tactical voting, this seems to me to be a serious drawback."

However, Woodall free riding can be prevented by restarting the STV count with the remaining candidates whenever a candidate has been eliminated. Actually, the Meek method [3] and the Warren method [4] do this. Therefore, Woodall [1] and Tideman [2] suggest that one of these methods should be used.

A good test for Woodall free riding is an STV election with *write-in options* (i.e. with the possibility for the voters to vote for any person by writing this person's name on the ballot). The City Council and the School Committee of Cambridge, Massachusetts, are elected by an STV method that is vulnerable to Woodall free riding and that has write-in options. In the elections to the 9 seats of the City Council, the voter can vote for up to 9 write-ins. In the elections to the 6 seats of the School Committee, the voter can vote for up to 6 write-ins. Here the optimal Woodall free riding strategy is to give one's first preference to a completely unimportant write-in.

	CC 1999	SC 1999	CC 2001	SC 2001
1	18,613	17,796	17,125	16,488
2	28	26	30	51
3	9	5	12	32
4	0	4	0	2
5	19	17	18	17

Table 2.1: Potential write-in Woodall free riders in the 1999 and the 2001 elections to the City Council and the School Committee of Cambridge, Massachusetts

In table 2, row "1" contains the numbers of voters in the 1999 City Council elections (column "CC 1999"), in the 1999 School Committee elections (column "SC 1999"), in the 2001 City Council elections (column "CC 2001"), and in the 2001 School Committee elections (column "SC 2001") in Cambridge, Massachusetts. Row "2" contains the numbers of voters who cast a first preference for a write-in. Row "3" contains the numbers of voters who have to be subtracted from row "2" because they cast preferences only for write-ins and who are therefore obviously not Woodall free riders. Furthermore, those voters who do not cast at least a valid second and a valid third preference have to be subtracted (row "4") because these voters cannot be Woodall free riders. Therefore, row "5" contains the numbers of voters who could be write-in Woodall free riders.

In all four elections, the number of voters who could be write-in Woodall free riders is about 0.1%. When we investigate these voters in greater detail we observe: Of the 19 potential write-in Woodall free riders in the 1999 City Council elections, only 2 cast a second preference for Galluccio. Of the 17 potential write-in Woodall free riders in the 1999 School Committee elections, only 2 cast a second preference for Turkel. Of the 18 potential write-in Woodall free riders in the 2001 City Council elections, only 5 cast a second preference for Galluccio, 2 for Davis, and one for Murphy. Of the 17 potential write-in Woodall free riders in the 2001 School Committee elections, only 4 cast a second preference for Turkel, one for Fantini, and none for Grassi. Therefore, also these voters seem to be not Woodall free riders because otherwise super-proportionally many of these voters would have cast a second preference for a candidate who reached the quota before candidates had to be eliminated. See table 2.2.

Suppose V is the number of voters. Suppose $V_1(A)$ is the number of voters who cast a valid first preference for candidate A. Suppose $V_2(A)$ is the number of voters who cast a valid first preference for candidate A and at least also a valid second preference. Suppose V(A,B) is the number of voters who cast a valid first preference for candidate A, a valid second preference for candidate B, and at least also a valid third preference.

Woodall free riding is a useful strategy only when one has at least a sincere first and a sincere second preference. A given voter can be a Woodall free rider only when he casts at least a valid first, a valid second, and a valid third preference. When a given voter whose sincere first preference is candidate B uses Woodall free riding then $V_2(B)$ decreases and for some other candidate A, who is eliminated early in the count, V(A,B) increases. Therefore, another good test for Woodall free riding is to calculate V(A,B) for each pair of candidates. If (1) $V(A,B)/V_1(A)$ is large compared to $V_2(B)/V$ and (2) $V(A,B)/V_1(A)$ decreases with increasing $V_1(A)$ for those pairs of candidates where candidate A is eliminated early in the count and candidate B is elected before candidates have to be eliminated then this is evidence that voters use Woodall free riding.

Table 2.2 contains $V_2(B)/V$ for each candidate B who is elected before candidates have to be eliminated. Tables 2.3 to 2.6 contain V(A,B) for each pair of candidates A and B where candidate B is elected before candidates have to be eliminated. Column "$V_1(A)$" contains the numbers of voters who cast a valid first preference for the candidate in column "candidate A". The column "Galluccio" (resp. "Turkel", resp. "Davis", etc.) contains the numbers of voters of column "$V_1(A)$" who cast a valid second preference for Galluccio (resp. Turkel, resp. Davis, etc.) and cast at least also a valid third preference.

In tables 2.3 to 2.6, $V(A,B)/V_1(A)$ rather increases than decreases with increasing $V_1(A)$. Also the prediction that $V(A,B)/V_1(A)$ is large compared to $V_2(B)/V$ is not fulfilled. This is surprising because in so far as Woodall free riding certainly is a useful strategy one would expect that at least some voters use this strategy. A possible explanation why voters do not use Woodall free riding is that they fear that when too many voters give their first preference to candidate A because they believe that he is eliminated early in the count then it could happen that candidate A gets so many votes that he is elected [2, 5, 6]. But this can only explain why $V(A,B)/V_1(A)$ does not decrease so fast with increasing $V_1(A)$; this cannot explain why $V(A,B)/V_1(A)$ increases with increasing $V_1(A)$. A possible explanation why $V(A,B)/V_1(A)$ increases with increasing $V_1(A)$ is

that voters are confronted with two problems:

1. It is a useful strategy not to waste one's vote by voting for a candidate B who is elected even without one's vote. However, when too many voters use Woodall free riding and cast a first preference for candidate A because they believe that he is eliminated early in the count even with one's vote then it could happen that candidate A gets so many votes that he is elected.
2. It is a useful strategy not to vote for a candidate A who is believed to be eliminated with a great probability even with one's vote, because otherwise there is the danger that there are not acceptable candidates anymore to whom this voter could transfer his vote when candidate A is eliminated.

Because of problem 2 only those voters who cannot identify themselves with any of the stronger candidates vote for candidates who are believed to be eliminated with a great probability; therefore, $V(A,B)/V_1(A)$ is low for low $V_1(A)$ for those candidates B who are elected before candidates have to be eliminated; therefore, $V(A,B)/V_1(A)$ rather increases than decreases with increasing $V_1(A)$.

3 Hylland Free Riding

Problem 1 can be circumvented by using Hylland free riding instead of Woodall free riding. Hylland writes [7]:

> "Both for groups and for individual voters it could be advantageous not to vote for a candidate who is considered certain of winning election, even if that candidate is one's first choice. Suppose that my true first and second choices are A and B, I am sure A will get many more first preferences than needed for election, but I find B's chances uncertain. If I list A as the first preference on my ballot, its weight is reduced before it reaches B. If I omit A, B gets a vote with full weight."

In short, a Hylland free rider is a voter who omits in his individual ranking completely all those candidates who are certain to be elected. Of course, when too many voters use Hylland free riding then it can happen that the candidate with the cast first preference is elected while the candidate with the sincere first preference is eliminated. However, when a voter uses Hylland free riding then the candidate with the cast first preference is one of this voter's favorite candidates while when this voter uses Woodall free riding then the candidate with the cast first preference is a candidate who this voter does not want to be elected.

Problem 2 can be circumvented by voting only for those candidates who are believed to be in the race until the final count. In so far as a candidate will be in the final count when he has more than V/(S+2) first preferences, where V is the number of voters and S is the number of seats, it is a useful strategy to cast one's first preference only for one of those candidates who are believed to get between V/(S+2) and V/(S+1) first preferences.

This voting behaviour could best be observed in Canada because here the city councils were elected for a one year term and in a single city-wide district so that the voters had very precise information about the support of the different candidates. A consequence of this voting behaviour was that usually almost all first preferences were concentrated on S+1 almost equally strong candidates [8, 9, 10]. Johnston [9] writes that one of the main criticisms of STV was that it was "one of the most common features of PR in Canadian municipal elections" that "the final count closely mirrored the results of the first count". And Pilon [10] writes that the main problem of STV in Canada was that it "did not seem to make much difference in the results. After days of counting, eliminating candidates, and transferring fractions of support from one aspirant to another, there was little difference between the first choice results and the final tally."

4 Summary

Free riding is a very serious problem of STV. The two free riding strategies that have been predicted in the literature are Woodall free riding [1, 2] and Hylland free riding [7]. It is not possible to extract the number of Hylland free riders simply from the ballot data. But with additional assumptions it is possible to extract the number of Woodall free riders.

I used the ballot data of the 1999 and the 2001 City Council elections and School Committee elections in Cambridge, Massachusetts, to estimate the number of voters who use Woodall free riding. I could not find any evidence at all that voters use this strategy. Possible explanations why voters do not use this strategy are:

1. When too many voters cast a first preference for candidate A, not because he is their sincere first preference but because they believe that he will be eliminated early in the count, it could happen that this candidate gets so many votes that he is elected [2, 5, 6].
2. It is not useful to vote for a candidate A who is eliminated with a great probability, because it could happen that there are not acceptable candidates anymore to whom this voter could transfer his vote when candidate A is eliminated.
3. When a voter considers his second favorite candidate to be only slightly worse than his favorite candidate then Hylland free riding [7] is less dangerous than Woodall free riding in so far as a backfire is less severe under Hylland free riding than under Woodall free riding.
4. The political organizations have not yet found a simple way to use Woodall free riding on a larger scale to increase their numbers of seats. Therefore, the voters are usually not pointed to this strategic problem.

5 References

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Election	Candidate B	V	V_1(B)	V_1(B)/V	V_2(B)	V_2(B)/V
1999 City Council	Anthony D. Galluccio	18,613	2,705	14.5%	2,515	13.5%
1999 School Committee	Alice L. Turkel	17,796	2,617	14.7%	2,360	13.3%
2001 City Council	Henrietta Davis	17,125	1,713	10.0%	1,645	9.6%
2001 City Council	Brian Murphy	17,125	1,716	10.0%	1,627	9.5%
2001 City Council	Anthony D. Galluccio	17,125	3,230	18.9%	2,947	17.2%
2001 School Committee	Joseph G. Grassi	16,488	2,135	12.9%	1,728	10.5%
2001 School Committee	Alfred B. Fantini	16,488	2,854	17.3%	2,353	14.3%
2001 School Committee	Alice L. Turkel	16,488	2,862	17.4%	2,484	15.1%

Table 2.2: V_2 (B)/V for each candidate B who is elected before candidates have to be eliminated

Candidate A	V_1(A)	Anthony D. Galluccio
Charles O. Christenson	28	2 (7.1%)
Daejanna P. Wormwood-Malone	28	0 (0.0%)
William C. Jones	31	2 (6.5%)
Alan Kingfish Nidle	40	0 (0.0%)
Vincent Lawrence Dixon	44	3 (6.8%)
Jeffrey Jay Chase	102	10 (9.8%)
Dorothy M. Giacobbe	109	22 (20.2%)
James M. Williamson	128	2 (1.6%)
Robert Winters	301	27 (9.0%)
Helder Peixoto	308	46 (14.9%)
David Hoicka	325	7 (2.2%)
Erik C. Snowberg	425	12 (2.8%)
David Trumbull	533	129 (24.2%)
Bob Goodwin	805	296 (36.8%)
David P. Maher	1,030	309 (30.0%)
Katherine Triantafillou	1,167	42 (3.6%)
Michael A. Sullivan	1,321	278 (21.0%)
Kenneth E. Reeves	1,420	149 (10.5%)
Henrietta Davis	1,458	70 (4.8%)
Jim Braude	1,480	50 (3.4%)
Timothy J. Toomey, Jr.	1,497	233 (15.6%)
Marjorie C. Decker	1,642	43 (2.6%)
Kathleen Leahy Born	1,658	100 (6.0%)

Table 2.3: Potential Woodall free riders in the 1999 City Council elections in Cambridge, Massachusetts

Candidate A	V_1(A)	Alice L. Turkel
Shawn M. Burke	212	6 (2.8%)
Jamisean F. Patterson	278	9 (3.2%)
Alvin E. Thompson	373	35 (9.4%)
Melody L. Brazo	471	82 (17.4%)
Donald Harding	698	24 (3.4%)
Elizabeth Tad Kenney	738	134 (18.2%)
Michael Harshbarger	1,550	109 (7.0%)
Nancy Walser	1,894	520 (27.5%)
Susana M. Segat	1,985	480 (24.2%)
Joseph G. Grassi	2,269	97 (4.3%)
Alfred B. Fantini	2,277	55 (2.4%)
Denise Simmons	2,408	506 (21.0%)

Table 2.4: Potential Woodall free riders in the 1999 School Committee elections in Cambridge, Massachusetts

Candidate A	V_1(A)	Henrietta Davis	Brian Murphy	Anthony D. Galluccio	Sum (Gallucio, Murphy, Davis)
James M. Williamson	58	2 (3.4%)	2 (3.4%)	3 (5.2%)	7 (12.1%)
James E. Condit, III	63	6 (9.5%)	0 (0.0%)	5 (7.9%)	11 (17.5%)
Helder Peixoto	69	5 (7.2%)	3 (4.3%)	7 (10.1%)	15 (21.7%)
Vincent Lawrence Dixon	92	2 (2.2%)	3 (3.3%)	7 (7.6%)	12 (13.0%)
Robert L. Hall	153	3 (2.0%)	13 (8.5%)	18 (11.8%)	34 (22.2%)
Jacob Horowitz	155	14 (9.0%)	12 (7.7%)	6 (3.9%)	32 (20.6%)
Steven E. Jens	278	8 (2.9%)	5 (1.8%)	35 (12.6%)	48 (17.3%)
Steve Iskovitz	345	29 (8.4%)	30 (8.7%)	9 (2.6%)	68 (19.7%)
Ethridge A. King	378	43 (11.4%)	46 (12.2%)	25 (6.6%)	114 (30.2%)
David P. Maher	1,017	32 (3.1%)	41 (4.0%)	304 (29.9%)	377 (37.1%)
John Pitkin	1,091	222 (20.3%)	202 (18.5%)	48 (4.4%)	472 (43.3%)
Kenneth E. Reeves	1,141	72 (6.3%)	34 (3.0%)	125 (11.0%)	231 (20.2%)
Michael A. Sullivan	1,315	45 (3.4%)	28 (2.1%)	316 (24.0%)	389 (29.6%)
Denise Simmons	1,339	186 (13.9%)	137 (10.2%)	74 (5.5%)	397 (29.6%)
Timothy J. Toomey, Jr.	1,402	44 (3.1%)	11 (0.8%)	272 (19.4%)	327 (23.3%)
Marjorie C. Decker	1,540	298 (19.4%)	215 (14.0%)	163 (10.6%)	676 (43.9%)
Henrietta Davis	1,713	—	254 (14.8%)	114 (6.7%)	
Brian Murphy	1,716	343 (20.0%)	—	105 (6.1%)	
Anthony D. Galluccio	3,230	137 (4.2%)	90 (2.8%)	—	

Table 2.5: Potential Woodall free riders in the 2001 City Council elections in Cambridge, Massachusetts

Candidate A	V_1(A)	Joseph G. Grassi	Alfred B. Fantini	Alice L. Turkel	Sum (Turkel, Fantini, Grassi)
Vincent J. Delaney	240	23 (9.6%)	29 (12.1%)	5 (2.1%)	57 (23.8%)
Fred Baker	324	28 (8.6%)	62 (19.1%)	9 (2.8%)	99 (30.6%)
Marla L. Erlien	1,193	21 (1.8%)	25 (2.1%)	272 (22.8%)	318 (26.7%)
Susana M. Segat	1,590	61 (3.8%)	107 (6.7%)	619 (38.9%)	787 (49.5%)
Nancy Walser	1,677	42 (2.5%)	68 (4.1%)	596 (35.5%)	706 (42.1%)
Richard Harding, Jr.	1,689	172 (10.2%)	156 (9.2%)	176 (10.4%)	504 (29.8%)
Alan C. Price	1,873	41 (2.2%)	71 (3.8%)	319 (17.0%)	431 (23.0%)
Joseph G. Grassi	2,135	—	698 (32.7%)	94 (4.4%)	
Alfred B. Fantini	2,854	942 (33.0%)	—	158 (5.5%)	
Alice L. Turkel	2,862	97 (3.4%)	133 (4.6%)	—	

Table 2.6: Potential Woodall free riders in the 2001 School Committee elections in Cambridge, Massachusetts