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EXPERIMENTALLY TESTING THE BORDA COUNT AND PLURALITY VOTING WITH MULTIPLE ALTERNATIVES

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ABSTRACT

Scholars have investigated the relative merit of plurality voting and the Borda count to guide the design of elections. Under plurality voting, each voter casts one vote, and the option with the most votes wins. In the Borda count, participants rank n candidates on a scale where the lowest-ranked candidate gets 0 points, and the highest gets n−1 points. We conduct a survey experiment that compares the efficiency of plurality voting and the Borda count. Throughout this experiment, participants engage in decision-making processes in which we compare which type of these voting mechanisms is most effective in which participants vote honestly and strategically. We conclude that plurality voting outperforms the Borda count in our context.

Keywords: Borda count,plurality.

JEL classification: D72

Introduction

In many circumstances, a group of individuals needs to decide in multicandidate elections. The group will often disagree on which alternatives are more critical or desired than others. This contention requires a form of aggregation to reach a decision that is acceptable to all members. Often, this system involves a system of voting. For example, early medieval monarchs would make decisions for the entire group for everyone's benefit, assuming they had good intentions. But, this does not consider the perspectives of others, so there might be biases. An increasing number of modern societies have adopted a more democratic system. There are many voting systems, but these societies use a voting system to make decisions for the entire group in every case. In any case, voters are provided with a list of valid candidates and report their preferences. In this study, we consider two types of voting methods: plurality voting and the Borda count.

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There will always be one winner unless multiple candidates are tied.

An alternative to these two methods is quadratic voting: a system in which people pay money and the intensity of their preference matters. Participants are given a certain amount of money, and depending on how many votes, n, they want to cast, they will have to pay n^2. As Jacob K. Goeree and Jingjing Zhang (2016) noted in *One Man, One Bid*, quadratic voting proved to be much more efficient than majority voting.

The most common electoral system is plurality voting, in which participants are asked for only their first preference, and the choice with the most significant number of votes wins. A vulnerability of this method is the spoiler effect which affects the outcome when the field of candidates expands – where candidate X or Y wins depending on whether a third candidate (the "spoiler") enters. As noted by N. R. Miller in Voting to Elect a Single Candidate (2006), Florida's electoral votes in the 2000 presidential election almost certainly would've been won by Gore, leading to his presidency had Nader not been on the ballot in Florida. With Nader's 97,488 votes in Florida, the removal of Nader could've given Gore the state's 25 electoral votes without the need for a recount. In a 2001 study, Gerald Pomper argues that Nader's removal would have led to Gore's victory: "approximately half (47 percent) of the Nader voters said they would choose Gore in a two-person race, a fifth (21 percent) would choose Bush, and a third (32 percent) would not vote. Applying these figures to the actual vote, Gore would have achieved a net gain of 26,000 votes in Florida, far more than needed to carry the state easily." Thus, it can be said that using plurality voting for multicandidate elections is not practical and is possibly the worst method. Plurality voting is ineffective in this case because it does not always select the best candidate. If Bush is the best candidate, plurality voting fails when only Bush and Gore are in the race. If Gore or Nader is the best candidate, then plurality voting fails when all three candidates are in the race.

A Borda count tries to achieve a result that satisfies all participants where participants rank n candidates on a scale where the lowest-ranked candidate gets 0 points, and the highest gets n - 1 points. The result, again, sums up the votes for the candidates. M. de Borda established the Borda count officially in 1770 and suggested the voting system described above. However, the method of rewarding points in an opposite manner was utilized where (first, second…. last) preferences are cast as per (n, n - 1,…, 1) or more frequently, (n - 1, n - 2,… , 0). Peter Emerson analyzes the partial voting and the Borda count in *The original Borda count and partial voting* (2013). He considers a system of partial voting that allows voters to give the maximum number of points to one candidate and the minimum number of points to all other candidates. He argues that if partial voting is allowed, participants will be incentivized to only rank one candidate, and thus the Borda count metamorphosizes into a plurality vote. However, the Borda count is easily

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manipulated and therefore not used often. For example, suppose that there is an option, option D, that you dislike. However, option D is not your least favorite option. If you believe that this option D is popular enough that it will win if you do not assign it the lowest ranking, but your favorite option will win if you assign D the lowest ranking, you have an incentive to manipulate the Borda count by giving D the lowest ranking.

Myerson (2006) studies an example showing that strategic voting can cause plurality voting and the Borda count to perform poorly. Myerson (2006) examines plurality voting and the Borda count in an environment with heterogeneous preferences and corruption. There are two ideological types of voters, left voters and right voters, who prefer candidates with similar ideologies to candidates with different ideologies. Candidates may also be clean or corrupt. All voters prefer a clean candidate of a given ideology to a corrupt candidate of the same ideology. If the clean left and the clean right candidates are the only ones with a shot, left supporters to have an incentive to rank the clean left candidate first and the clean right candidate fourth. Right supporters have an incentive to rank the clean right candidate first and the clean left candidate fourth. Suppose left supporters rank the corrupt left candidate second and the corrupt right candidate third and vice versa for right supporters. Under the assumption that left and right supporters are equally numerous, the election becomes a 4-way tie, and our belief that only clean candidates have a shot therefore no longer holds. As a result, using the Borda count, all candidates are reasonably likely to win.

In this setting, voters have an incentive to manipulate the outcome by dishonestly reporting their preferences. Left supporters favor the clean left candidate and know that the clean right candidate will be the clean left candidate's most formidable opponent. They, therefore, have an incentive to manipulate the outcome by misreporting their preferences. By assigning the lowest ranking to the clean right candidate, they reduce the chance that the clean right candidate will defeat the clean left candidate. Such voting tactics are insincere since left supporters dislike corrupt right candidates even more than clean right candidates.

In contrast to the Borda count, plurality voting has multiple equilibria. A good equilibrium exists where the clean candidates attract the votes of their ideological supporters, and therefore no incentive exists to vote for the corrupt candidates. However, an unsatisfactory equilibrium occurs if voters on each side vote for the corrupt candidate that supports their favored policy. In this equilibrium, the clean candidates are unlikely to win even if an individual voter votes for them. Therefore, it is in each voter's interest to vote for an ideological supporter of the corrupt candidate. From this model, we conclude that it is possible for either plurality voting or the Borda count to produce more efficient results. However, we also conclude that neither mechanism is guaranteed to deliver an optimal outcome.

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An ideal democratic competition should implement the majority's preferences and provide a deterrent against the corrupt abuse of power (Myerson 2006). We consider the performance of approval voting in a modified version of the previous environment that adds neutral voters who only care about an honest government. When approval voting is used, all left voters will only approve clean left candidates, and right voters will approve of clean right candidates. Neutral voters will only care about corruption and so will endorse all clean candidates. To defeat the clean candidates in approval voting, a corrupt candidate would need votes from leftist and rightist voters. Myerson proves that approval voting is unique because it creates pressure against political corruption. Myerson (2006) does not consider that approval voting may suffer from a problem that Jack Nagel calls the Burr dilemma. Nagel arrives at his conclusion by using a model that is different from Myerson's. Myerson's model features voters who choose who to vote for, while Nagel's model features candidates who can directly influence voters' votes.

In The Burr Dilemma in Approval Voting by Jack Nagel (2007), when three or more candidates compete for office, and only one can win, candidates (C_1 and C_2) seek support from a group of voters (G). They will maximize their respective votes if members of G vote for both C_1 and C_2. This voting would result in a tie. Both candidates now have an incentive to encourage some members of G to only vote for themselves. If both candidates followed the strategy, there is a chance that either or both candidates may receive fewer votes than some other candidate C_3. Continuing this idea, Nagel states: "At the limit, such retribution reduces approval voting to conventional single-vote balloting among the members of G (voters) or, if the problem is endemic, among all voters." Because approval voting seems to be the most effective voting method, it is surprising that it has not been implemented in countries with democratic systems. Its lack of usage may be because it still has a flaw.

Myerson (1999) characterizes voting mechanisms theoretically. A scoring rule can represent both the Borda count and plurality voting. In a scoring rule voting system, each voter's ballot specifies some points to give to each candidate, and the candidate with the most points wins. For an election with K alternatives, a rank- scoring rule is characterized by a list of numbers $s_1,\cdots,s_k$ such that $1 = s_1 \geq s_2 \geq \cdots \geq s_{k-1} \geq s_k = 0$. A. rank-scoring rule restricts a voter's ballot to be some permutation of $(1, s_2 , \cdots , s_{k-1} , 0)$. Plurality voting is a rank-scoring rule characterized by $s_j = 0$ for all $j > 1$. The Borda count is a rank-scoring rule characterized by

$$s_1 = 1, s_2 = \frac{K-2}{K-1}, \cdots, s_{K-1} = \frac{1}{K-1}, s_K = 0.$$

A scoring rule is best-rewarding if it has small values of (s_2 ….. s_{k-1}). A scoring rule is worst-punishing if it has large values of (s_2 …. s_{k-1}). Thus, Plurality voting is the best-rewarding rule,

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while the Borda count is the somewhat worst-punishing rule.

Because plurality voting is best-rewarding, options are strengthened by the perception that they are likely to succeed. In plurality voting, nobody wants to waste a vote on an option that is hopelessly behind. Hence, the perception that an option is not a severe contender ensures that the option will not win. Because the Borda count is somewhat worst-punishing, an option can be strengthened by the perception it is unlikely to succeed. If an option is perceived as not a serious contender, it can begin making a comeback because there is little incentive to punish options that are unlikely to win by placing them at the bottom of your list. Suppose an option is perceived as unlikely to succeed. In that case, participants who dislike that option have an incentive to place it in the middle of their lists so that they can reserve the bottom of their lists of severe contenders that they dislike.

Different systems may produce different results (Myerson 2006). Therefore, we compare these two methods and decide which is most effective and whether participants should vote strategically or honestly.

This study asked people to vote on eight different drinks consisting of coffee, fruit smoothies, boba tea, hot cocoa, soft drinks, plain milk, fruit juice, and tea. However, due to the restrictions of COVID-19, we must assume that everyone answered honestly. Honesty is not guaranteed because our question is hypothetical. List (2001) studies the bidding behavior of dealers and non dealers in theoretical and actual auctions involving sports cards. For both non dealers and dealers, the mean hypothetical bid to mean real ratio was 1.8-1.95.

In a subcategory of the Borda count, participants were incentivized with $10 to manipulate the process so that their drink might win. With one exception, each voter chose a drink they would vote for during plurality voting and place it at the top of their list during the Borda count. There was a consensus that coffee was the best drink in the honest Borda count. However, the incentivized Borda count resulted in a victory for tea by a significant amount with no participant able to change the result. This outcome implies that a manipulated voting may be more detrimental to the crowd than helpful.

Conceptual Framework

We adopt a quasilinear framework. We assume that the participant i would receive a payoff of Vi,d – Pi,d if the participant receives drink d but must pay a price $P_{i,d}$ for it. As a result, $V_{i,d}$ can be interpreted participant i's willingness to pay for drink d. We assume participants maximize the expected payoff.

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Experimental Design, Procedures, and Hypotheses

Due to COVID-19 restrictions, we conducted most of our experiments via email and surveys. We allowed participants to choose from 8 pre-decided drinks to understand the performance of plurality voting and the Borda count when dealing with multiple alternatives.

We study and compare the performance of these two voting mechanisms using a group of 30 participants. We sent out a total of two surveys. Before participants voted, we explained how each voting process worked in the instructions. Participants were asked questions regarding the following list of eight drinks: coffee, fruit smoothies, boba tea, hot cocoa, plain milk, fruit juice, and tea. We opted for such a variety of drinks to ensure participants would at least favorite one. Participants were asked to order these drinks from most to least preferred. A week later, in a second survey, we required them to report a willingness to pay for each of these drinks between 0 and 10 dollars inclusive. This valuation data is critical for evaluating mechanism efficiency. In our case, attrition was not an issue as all participants who filled out the first survey filled out the second survey. Attrition can result in false conclusions (Zhou and Fishbach 2016) if they are endogenous. In some cases, attrition may not induce bias because dropping out is an exogenous event (Arechar et al. 2018).

We asked participants to participate in two voting mechanisms. The first mechanism was plurality voting: participants were required to vote for precisely one drink. The second mechanism was the Borda count: participants were required to assign eight points to one drink, seven points to one drink, six points to one drink, five points to one drink, four points to one drink, three points to one drink, two points to one drink, and one point to the last drink. The drink with the highest total number of points won. There were no ties in the plurality voting nor the Borda count, so there was no need to break ties. We created two versions of the Borda count, one where participants were asked honestly and the second where they were asked to vote strategically. Participants were aware that they might win a $10 Amazon gift card based on their voting behavior in the second. Specifically, the information we provided was "If your drink wins (read the survey carefully for more details), you will receive a $10 Amazon gift card." In the survey, the question provided regarding this was: "Please vote in a way so that your favorite drink will win among a crowd of 30 participants. Your drink will win if it has the most points at the end of the survey." We ended up awarding a gift card to any participant that voted for tea, the winner in the Borda count, during plurality voting. We use the term "incentivized Borda count" to refer to the data from this question.

Procedures

We recruited a convenience sample of 30 subjects. The survey was carried out online through

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Google Forms. In addition, eight participants received gift cards. We collected data in two rounds. The first round was sent out on June 16, 2021. The first round contained both Borda count surveys and the plurality voting survey. The second round was sent out on June 23, 2021. The second round contained the valuation survey. The delay between the two rounds may explain that the implied preference orderings from the honest Borda count survey and valuation survey do not always agree: preferences may have changed between the two surveys.

Hypotheses

We hypothesized that the Borda count might perform poorly due to strategic voting. For instance, it is known that the Borda count has a substantial chance of electing a corrupt candidate in a context with disagreement on policy questions and corruption.

Results

Preferences

We first explore the preferences of our participants. Table 1 displays summary statistics of our preference data. Coffee was a popular drink in this group. It is the most common favorite drink. For average ranking, lower numbers indicate drinks that were more likely to be preferred by members of this group. For instance, coffee had the highest average ranking, and plain milk had the lowest average ranking. We use our question about willingness to pay for drinks to determine the value of drinks to participants. Coffee has the second-highest average value. Fruit smoothies have the highest average value, despite that only two people view fruit smoothies as their favorite drink.

Table 1: Summary of preference data

	Coffee	Fruit Smoothies	Boba Tea	Hot Cocoa	Soft Drinks	Plain Milk	Fruit Juice	Tea
Number of consumers who rank drink first	11	2	1	3	1	2	2	7
Average ranking	3.1333	3.6667	5.4000	5.5333	5.0667	5.5000	4.1000	3.6000
Average value	5.7000	5.7333	3.6833	3.4833	3.0333	2.6500	4.2667	4.7500

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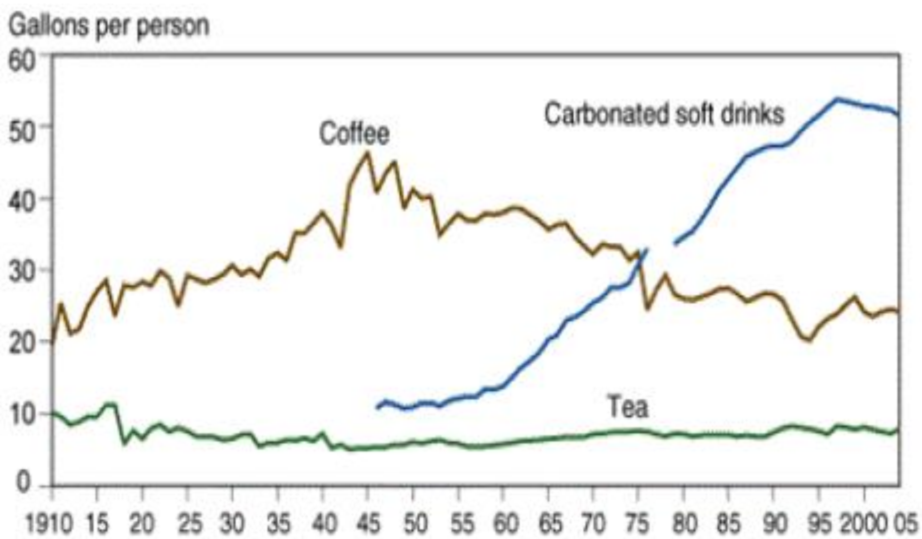
Fruit smoothies have a slightly higher average value than coffee. Because fruit smoothies have the highest average value, an efficient decision-making mechanism would choose fruit smoothies. However, plurality voting and the Borda count may fail to select fruit smoothies. For instance, they would not select fruit smoothies if participants voted honestly. Coffee has a higher average value than tea. These results indicate that our group is more biased towards some drinks when compared to the average United States population. The graph suggests that soft drinks are more popular than tea and coffee, but that is not the case here. Coffee and tea were ranked first and second in the average rankings, while soft drinks ranked fifth. It is not surprising that coffee beats tea, but the surprising part is soft drinks are much higher than both. This finding may be due to soft drink's lower price point.



Source: USDA, Economic Research Service using data on carbonated soft drinks from the Bureau of the Census for 1947-77 and the Beverage Marketing Corporation for 1980-2005.

Voting Behavior

Comparative Efficiencies

Following Lalley and Weyl (2019), we define efficiency as the unique increasing linear function of welfare that takes values between 0 and 1. Let W_{best} be the total value measured in dollars provided to the group by the best decision, W_{worst} be the total value measured in dollars provided to the group by the worst decision, $W_{mechanism}$ be the total value measured in dollars provided to the group by the mechanism and $E_{mechanism}$ be the efficiency of the mechanism.

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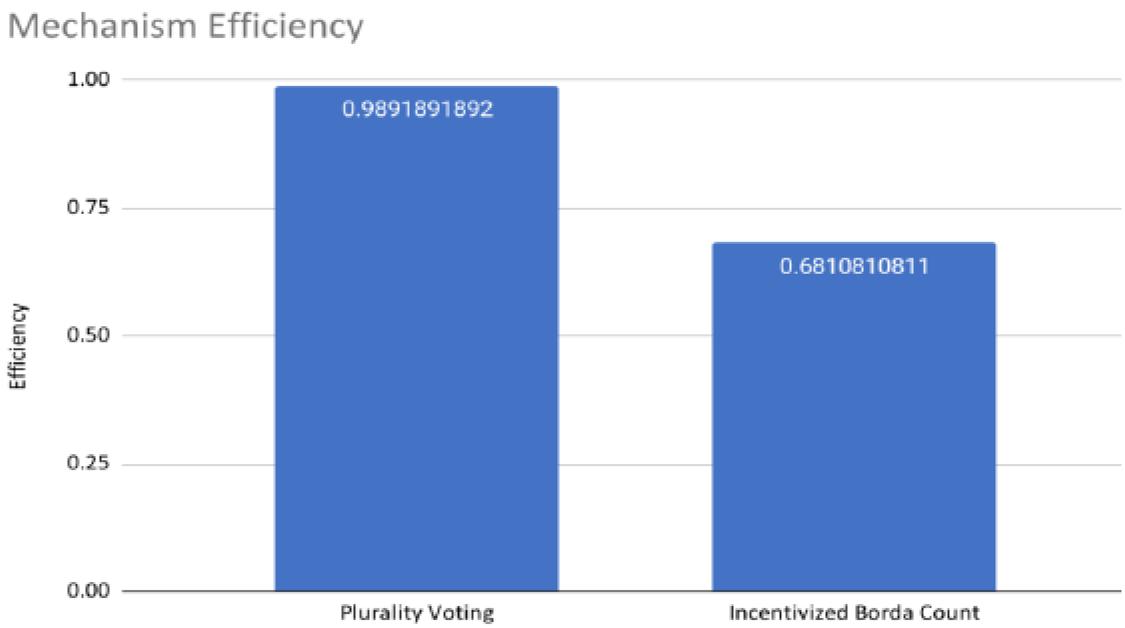
We define the mechanism's efficiency as $E_{mechanism} = \frac{W_{mechanism} - W_{worst}}{W_{best} - W_{worst}}$

($W_{mechanism}$ is calculated by averaging the mechanism's efficiency across tiebreaker outcomes if the mechanism resulted in a tie.)

The chart below compares the relative efficiency of the mechanisms.



Plurality voting has higher efficiency than the Borda count.

Comparative Equity

The incentivized Borda count produced a selection of tea, which was more universally acceptable than coffee, the choice of plurality voting. Four participants did not value coffee, but all participants valued tea. The graph below shows the distribution of valuations for coffee and tea.

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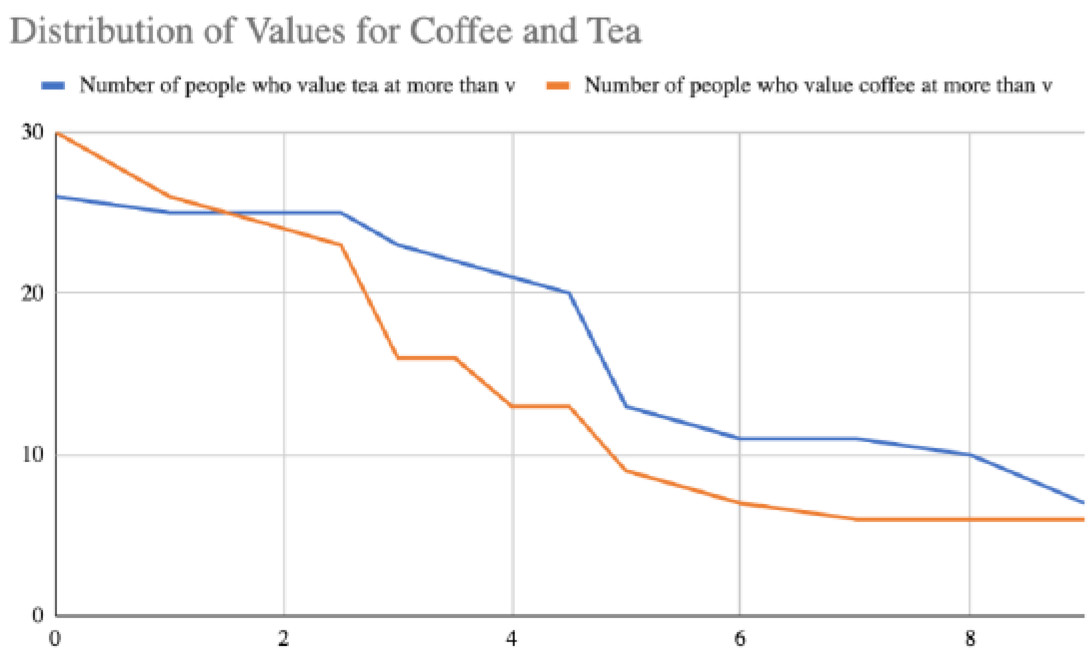

Although more people like tea at least a little than people who like coffee at least a little, more people who want coffee a lot than there are people who like tea a lot. This behavior is an example of the tendency of the Borda count to choose a broadly acceptable alternative (Lippman 2017).

Borda Count

Coffee won in plurality voting, and tea won in the incentivized Borda count. Strategic voting occurred in both mechanisms. In plurality voting, 29 participants voted for their favorite drinks. One of the participants who preferred coffee voted for tea. This participant liked both coffee and tea. This participant indicated a value of \$10 for coffee and \$9 for tea. As a result, coffee received ten votes, and tea got eight votes. No participant could have caused a preferred drink to win under plurality voting by changing their vote.

Each person’s vote in the incentivized Borda count differed from their preference ranking. As mentioned before, coffee won in the honest Borda count, signifying that the crowd's favorite and tea had come in second. However, in the incentivized Borda count, the positions were reversed. In both cases, each drink won by a significant margin, with no participant able to change the outcome. Because coffee had a higher value than tea, plurality voting outperformed the Borda count.

We created a simulation of running each participant's strategy 10,000 times against other

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strategies to figure out why this happened. In each simulation, 29 strategies will be chosen with replacement from a pool of the 29 other participants and be compared to the main one. For each participant, our output contains three numbers representing the expected payoff for their honest strategy, incentivized strategy, and the differences between their strategies (p-value). The numbers can represent the expected payoff in dollars for the honest and incentivized strategies. The third number shows us the significance of the difference between the payoffs of each strategy. A lower number signifies that both strategies give different average payoffs, while a higher number indicates similar average payoffs. When analyzing the contribution of various types of voters to the win of tea, we only took the ones where the difference where the p-value was less than .05 to make sure the participant's choice had a significant impact on the result. We found that the victory of tea was due to the good and bad decisions of participants. Out of 30 participants, six voted smartly to lead their drink to victory. On the other hand, a total of 17 participants voted in a way that did not contribute to the victory of their drink and indirectly contributed to the victory of tea, thus making bad decisions during the voting process. For each of the other seven participants, voting honestly would have achieved similar payoffs to using the observed voting strategy. Based on this information, it is noticeable that a Borda count usually has negative side effects, which may explain why it is rarely used.

Using similar simulations, we also compare the basic strategy with a strategy based on the valuation data. We test the method to rank drinks according to valuation and use the relative rankings in the honest Borda count to break ties. This strategy performs as well or better than actual strategies used for all participants.

Fifteen of the participants would have done as well with this strategy as with their chosen incentivized Borda count strategy. The other 15 participants would have done better with this strategy than their chosen incentivized Borda count strategy. If everyone voted according to this strategy, the group would have made the efficient choice of fruit smoothie.

Plurality Voting

We conducted a similar analysis to determine the most effective way for each participant to vote for plurality voting. We assumed that participants believed opposing strategies would be independent and identically distributed draws from the pool of opposing strategies they faced. This assumption implies that voters thought that each opponent had a certain probability of voting for each drink (each opponent votes for drink d with probability pd), and these probabilities are not affected by the vote of any other opponent. The identically distributed assumption implies that pd does not depend on the opponent's identity. Each

participant's strategy would be run 10,000 times against other participants. Once again, 29

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strategies would be chosen with replacement from a pool of the 29 other participants and be compared to the main one. For each participant, we output three numbers. The first represents the average payoff of the actual plurality voting, and the second represents the average payoff of the optimal plurality voting strategy. The second one was greater than or equal to the first, signifying that some voted ineffectively while others voted optimally in plurality voting. The third number represented which drink the participant should have voted for to receive the highest average payoff.

We found that all participants should have voted for coffee or tea, which signified many participants were wasting their vote since all the other drinks were too far behind. Coffee fans should vote for coffee, and tea fans should vote for tea. More precisely, any participant who values coffee more than tea should vote for coffee, and any participant who prefers tea more than coffee should vote for tea. The closest race in most simulations is between the two most popular drinks, coffee, and tea. Therefore, participants are the most likely to influence the election result if they vote for coffee or tea, so they should vote for the top two drinks they prefer if they have a sufficiently intense preference regarding which top two drinks should win. Twenty-nine participants reported unequal valuations for coffee and tea.

Participant 29 reported an equal valuation between coffee and tea and therefore had a more complicated strategic decision. Participant 29 said a valuation of $5 for coffee and tea and $10 for a fruit smoothie. Participant 29 did not value any other drink. Thus, it is somewhat surprising that the simulation reveals that participant 29 should vote for coffee. However, under closer examination of the data, we can see how it makes sense for participant 29 to vote for coffee. Hot cocoa was as popular as a fruit smoothie, and the other four drinks that participant 29 did not value also had some support. Participant 29, therefore, traded off two competing objectives: maximizing the chance that fruit smoothie wins and minimizing the possibility that one of the five drinks that were not valued wins. For participant 29, the difference in payoff between receiving a fruit smoothie and receiving coffee was equal to the difference in the gain between receiving coffee and receiving a worthless drink. Because there were five less-valued drinks that each had supporters, including one that was more popular than a fruit smoothie, worthless drinks came close to winning more often than a fruit smoothie came close to winning. As a result, it is optimal for participant 29 to mitigate the relatively common problem of worthless drinks winning by voting for coffee, even though that strategy rarely results in a failure for a fruit smoothie to win. Voting for coffee is the best strategy for participant 29 because coffee is the most popular drink. Thus, the most effective way for participant 29 to increase the likelihood of receiving a valuable drink is to vote for coffee.

We classify voters in two ways. First, we classify voters as strategic or sincere. We classify a

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voter as strategic if they voted for a drink for plurality voting that was not the most highly valued according to the prices. We classify a voter as sincere if he or she voted for the drink they valued most highly according to the prices for plurality voting. Second, we classify voters as optimal or suboptimal. Optimal voters choose strategies that maximize their expected payoff in the simulation and suboptimal voters do no. Of the 24 sincere voters, 14 of them were optimal and 10 were not. For the six strategic voters, two were optimal and four were not. Finally, there were a total of 16 optimal voters. Our simulation provides suggestions on optimal strategy for all participants.

Preferences

Effectiveness of Voting Methods for Expressing Preferences

Neither plurality voting nor the Borda count is guaranteed to allow voters to summarize their preferences in their votes. As a result, some inefficiency can occur because the information is lost when voters translate preferences into votes. We now explore the magnitude of this information loss. The correlation between a binary variable indicating whether a drink is your favorite drink and your dollar valuation for a drink is 0.6096. The square of the correlation can be interpreted as the proportion of the variance in one variable that the other variable can explain. Using this interpretation, we find that 37% of the variance in valuations for drinks is known after knowing which drink is your favorite. A participant's ranking of a drink is more correlated with the value of the drink. The correlation between the variable that takes on a value of eight for the favorite drink, seven for the second-favorite drink, six for the third-favorite drink, five for the fourth-favorite drink, four for the fifth-favorite drink, three for the sixth-favorite drink, two for the seventh-favorite drink and one for the eight-favorite drink and valuation is 0.8189. Therefore, 67% of the variance in drink valuations is explained by a linear function of the drink's rank in the preferences. Thus, the Borda count better facilitates voters' ability to express their preferences in this context.

Limitations

Did Aggregate Preferences Change Between the Surveys?

Given that a week passed between the surveys, it is helpful to see if any aggregate preference shocks affected the participants. To do this, we first construct a July 23 version of the honest Borda count based primarily on valuation data, which uses honest Borda count data to break ties. We then compare the value given to each drink by the honest Borda count and its July 23 variant using two-tailed matched-pairs t-tests. Because there are eight drinks, a false positive is more likely to result from multiple hypothesis testing. Because there is a chance of rejecting the null

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hypothesis even when the null hypothesis is true, rejecting at least one null hypothesis even when all null hypotheses are true grows as the number of tests increases if the significance level is held constant. In our context, there are eight null hypotheses. Each claims that the average Borda rating of a given drink does not change between the two data-collection rounds. To address this problem, we apply the Bonferroni correction to the significance level and test all hypotheses at $P = \frac{0.05}{8} = 0.006$. Using the Bonferroni correction; we ensure that the chance of at least one false-positive remains below 0. 05. We reject two of these null hypotheses at the p = 0.00625 level. The table below shows our p-values.

Drink	*P*
Coffee	0.5362
Smoothie	0.0007
Boba Tea	0.0384
Hot Cocoa	0.1694
Soft Drinks	0.0200
Milk	0.0046
Fruit Juice	0.5861
Tea	0.0411

Fruit smoothie showed a substantial increase in popularity of 0.83 ranks. Conversely, milk showed a significant decrease in popularity of 0.43 ranks. The rise in popularity of fruit smoothie over this week explains why fruit smoothie has the highest total valuation yet did not do well in either plurality voting or the Borda count. One limitation of our analysis is that the valuation data is collected at a different time than the voting surveys and therefore may not reflect preferences at the time of the voting survey. The potential for consumers to experience significant preference

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changes even over a single week highlights the importance of market research. Another limitation of the study is that participants may have used price to determine the order of their preferences over drinks. Although we think it is likely that participants did not use price to decide, we cannot rule out the possibility that price may have played a factor in determining preferences. Finally, due to the health risks associated with the ongoing COVID-19 pandemic when the experiment was conducted, we were unable to meet with participants in person. This constraint prevented us from using drink rewards to conduct a study with real incentives. The lack of real incentives is, therefore, a limitation of this study. A productive avenue for future research is implementing designs with realistic incentives by using drinks to reward participants. These limitations can be addressed in future work.

Conclusion

Plurality voting generated a more efficient decision than the Borda count in our study. The efficiency of plurality voting was 31% higher than the efficiency of the Borda count. The Borda count generated a more equitable outcome: the minimum valuation for the choice of the Borda count exceeded the minimum valuation of the choice of plurality voting. We also observed the presence of strategic voting. However, participants did not always use strategic voting effectively. Most (4 of 6) strategic voters in plurality voting would have been better off voting sincerely. Our study also suggests that neither plurality voting nor the Borda count generates socially optimal outcomes: neither choose the option with the highest total value.

We would have also liked to compare the quadratic voting's efficiency and the other two voting mechanisms. In addition, it would be better to conduct both surveys simultaneously to reduce the chance that participants' preferences change. We also wish to make a choice real rather than hypothetical. For instance, we could allow participants to win the drink they were voting for instead of a $10 Amazon gift card to secure more honest results. This change would eliminate the possibility that participants only voted for a drink that they thought would win. Finally, although we have no evidence that participants changed answers, a Google survey does allow participants to go back and change their answers.

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Electronic Supplementary Materials

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Google Sheet containing raw data and some analysis.

Google Survey involving Plurality voting and the Borda count. Google Survey involving the prices participants were willing to pay.

Google Drive containing code for both Plurality voting and the Borda count.

