Political economics in the laboratory

Tyszler, M.

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Chapter 3

Strategic Voting and Heterogeneous Preferences

3.1 Introduction

Since we observe voting at all levels of society, such as national elections, parliament decisions, committees and boards, the (possible) occurrence of strategic voting may have far-fetching consequences for many aspects of our daily lives. Understanding this phenomenon is intrinsically connected to understanding how democratic societies make decisions. The occurrence of strategic voting and its interaction with information has been studied theoretically, empirically and experimentally (e.g. Forsythe et al. 1993, Forsythe et al. 1996, Morton & Williams 1999, Myerson & Weber 1993) in various settings and considering different voting body sizes.

Strategic voting will likely be affected by the distribution of preferences across voters. In this chapter, we focus on the importance of preference heterogeneity. Heterogeneity in preferences has been shown to be important in explaining political and economic behavior concerning social preferences (e.g. Erlei 2008, Fischbacher & Gaechter 2006) , risk and time (e.g. Andersen et al. 2010), perception of national economic conditions (e.g. Duch, Palmer & Anderson 2000) and electoral choices (e.g. Rivers 1988). The interaction between strategic voting and preference heterogeneity has received less attention and is the topic of this chapter.

The model used here builds on chapter 2, where we theoretically and experimentally investigate voting behavior in a setting characterized by plurality rule and mandatory voting. The model and experimental design used there focuses on two variables: (i) the amount of pre-election information and (ii) the intensity of preferences - measured by the relative benefit of a voter's best option compared to her second best option. Throughout that previous analysis we assumed preference homogeneity, i.e., in a given electorate, all voters have the same intensity of preferences, and, therefore, only the preference ordering distinguishes voters. It is plausible, however, that in a more general setting voters will also vary in preference intensity. Relaxing the assumption of preference homogeneity may lead to different results. For example, we previously showed a positive correlation of strategic voting with the relative benefit of one's second best option, when comparing across homogeneous electorates. However, once voters in the same electorate can have distinct intensities of preferences this may change. As an illustration, consider a voter who cares little about her second option and would be less likely to cast a strategic vote in the homogeneous model. With heterogeneous preferences she might decide to vote strategically if she believes (or is informed) that there are other voters in the population with similar preference ordering but with higher value attributed to their second best option. The intuition behind such reasoning is that the attractiveness of a strategic vote is directly connected to its expected utility. Its expected utility, in turn, depends on the beliefs about others voting for a similar option. If other voters consider this option more attractive, the expected utility of choosing this option will increase even for a voter with low intensity of preferences. The current study theoretically and experimentally addresses exactly this type of question.

With homogeneous preferences, our theoretical results supported by experimental data reveal evidence of strategic voting, with its extent depending on the available information, the relative importance given to one's second best candidate, the benefit that a voter would receive from the leading candidate on the polls and the position of one's first best candidate in a poll. Strategic voting increases as the importance of one's second best option increases and voters whose candidate placed third (last) in a poll are more likely to vote strategically. It is possible, however, that such results will not carry over to an environment with heterogeneous preferences. This is the first question we will pursue. In particular we investigate the impact of heterogeneity within and across information settings. We will show both theoretically and experimentally that heterogeneity does not change the comparative statics across groups while keeping the information setting constant. Specifically, voters with high value for their second best option vote more strategically than voters with a low value, and voters who support the 3$^{\text{rd}}$ placed candidate in a poll are always more likely to cast a strategic vote. When checking for the effect of heterogeneity across information settings, results do not change on average but do change when sub-groups are considered. Some of the predicted theoretical changes, however, are not in line with the experimental data. For example, supporters of the 2$^{\text{nd}}$ placed candidate in a poll with a high value for their second best option are expected to vote more strategically under heterogeneous preferences than with homogeneous preferences. This is not observed in the data. As a general result, heterogeneity seems to decrease the level of strategic voting in our experiment. A possible explanation is that when the complexity of the environment increases, voters are more likely to replace rather complicated strategies by more simple heuristics, such as sincere voting. This is in line, e.g., with Conlisk (1996) and Schwenk (1984).

It is important to notice that information in this context contains, in fact, two components: (i) the aggregate distribution of voters with respect to the preference ordering and (ii) the intensity of preferences within each group. Under homogeneous preferences (ii) is known when (i) is. Expanding the original model to allow for heterogeneous preferences makes it possible to inform voters about the aggregate distribution of preference ordering (i) without giving information on the intensity of preferences (ii). Therefore a second relevant question is asked, namely which piece of information drives voting behavior: information on the aggregate distribution of preferences or information on the intensity of preferences. This question is also addressed here. We observe, both theoretically and experimentally that comparative static results are robust to preference heterogeneity. Moreover, information about the aggregate distribution of preferences seems to be the element that explains the observed differences across treatments in voting behavior.

This chapter is structured as follows: the next section presents the model, its theoretical analysis and derives testable behavioral predictions. Section 3.3 introduces the experimental design and procedures and is followed by the Results section. Section 3.5 then concludes, summarizing the main findings.

3.2 The Model

We follow the general specification as in chapter 2. Each voter $i = 1, \dots, N$ has a strict preference ordering over alternatives A,B,C and is required to cast exactly one vote for an alternative. Voters are assumed to maximize (expected) utility, which is determined by the elected alternative. Plurality rule determines the winner, with ties broken by an equal probability random draw. The utility of each voter is set according to the rank of the elected alternative. If her preferred, intermediate or least preferred alternative is elected she receives u^b, u^m or u^l respectively. Normalizing u^b and u^l, each voter's preferences are characterized by u^m, the utility attributed to the intermediate option.

Before each election, all voters' preferences and value of u^m are determined randomly, independently across voters and voting periods. While the own preference ordering and u^m value are revealed to the voter by nature at the beginning of each period, the extent of information about the electorate's preferences and u^m values are also variables in the model. An electorate is, therefore, characterized by the number of voters, probability distributions of preference orderings and u^m values and the amount of pre-election information.

Because we are not interested in specific characteristics of the distinct options, we again focus on a game in which every voter has an *a priori* symmetric problem regardless of her preference ordering. We therefore restrict the possible preferences to $\{(A, B, C);$ $(B, C, A);$ $(C, A, B)\}$, in which the listed order represents the preference ordering. Preference orderings are randomly chosen from this set. Note that these preferences typically form a Condorcet cycle potentially giving rise to strategic behavior.

We consider two values for the intermediate option u^m. A low value $u^m = 3$ indicates a low relative importance of one's second best option compared to the best option and, thus a high intensity of preference. A high value $u^m = 8$ reflects a high importance and low intensity of preference. With homogeneous preferences, in a given electorate all voters have either a low or high value. In a heterogeneous setting, each voter can have either a low or high value with equal chance.

Finally, three distinct levels of information will be of interest: (i) in an *uninformed* setting, aside from their own values, voters know only the prior probability distributions of preferences and u^m; (ii) in an *aggregate information* setting, voters also know the ex-post realized distribution of preferences for the election concerned, but not the realized distribution of u^m; (iii) in a *full information* setting voters also know the ex-post realized distribution of u^m within each preference ordering.

3.2.1 Theoretical Analysis

In line with chapter 2, a Quantal Response Equilibrium model (henceforth QRE, McKelvey & Palfrey 1995) is used to analyze the game.

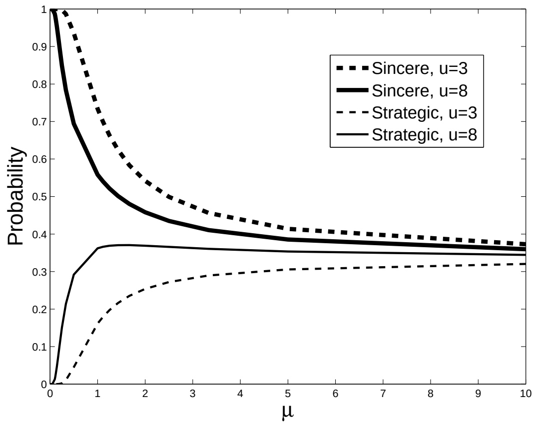
Without information, a voter knows only the electorate size, the prior probability distribution of preference orderings, the prior distribution of the intensity of preferences and the own preference ordering and intensity.

Knowing the own preference values the voter can update the probability distributions using Bayes' rule and use this to calculate the probability of being pivotal given others' strategies. Then, she can compute the expected payoff differences between voting for her best, second best or for the least preferred alternative. The Quantal Response Model captures the pivotal probabilities since in its computation only the differences in expected payoff matter, meaning all non-pivotal situations will be irrelevant (see Appendix 2.A for details).

As in chapter 2 and in line with, e.g., Blais & Nadeau (1996), Blais et al. (2001) and Cain (1978) we will define a *sincere* vote as a vote for one's preferred option and a *strategic* vote as a vote for one's second best option. Figure 3.1 shows probabilities of voting strategically and sincerely on the principal branch of the Multinomial Logit Correspondence (MLC)[1] for the game without information. As in chapter 2, for the noise parameter μ we will concentrate on the range $\mu = [0.4; 0.8]$. To start, we replicate the homogeneous setting of chapter 2 and distinguish between the two different values of the intermediate option. For this purpose, figure 3.1 replicates figure 2.1(a).

[1]The principal branch of the Multinomial Logit Correspondence is defined and explained in section 2.2.1

Figure 3.1: Multinomial Logit Correspondence (Uninformed Setting)



Notes. Lines show the principal branch of the MLC for high ($u^m = 8$) and low ($u^m = 3$) values of the intermediate option, reproducing figure 2.1(a).

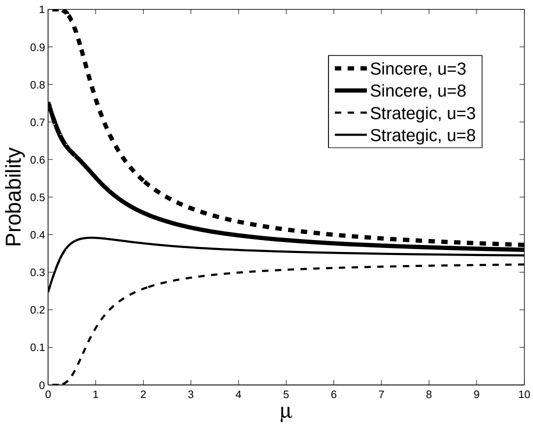
Recall that as μ decreases behavior converges to a Bayes-Nash Equilibrium in which all voters vote sincerely. Therefore a full rational analysis would predict no difference in behavior when the value of the intermediate option varies. However, for almost all positive levels of μ, the equilibrium probability of a strategic vote is higher for voters with a high value for the intermediate option. As it turns out, predicted (equilibrium) behavior of voters in the heterogeneous setting can be illustrated by the same figure 3.1, by simply reading the labels as the behavior of a voter when she has intermediate value of 3 or 8. This follows from the symmetry of the game: the equal probabilities of orderings interacts with the equal probabilities of intensity of preferences such that, with only prior information, a player's better response depends only on her own intensity of preferences. Two behavioral predictions can be made. First, a voter is more likely to vote strategically when her intermediate option value is high. Second, theory predicts no difference in behavior when comparing uninformed voters under homogeneous versus heterogeneous settings.

Consider next the settings with information. Voters know the aggregate distribution of preferences and may or may not know the realized distribution of the intensity of preferences. For an illustration, consider the cases that can serve as direct comparison for the *a priori* expected situation. With aggregate information this is the equal split on the preference orderings (i.e., 4 voters with each preference ordering)[2]. With full information this corresponds to the equal split on preference orderings and on intensity of preferences (i.e., in addition, two voters of each group have $u^m = 3$ and two have $u^m = 8$). As information increases the uncertainty about the situation is reduced. Figure 3.2 depicts these two cases and replicates the homogeneous case (figure 2.2(a)) for comparison.

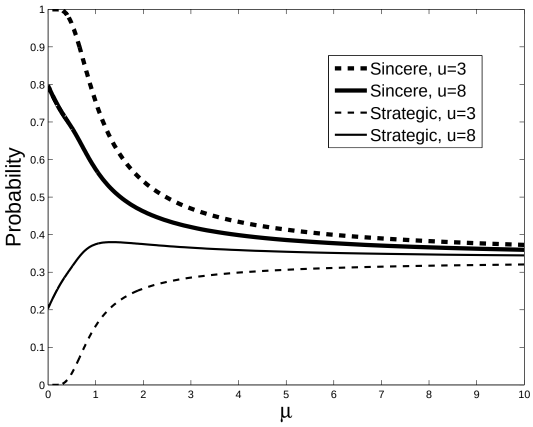
First notice that with information and high importance of the intermediate option the

[2]Recall that this is also the *a priori* expected situation for the full information homogeneous case.

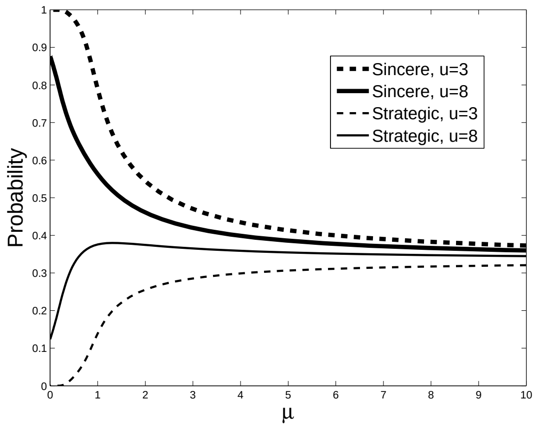
Figure 3.2: Multinomial Logit Correspondence (Informed Settings)



(a) Aggregate Information



(b) Full Information

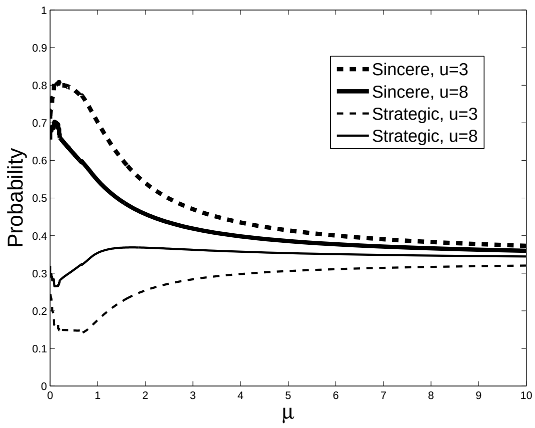


(c) Homogeneous case

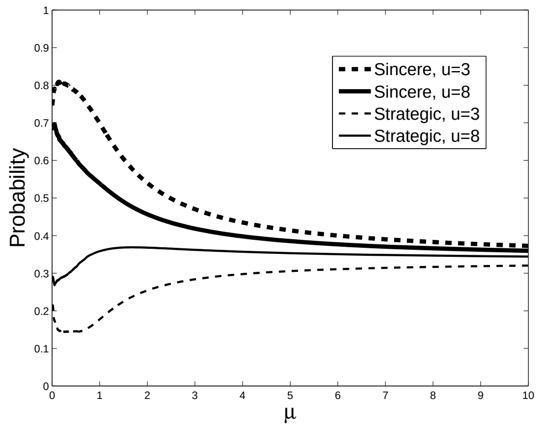
Notes. Lines show the principal branch of the MLC for high ($u^m = 8$) and low ($u^m = 3$) values of the intermediate option, varying in the extent of information available. In panel (a) voters know the realized aggregate distribution of preference ordering, but only the distribution of intensity of preferences. In panels (b) and (c) (reproducing figure 2.2(a)) voters also know this piece of information. In all panels $(N_{ABC}, N_{BCA}, N_{CAB}) = (4, 4, 4)$, while in panel (b), additionally, two voters of each group have $u^m = 3$ and two have $u^m = 8$.

limiting QRE does not comprise sincere voting. The equilibrium converges to a mixed strategy profile in which a strategic vote happens with 24% and 21% respectively for the aggregate and full information cases. Second, notice how similar the three cases are. This seems to indicate that the aggregate information about preferences, which is the common element, is the key to understanding behavior in the model. Naturally, the cases depicted in figure 3.2 are just one of the possible realizations. Figure 3.3 depicts the average behavior across all possible realizations (and replicates the homogeneous case (figure 2.3) for comparison).

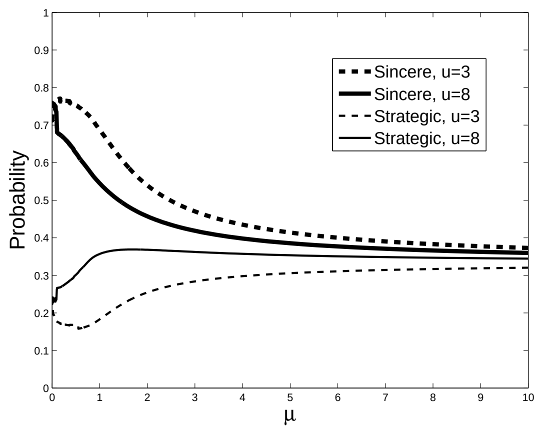
Figure 3.3: Average Multinomial Logit Correspondence (Informed Settings)



(a) Aggregate Information



(b) Full Information



(c) Homogeneous case

Notes. Lines show the weighted average of the principal branch of the MLC for high ($u^m = 8$) and low ($u^m = 3$) values of the intermediate option, varying in the extent of information available. In panel (a) voters know the realized aggregate distribution of preference ordering, but only the distribution of intensity of preferences. In panels (b) and (c) (reproducing figure 2.3) voters also know this piece of information. The average is across all possible combinations of preference orderings, weighted by the probabilities with which they occur.

Qualitative, the results are similar. Notice that now in all cases the limiting average Nash equilibrium is a mixed profile. Specifically, for the low (high) intermediate values it converges to 23% (32%) for the aggregate and 23% (29%) for the full information case. Three behavioral predictions can be made. First, as in the uninformed case, the probability of a strategic vote is increasing in the importance given to the second best option. Second, also as in the uninformed case, controlling for the intensity of preferences, there is no effect of heterogeneity on average behavior. Third, if preference orderings are known, information about other's intensities of preferences does not affect strategic behavior. Comparing figures 3.1 and 3.3 suggests one additional behavioral prediction, namelly more strategic voting with information than without.

With information voters know the realized distribution of preferences. Figure 3.4 shows, for the informed settings, the probability of a strategic vote with voters grouped by Rank-Type[3] and intensity of preferences. It includes the homogeneous cases for completeness[4].

First notice that when grouping by Rank-Type, the probability of a strategic vote is still increasing in the value of the intermediate option (with the exception of the comparative statics for Rank 2$^{\text{nd}}$ under homogeneous preferences). Next, notice that as the literature suggests[5], Rank 3$^{\text{rd}}$ voters are more likely to cast a strategic vote. Different behavior, however, is predicted when comparing across information settings, keeping constant the Rank-Type and intensity of preference (i.e., within panel). For Rank 3$^{\text{rd}}$ voters and high value of the intermediate option the introduction of heterogeneity reduces the likelihood of a strategic vote. This is in line with intuition, since the attractiveness of a strategic vote (i.e., expected value) is related to the expected behavior of other voters with the same preference ordering. If these players attribute, on average, lower value to the second option, their probability of a strategic vote is smaller, which in turn should reduce the equilibrium behavior of voters with a high value. This comparative static is reversed when considering Rank 2$^{\text{nd}}$ voters with high value. For voters with a low value of the intermediate option the effect of heterogeneity is exactly the opposite of their high value counterpart, but the effect is small.

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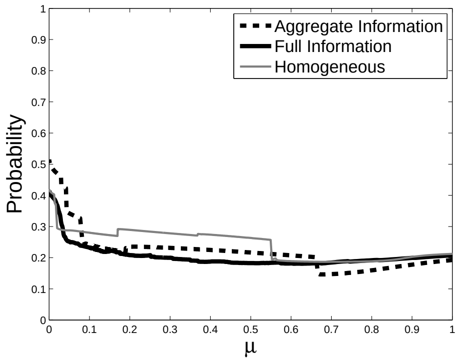
[3]Rank-Types are defined according to how a voter's most preferred candidate ranks in the poll. See definition 2.3 for details.

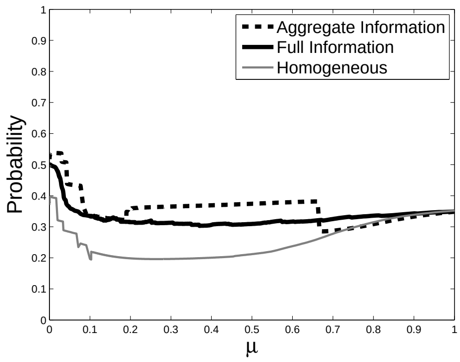
[4]We plot the probabilities for $\mu \in [0, 1]$. For $\mu > 1$, there is little difference and all cases converge monotonically to 1/3.

[5]Duverger's law suggests that supporters of the trailing candidate are more likely to change their vote towards the leading candidates. See, e.g., Fey (1997), Palfrey (1989) and Riker (1982*b*).

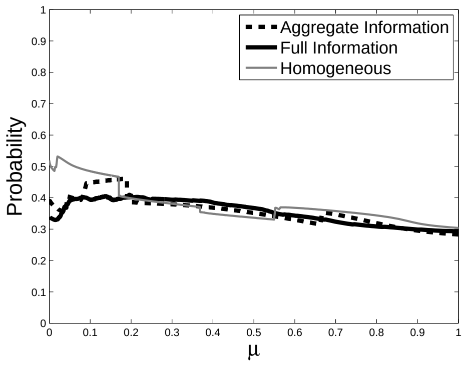
Figure 3.4: Strategic Voting by Rank-Type



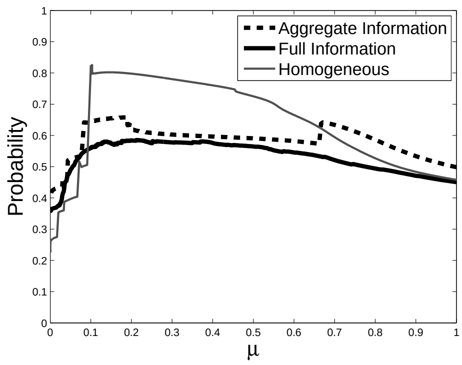
(a) Rank 2[nd], $u^m = 3$



(b) Rank 2[nd], $u^m = 8$



(c) Rank 3[rd], $u^m = 3$



(d) Rank 3[rd], $u^m = 8$

Notes. Lines show the weighted average of the principal branch of the MLC, distinguishing among the extent of information available, including the (full information) homogeneous case for completeness. Panels distinguish among the possible combinations of Rank-Type and value of the intermediate option. The average is across all possible combinations of preference orderings, weighted by the probabilities with which they occur. Cases where groups are tied for Rank 2$^{\text{nd}}$ are not included in the graph (cf. fn 25 from chapter 2).

3.2.2 Behavioral Predictions

The experiments to be described below study strategic voting and its interaction with information and preference heterogeneity. Summarizing the analysis from the previous sub-section, the following behavioral predictions will be tested:

1. The probability of strategic voting is increasing in the value for the intermediate option, for all information settings. (Figures 3.1, 3.3 and 3.4)

2. Without information, there is no effect of heterogeneity on the probability of strategic voting (Figure 3.1).

3. With information, there is no effect of heterogeneity on average behavior (Figure 3.3).

4. Information about other's intensities of preferences does not affect strategic behavior if preference orderings are known (Figure 3.3).

5. The probability of strategic voting is higher with information than without (Figure 3.1 vs. figure 3.3).

6. With information, Rank 3$^{\text{rd}}$ voters vote more strategically than other Rank-Types Figure 3.4).

7. Heterogeneity decreases the probability of strategic voting of Rank 3$^{\text{rd}}$ voters with high intermediate value (Figure 3.4).

8. Heterogeneity increases the probability of strategic voting of Rank 2$^{\text{nd}}$ voters with high intermediate value (Figure 3.4).

3.3 Experimental Design

The experimental design aims at studying the effect of preference heterogeneity on voting behavior, when the relative importance of the intermediate option and the extent of information are varied.

The electorate is fixed during a session and consists of 12 voters. There are 3 preference orderings, $\{(A, B, C); (B, C, A); (C, A, B)\}$, which are assigned with equal probability to each subject. There is a new draw of preferences before every election, independently across subjects and elections. In every election each subject is required to cast one vote for either A, B or C. Plurality rule determines the winner, with ties broken by equal probability random draw. Subjects are paid in each round according to the rank of the winner in their own preference ordering. A subject is paid 10 points if the winner is ranked first and 1 point in case it is ranked last. To obtain preference heterogeneity, the value paid in case the winner is the intermediate option is also randomly drawn. Prior to the election, at the individual level and independently across subjects and elections, it takes either the value 3 or 8 with 50% chance. All this is common knowledge. In any session, 40 elections are held. Aggregate election results are shown to every subject after every election.

We added three treatments to the four treatments discussed in chapter 2, where subjects were homogeneous with respect to intensity of preferences (i.e., the value attributed to the intermediate option was fixed within electorate). The three treatments vary in the amount of information voters have about each other's preferences. In the *uninformed* treatment subjects are informed only about the realization of their own preference ordering and the own value of the intermediate option. With *full information* subjects are informed about the realization of the aggregate preferences orderings and for each preference ordering, they are also told the realized distribution of intermediate preferences. Table 3.1 gives an example.

Table 3.1: Example of Information Provided to Subjects

Preference Ordering	Intermediate Value = 3	Intermediate Value = 8	Total
A B C	2	3	5
B C A	1	2	3
C A B	2	2	4

Notes. This table shows an example of the information provided to subjects. Each row provides information about one of the possible preference orderings. Cells in columns 2 and 3 indicate the number of voters (including the own subject) in the electorate with value of the intermediate option of 3 or 8, respectively. Cells in the final column show the aggregate number for that row, i.e., the addition of columns 2 and 3 indicating the total number of voters with the correspondent preference ordering.

The remaining treatment lies between no information and full disclosure of preferences. With *aggregate information* subjects know the aggregate preferences, but not the realized distribution of the intermediate values, i.e., they know only the prior distribution. This is done by providing only the first and last columns of table 3.1, with subjects aware that intermediate values may vary across voters.

All comparisons are made across subjects. Every experimental electorate experienced the same realizations of the random distribution of preference orderings, making it possible to directly compare across groups. This is the same realization as used for the homogeneous treatment of chapter 2 (c.f. Appendix 2.C). The realization of the value for the intermediate option was also the same across groups.

Ten sessions were run at the CREED laboratory at the University of Amsterdam, in June, 2009, with the participation of 204 subjects[6] allowing for 17 independent elec-

[6]Subjects that participated in the homogeneous sessions were not allowed to take part in the new set

torates[7]. In addition to a show-up fee of €7, subjects were paid €0.05 per experimental point. Average earnings were €20.07, including the show-up fee. Each session lasted about one and a half hours.

The experiment was computerized using z-tree (Fischbacher 2007). Instructions can be found in Appendix 3.A.

3.4 Results

This results section will focus on analyzing the two main questions addressed in this chapter: (i) what is the behavioral effect of heterogeneity on the level of strategic voting and, (ii) which component of the information is more relevant for voting behavior: information on the aggregate preference ordering or information about the intensity of preferences. In the analysis to follow we first look at the comparative statics concerning the value of the intermediate option holding the remaining variables constant and then, holding fixed the intermediate value, we look at the effect of heterogeneity and/or information. Statistical tests in this section will be non-parametric, using average behavior of (sub-group of) voters per electorate as unit of observation. The grouping should be clear from the text. The statistical testing takes into account that sub-groups of voters within the same electorate are not independent.

In general we will see that previous findings from chapter 2 are quite robust with respect to preference heterogeneity and that the information on the aggregate preference ordering is ultimately driving voting behavior. The following sub-sections detail and support these claims.

3.4.1 Election Winner

A first question regards the election winner. More specifically we are interested in the probability that the majoritarian candidate wins an election. Figure 3.5 shows the winning probability by the majoritarian candidate under each information setting[8].

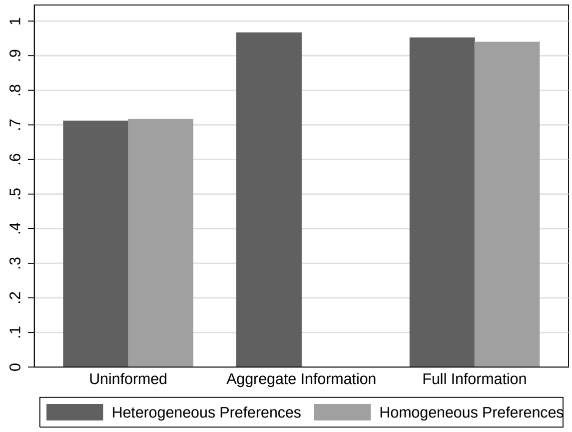
Notice that for the homogeneous treatments the addition of information increases the winning probability of the majoritarian candidate by 0.22 percentage points. To check for the effect of preference heterogeneity, we compare the homogeneous and heterogeneous treatments with no information and full information (first and last pairs of bars in figure 3.5). It is clear from the graph that differences between the two treatments are small, both without information and with full information. Within each information treatment the differences are indeed statistically indistinguishable for the uninformed ses-

of sessions.

[7]There were 5 *uninformed* electorates, 6 electorates with *aggregate information* and 6 electorates with *full information*.

[8]For the homogeneous settings we average over treatments with low and high intermediate values.

Figure 3.5: Majoritarian Candidate Winning Probability



Notes. Bars show for each treatment the fraction of elections won by the majoritarian candidate, counting as 0.5 (0.33) cases involving a two-way (three-way) tie, before the random tie breaking procedure. The extent of information are distinguished along the horizontal axis and presence or absence of heterogeneity by the color of the bars.

sions (Mann-Whitney (MW) rank-sum test, $Z = 0.316$, $p = 0.7517$, $N = 17$) as for the (fully) informed sessions (MW, $Z = -0.237$, $p = 0.8128$, $N = 18$).

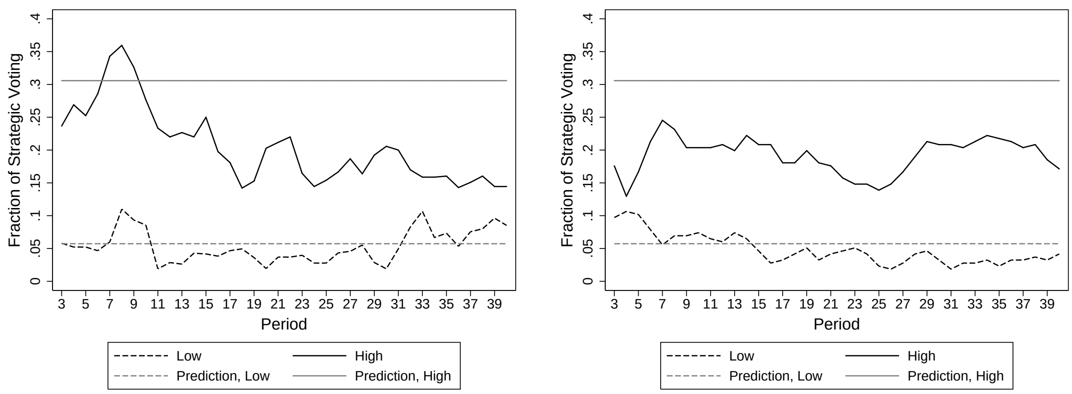
To check the relative importance of the two kinds of information, we consider the aggregate information treatment. Note that in this treatment subjects have the same information about aggregate preferences as in full information, but no information regarding the intensity of preferences. From the graph it is clear that there is no substantial difference between the winning probability of the majoritarian candidate in the aggregate and full information treatments. Indeed, the difference turns out to be statistically insignificant (MW, $Z = 1.137$, $p = 0.2556$, $N = 12$). This indicates that information about the aggregate distribution of preferences is sufficient to explain the probability increase in the full information treatment.

Next, we will consider in more detail the voting patterns in distinct treatments.

3.4.2 Aggregate Behavior

We start by analyzing the uninformed treatments. Figure 3.6 shows the average fraction of strategic votes by period in the uninformed electorates, grouped by value of the intermediate option. Panel 3.6(a) shows the heterogeneous treatments while Panel 3.6(b) shows the homogeneous treatment (replicating figure 2.6(a)). A first look at the graphs suggest that there is more strategic voting when the intermediate value is high and that there is little difference between the homogeneous and heterogeneous treatments for a given value of the intermediate option. These suggestions are confirmed by statistical tests, in line with behavioral predictions 1 and 2. Specifically, strategic voting observed in voters with high intermediate value is statistically different from voters with low intermediate value both under heterogeneous preferences (Wilcoxon (W) signed-rank test, $Z = -2.023$, $p = 0.0431$, $N = 5$) and under homogeneous preferences (MW, $Z = -2.882$, $p = 0.0039$, $N = 12$) . Non-parametric tests cannot statistically differentiate the effect of heterogeneity when the intermediate value is high (MW, $Z = -0.365$, $p = 0.7150$, $N = 11$) nor when it is low (MW, $Z \approx 0$, $p \approx 1.000$, $N = 11$).

Figure 3.6: Experimental Data and Predictions: Uninformed Treatment



(a) Heterogeneous

(b) Homogeneous

Notes. Lines show the 3-period moving average of the fraction of strategic votes in the uninformed heterogeneous (panel (a)) and uninformed homogeneous (panel (b), replicating figure 2.6(a)) sessions. Dashed (solid) lines refer to low (high) intermediate values. Light lines show the MLE predictions.

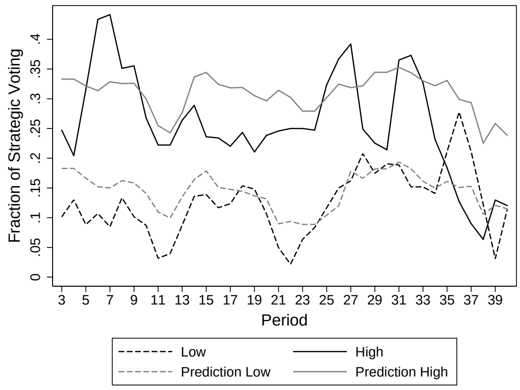
Also important to notice is that behavior is very much in line with the equilibrium predictions of the Quantal Response Equilibrium model. Observations for $u^m = 3$ are close to the predicted level for both the homogeneous treatment and heterogeneous treatments for $\mu = 0.55$[9]. For $u^m = 8$, there is slightly less strategic voting than predicted, but the comparative static prediction of more strategic voting than for $u^m = 3$ is supported.

Figure 3.7 shows similar graphs for the informed treatments. Still in line with behavioral prediction 1, voters with a high intermediate value are more likely to cast a strategic vote than voters with with a low intermediate value (for the aggregate information, heterogeneous electorates: W, $Z = -2.201$, $p = 0.0277$, $N = 6$; for the full information, heterogeneous electorates: W, $Z = -2.201$, $p = 0.0277$, $N = 6$; for the full information, homogeneous electorates: MW, $Z = -2.882$, $p = 0.0039$, $N = 12$).

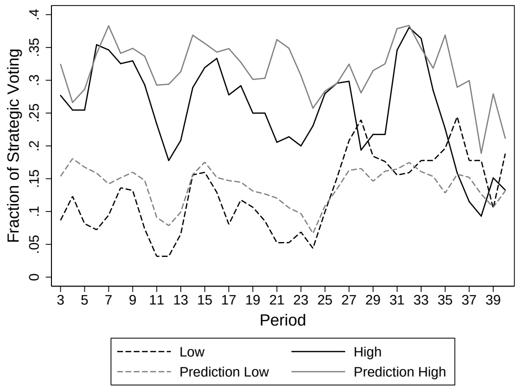
When checking for the effect of heterogeneity on average behavior, behavioral prediction 3 has partial support. It predicts no effect of heterogeneity. For the voters with high intermediate option, there is indeed no statistically significant effect (Kruskal-Wallis (KW) test, $\chi^2 = 0.327$, $p = 0.8488$, $N = 18$), whereas for the voters with low inter-

[9]This parameter value comes from a pilot maximum likelihood estimation of μ. For reference check section 2.3.

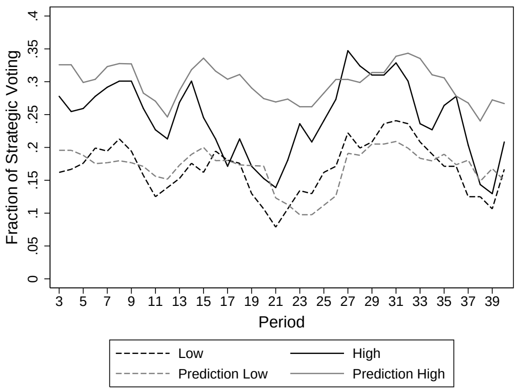
Figure 3.7: Experimental Data and Predictions: Informed treatments



(a) Aggregate Information, Heterogeneous



(b) Full Information, Heterogeneous



(c) Full Information, Homogeneous

Notes. Lines show the 3-period moving average of the fraction of strategic votes in the aggregate information, heterogeneous electorates (panel (a)), full information, heterogeneous electorates (panel (b)) and full information, homogeneous electorates (panel (c), replicating figure 2.6(b)). Dashed (solid) lines refer to low (high) intermediate values. Light lines show the 3-period moving average MLE predictions. Note that the MLE prediction in a round depends on the realized distribution of preferences, the realized intensity of preferences and voter's knowledge about it.

mediate value there is (KW, $\chi^2 = 9.564$, $p = 0.0083$, $N = 18$). This difference is due to the higher rate of strategic voting by homogeneous voters (16.87%) compared to heterogeneous voters (12.62%). This is a first indication that heterogeneity may reduce the probability of strategic voting.

Comparing to chapter 2, we observe the overall effect of adding heterogeneity: no impact without information and a partial impact with information, reducing the level of strategic voting for voters with low intermediate value. For both cases, we observe the same comparative static of more strategic voting by voters with high intermediate value.

When investigating which aspect of information is most relevant to determine behavior, the evidence indicates that this is the aggregate information about preferences. In line with behavioral prediction 4, this can be seen from the lack of statistical difference when comparing the two heterogeneous informed treatments (for low intermediate values: MW, $Z = -0.080$, $p = 0.9358$, $N = 12$; for high intermediate values: MW, $Z = 0.0160$, $p = 0.8726$, $N = 12$). In other words, heterogeneity of preferences affects behavior, but detailed information about the intensity of preferences does not play a role.

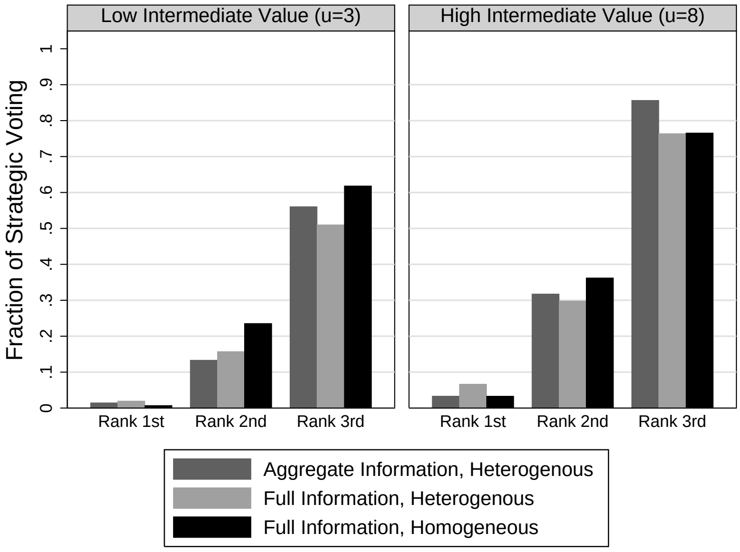
Finally, behavioral prediction 5 concerns the comparative static of strategic behavior in the uninformed treatments versus the informed treatments. As predicted for the heterogeneous treatments, this average is higher with information. The differences are statistically significant (for low intermediate values: MW, $Z = -2.485$, $p = 0.0130$, $N = 17$; for high intermediate values: MW, $Z = -1.899$, $p = 0.0576$, $N = 17$) , being stronger for the low value group. This comparative static is also present in the homogeneous treatments of chapter 2.

3.4.3 Strategic voting by Rank-Type

Next, we focus specifically on the informed treatments. As outlined above, in these treatments we can group subjects according to their Rank-Type. Figure 3.8 shows the average fraction of strategic voting for each Rank-Type, grouped by the value of the intermediate option. For each Rank-Type, the figure separately shows strategic voting under each informed treatment.

Within each informed treatment, Rank 3^{rd} voters are most likely to vote strategically. The differences are significant when comparing to both Rank 2^{nd} and Rank 1^{st} voters, both for low intermediate values and for high intermediate values (W, $Z = -2.201$, $p = 0.0277$, $N = 6$; for all pairwise comparisons). This is in line with intuition from Duverger's Law and behavioral prediction 6. Also, as expected Rank 1^{st} voters barely vote strategically. The comparative statics within Rank-Types are as expected, since the fraction of strategic voting is statistically higher when the importance of the intermediate option is high, for each and every group ($p < 0.05$ for all comparisons, using W or MW test where appropriate, $N = 6$).

Figure 3.8: Level of Strategic Voting by Rank-Type



Notes. Bars show the fraction of vote that was strategic, grouped by the value of the intermediate option. Voter Rank-Types are distinguished along the horizontal axis and treatments by the color of the bar.

When checking for the effect of heterogeneity, results are against behavioral predictions 7 and 8. It was predicted from the QRE analysis that for voters with high intermediate value, heterogeneity would increase the likelihood of a strategic vote for Rank 2$^{\text{nd}}$ voters and reduce it for Rank 3$^{\text{rd}}$ voters (behavioral predictions 7 and 8). The general result is, if any, a reduction in the strategic voting probability for Rank 2$^{\text{nd}}$ voters[10] and no reduction for Rank 3$^{\text{rd}}$ voters[11]. Moreover, with the exception of Rank 3$^{\text{rd}}$ voters with high intermediate value, all comparative statics indicate a lower probability under heterogeneity when compared to homogeneity. This seems to indicate that when the complexity of the situation increases, subjects tend to move to simpler heuristics, such as sincere voting.

When investigating which element of the information provided is determinant of strategic behavior, once more the evidence is in favor of the aggregate information. For the comparison of aggregate to full information we cannot reject the null hypothesis of these coming from the same distribution on any sub-group (W, $N = 12$, $p > 0.46$), with the exception of the sub-group of heterogeneous Rank 3$^{\text{rd}}$ voters with high intermediate values (W, $Z = 2.262$, $p = 0.0237$, $N = 6$). Therefore the additional information on the intensity seems to have little effect on strategic voting behavior.

[10]We obtain the following p-values for W, $N = 12$ compared to voters in the Full Information, Homogeneous Electorates. Aggregate Electorates, $u = 3$: $p = 0.0161$; Aggregate Electorates, $u = 8$: $p = 0.1986$; Full Information Electorates, $u = 3$: $p = 0.0370$; Full Information Electorates, $u = 8$: $p = 0.0771$.

[11]We obtain the following p-values for W, $N = 12$ compared to voters in the Full Information, Homogeneous Electorates. Aggregate Electorates, $u = 3$: $p = 0.1460$; Aggregate Electorates, $u = 8$: $p = 0.0152$, in the opposite direction; Full Information Electorates, $u = 3$: $p = 0.0530$, Full Information Electorates, $u = 8$: $p = 0.4209$.

All in all, heterogeneity seems to reduce the overall level of strategic voting. However, the differences across Rank-Types and the differences between low and high intermediate options are much more pronounced than the effect of heterogeneity. These results provide further support to two claims. First, the main comparative statics reported in chapter 2 are robust with respect to preference heterogeneity. Second, information about aggregate orderings are driving the results.

3.5 Concluding remarks

In this chapter we studied the effect of preference heterogeneity in strategic voting and its interaction with information . We also investigated which element of the information provided to voters is more relevant to understand and predict behavior. We built on the model from chapter 2. In that model, only preference ordering distinguishes voters; the intensity of the preferences is kept homogeneous. We introduce heterogeneity by allowing the intensity of preferences to vary within an electorate (and across rounds). This also allows us to decompose the information provided to voters into two pieces: information about the aggregate preferences and information concerning the intensity of those preferences.

Our experimental data support most of the behavioral predictions. In particular, we observe that strategic voting increases as the value of a voter's second best option increases and more strategic voting occurs with information than without. Also, Rank-3$^{\text{rd}}$ voters are more likely to vote strategically than other voters. Partial support is obtained concerning the effect of heterogeneity. We observe no effect of heterogeneity for uninformed voters (as predicted) but a negative effect on informed voters, when prediction was also neutral. Moreover, when analyzing voters by Rank-Type, both Rank-2$^{\text{nd}}$ (against prediction) and Rank-3$^{\text{rd}}$ (as predicted) voters are negatively affected by heterogeneity. We conclude that the overall effect of heterogeneity is a reduction in the probability of a strategic vote. This is in line with general argumentations about bounded rationality which point to a choice of simpler heuristics, such as sincere voting, once the complexity of the environment increases. In terms of effect size, however, heterogeneity comes second to both the value of a voter's second best option as to her Rank-Type. This indicates that the general comparative static results from chapter 2 are stable even in this more complex environment.

Finally, data support the behavioral prediction that information about the aggregate preferences is determinant for behavior. We observe that the additional information about intensity of preferences add very little to behavior both in the theoretical analyses and in the experimental data.

This chapter, thus, provides evidence that aggregate information of preferences is the relevant piece to understand strategic voting behavior in this setting and that heterogeneity lowers its probability, but does not challenge the findings obtained from a similar study in a homogeneous setting.

Appendix 3.A Experimental Instructions

In this appendix we provide a transcript of the experimental instructions. The paragraphs denoted in italics were omitted in the treatment with *no information*. In the treatment with *aggregate information* the first paragraph in italics was included and in the treatment with *full information* the paragraph in brackets was included instead.

Welcome

Welcome to this experiment in decision making. Please read these instructions carefully. They will explain the situations you will be facing and the decisions you will be asked to make.

In this experiment you will earn money, which will be paid to you privately at the end of the session. Your earnings will depend on your decisions as well as on the decisions of other participants in today's experiment.

Your earnings in the experiment will be in experimental "points". At the end of the experiment, each experimental point will be exchanged for euros at a rate of €0.05 per point. For example, if you earn 200 points, your earnings will be €10. In addition, you have already received €7 for showing up on time.

Rounds and Decisions

In this experiment, you will play various rounds. The total number of rounds will not be revealed, however. In each round, you will be asked to make exactly one decision.

Your decision in any round consists in voting for one of the options: A, B or C. The electorate consists of 12 people whose identities will not be revealed. This electorate will be kept fixed during the whole experiment. Each member of the electorate will have the same three options to vote from.

The option elected will be the one receiving the highest number of votes (out of 12). In case of a tie, one of the options with the highest number of votes will be randomly selected with equal chance.

Your Preference Ordering

In **each round** you will be assigned a preference ordering which will determine your earnings according to the winner of the vote.

Your preference ordering, and the preference ordering of your colleagues, can be one of the following:

A B C
B C A
C A B

In case the elected option is the option listed first you will receive **10 points**;
In case the elected option is the option listed second you will receive X **points**;
In case the elected option is the option listed last you will receive **1 point**.

In **each round**, each of the 3 preference orderings will be attributed to **each person** independently with equal chance.

Also, in **each round**, we will randomly choose an X for **each person** with equal chance of being 3 or 8. This will be done independently for each participant.

Therefore an electorate will typically have some people with preference ordering A B C, others with B C A and others with C A B. In addition, some will receive 3 points if their middle option is selected and others will receive 8 points.

Note that your preference ordering and X will often change from one round to another. Similarly, the preference ordering and X of others will change from round to round.

Before you cast your vote, you will be informed of your own preference ordering and the points you will receive for your middle option (X) in that round. We advise that at the start of every round you take a moment to check this information.

In addition, at the start of every round, you will be informed how many participants in your electorate have been attributed to each of the three preference orderings. For example, you may hear that 5 voters have preference ordering A B C, 3 voters have B C A and 4 voters have C A B. You will not know others' value for the middle option, however.

[*In addition, at the start of every round, you will be informed how many participants in your electorate have been attributed to each of the three preference orderings and how many points they will get for the middle option (X). For example, you may hear that 2 voters have preference ordering A B C with X=3 and 3 with X=8; 1 voter have B C A with X=3 and 2 with X=8 and 2 voters have C A B with X=3 and 2 with X=8.*]

Trial Round

Before we start with the actual experiment, there will be one trial round at the start of the experiment. This trial round proceeds in exactly the same way as the rounds in the experiment itself, but it will have no consequences for actual earnings.