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School of Social Sciences and Humanities (S3H)
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Abstract

Application of behavioral methodologies to Political Economics show that individuals are more susceptible to biases and various cognitive problems in the political field, which ultimately may not result in people making sincere choices. Using a voting game, the study aims at identifying whether heterogeneous economic agents change decisions during the process and what factors contribute to their decision making. For this purpose, Quantal Response Equilibrium (QRE) models the situation as a strategic game first to formulate behavioral predictions from it which are then eventually compared with the experimental results. The results show a significant proportion of strategic behavior by the voters. Furthermore, the study finds out that limited amount of information always distorts the judgement as compared to no information where people adhere to their preferences and full information where they make decisions based on the best of their knowledge & all available information.

Key words: Strategic Voting, Heterogeneity, Quantal Response Equilibrium, Experiment

1. Introduction

Agents maximize their expected utility which is not only restricted to the marketplace, but also in the political arena as voters, bureaucrats, politicians and lobbyists. Voting has been used as the main tool to voice the choice of majority and for it to be effective and efficient, the fundamental assumption behind it is correct aggregation of the preferences of individuals. This instinct fails when few people do not vote for the option they prefer the most but in its place vote strategically for the alternative they prefer less, most likely to avoid their least preferred alternative from winning (Farquharson 1969).

Considering the rich literature and research on this, Downs (1957, 48) proposed the basic idea of strategic voting and findings by Ordeshook, P. C. and Zeng, L. (1997) support the proposition that, if not all, most of the voters do vote strategically. Alvarez, R. M., F. J. Boehmke, Nagler, J. (2004) and Blais, A. and Nadeau, R. (1996) findings show that tendency to vote strategically becomes larger when there is a close run between two parties that are leading. Data on British General elections was used by Bruce E. Cain (1978) to show that individuals tend to strategically vote for their second ranked preference when they notice their first choice has lower chance of victory.

Heterogeneity in electorates is introduced as voters differ in the relative importance that they attribute to the second most preferred option. In case of divided electorate, sincere voting tends to emerge as an equilibrium (Ginzburg, B. 2017). Results from an experimental study by Tyszler, M. & Schram, A. (2013) generally suggest that heterogeneity lowers the level of strategic voting. On the other hand, W. Hochtl et al. (2012) found out the existence of strictly self-interested median voter while Gerber, E.R. & Lewis, J.B. (2004) show median voter preferences better predict behavior in settings that are homogenous. A theoretical model on competition among parties in heterogeneous electorates was constructed by Bischoff, I. (2005) which shows that voters have preferences on policy that are highly polarized on the scale of preferences.

The Condorcet model was analyzed by Acharya, A & Meirowitz, A. (2017) to show that voters learn considerably less from the pivotal events as compared to their private signals. The collective findings of a study by Nordin, M. (2014) indicate that uninformed voters are significantly worse off than the informed voters when voting for their preferred candidates. Morton, R. B. & Piovesan, M & Tyran, J-R. (2013) experimentally study information aggregation and show that majority voting can be beneficial in way that democratic choice proves to be superior to the opinion of average voter only if the information is aggregated effectively. Similarly, studies showed significant support in favor of bounded rational updating mechanism (Sinclair, B & R. Plott, C. (2012). Tyszler, M & Schram, A. (2011) suggest that information does impact voter behavior in some scenarios through the

differentiation of voter patterns across types and promotion of higher chance of winning of the Majoritarian candidate. Another study looks into the sincerity assumption in the Condorcet Jury Theorem and findings show that sincere voting does not result in a Nash equilibrium (Austen-Smith, D., & Banks, J. (1996).

Psychological phenomenon of 'wasted vote' emphasized in Duverger Law found support through Herrmann, M. (2012) empirical estimates and theoretical model by Fey, M. (1997). Fujiwara, T. (2011) show that the effect tends to be much more in close elections. On the other hand, as opposed to Duverger's Law, there can be emergence of more than two parties in single-member plurality systems even when voting is strategic (Clough, E. 2007). Moreover, findings by Myatt, D. & Fisher, S. (2002) suggest that under equilibrium, only partial tactical voting takes place as voters are less likely to vote tactically if they believe all others are voting truthfully. Another addition to theory suggest 'too weak' and 'too strong', both candidates are strategically deserted by the voters in multimember districts who are only interested in the election outcome (Reed, R. S. 1990).

The goal of the study is to see whether people vote strategically or not, how much people deviate from perfect rationality, and which of the factors affect the likelihood of voting strategically. Furthermore, which particular component of the information that is provided to the voters is more relevant in understanding and predicting human behavior. The study will look into the following Research Questions; • Do people change choices? • Does strategic voting exist in the presence of Condorcet cycles? • What is the impact of varying levels of information about the aggregate preference distribution in explaining the observed differences across different treatments in voting behavior? • What is the effect of heterogeneity in electorates on the voting outcomes? The rationale behind this study is basically to research on the voting patterns of people, what factors operate behind that can further explain it so that it can ultimately help in achieving true preferences of voters in any kind of election.

The paper proceeds as follows. The next section briefly summarizes the theoretical framework and results on which the experiment is based; section 3 describes the empirical methodology covering the experimental design; section 4 reports the experimental results, and section 5 concludes.

2. Methodology

2.1. Theoretical Framework

The Social Theory in Economics deals with an important formulation; The Condorcet Paradox which hypothesizes that even when individuals have transitive preferences, the collective preferences can come out to be cyclic. Two inferences can be made from the Condorcet paradox. In a narrow spectrum, it shows that with more than two options, the order of preferences can have a potential influence over the result of democratic election. In a broad spectrum, majority voting itself is not a true indicator of the preferences of individuals.

While Arrow's Impossibility Theorem does not support abandoning of democratic form of government, it does postulate that whatever form of voting is adopted by the society for the purpose of aggregating preferences of the individuals, it will in one way or the other be weak and imperfect as a tool for social choice.

Duverger Law puts forward an argument that voters will not be willing to waste their vote on a third party having little to no chance of winning and will in place vote for a less preferred party which has an enhanced probability at winning resulting in a two-party system under plurality rule election

2.2. Theoretical Model

The model is an adaptation of the model formulated by Tyszler & Schram (2011, 13)1. There are three alternatives, A, B and C, where each of N voters must choose from the given alternatives. Every voter, i = 1, N, has a strict ordering of preferences concerning the alternatives and must give exactly one vote to the preferred option. Winner is decided using plurality rule, with any tie broken through equal probability random draw. Due to the assumption of mandatory voting, the study focuses on voting decision without having the need to correct for interaction with the decision of turnout. Candidate utility is denoted as UH, UM or UL if candidate's most preferred, intermediate or least preferred alternative is chosen, respectively, through election where UH = 10 and UL = 1. Simultaneously, the intermediate option, UM, is assigned two distinct values which differs across individuals and thus gives rise to the idea of heterogeneous electorates. Low intermediate value i.e. UM = 3, shows a relatively low importance of individual's intermediate option as compared to the most preferred option and hence a strong preference intensity. On the other hand, a high intermediate

[1] Marcelo Tyszler & Arthur Schram, 2011. "Information and Strategic Voting," Tinbergen Institute Discussion Papers 11-025/1, Tinbergen Institute.
Tyszler, Marcelo & Schram, Arthur, 2013. Strategic Voting in Heterogeneous Electorates: An Experimental Study. Games. 4. 624-647.

value i.e. UM = 8, shows a relatively high importance of individual's intermediate option as compared to the most preferred option and hence a weak preference intensity.

The possible ordering of preferences is limited to [(A, B, C), (B, C, A), (C, A, B)] where the listing order shows the ordering of preferences e.g. for (A, B, C) individual's preference ordering is A > B > C. Degree of information about preferences of others is a variable in the model which basically helps in capturing the likely publication of (noiseless) pre-election ballots. The level of information available to the candidates would be varied resulting in three scenarios:

i) Uninformed setting where apart from own preferences, voters know the former probability of preferences and UM,

ii) Partial information setting where voters know the post voting preference orderings for each election but not the realized distribution of UM,

iii) Full information setting where voters know their preference ordering, the post voting preference orderings as well as the realized distribution of UM within every preference ordering.

It is further assumed that preferences of all voters are randomly determined independent of other voter's draws and previous preferences. Own preferences are disclosed to every voter by nature before elections. An electorate is described by the voter count, distribution of preferences, UM, degree of pre-election information. Sincere vote is defined as voter for the most preferred alternative. Strategic vote, on the other hand, is defined as to be the vote for the second preferred alternative according to stated preference ordering2. Whereas, vote for the least preferred alternative is taken to be noisy behavior as it is a dominated strategy and in no situation can help in the maximization of expected utility.

2.3 Theoretical Analysis

For many of the political choice problems, Quantal Response Equilibrium[3] (QRE) has shown to be a much accurate forecaster of individual choices than Nash equilibrium[4]. Quantal Response Equilibrium is therefore used to the analyze the game since it has the benefit of allowing for bounded rational behavior while simultaneously supposing that deviation from rational behavior decreases as numbers become larger.

[2] Blais and Nadeau 1996; Blais et al. 2001; Cain 1978
[3] QRE; McKelvey and Palfrey, 1995
[4] Goeree and Holt 2005

The model adapted starts the QRE analysis by allowing for the expected utility consequential of voting for different alternatives. Considering, e.g. a voter *i* with (A, B, C) as the preference ordering. The expected payoff resulting from voting for option A ($\mu^e_{A)}$ is dependent upon the choices of other voters. The expected payoff for any alternative is a function of odds with which rest of the voters, having either same or different preferences, vote for the three options. Analysis of Nash equilibrium assumes that voter *i* will cast a vote for the option which gives the highest expected utility i.e. best response to the voting probabilities of other voters. On the other hand, QRE analysis lets the possibility that i may make a judgement error in deciding which option or alternative to choose. The error is allowed in the model in the form of a stochastic term added to the expected utility function resulting in expected utilities $(\mu^e_A + \mu\varepsilon_A)$, $(\mu^e_B + \mu\varepsilon_B)$, and $(\mu^e_c + \mu\varepsilon_c)$ for A, B, and C alternatives, respectively. In all these terms $\mu > 0$ is the error parameter and term 'ε' is I.I.D realization of random variable. Errors are assumed to follow extreme type 1 distribution. The taken parameterization helps in capturing different sources of noisy behavior such as perception bias, distractions, miscalculation or limited computational capability[5].

The QRE analysis is done for each information setting separately which is used to draw behavioral predictions then to be used for comparison with the experimental results. Hence, QRE under the theoretical model basically analyzes that given there are behavioral noises in human decision making, how much rationality is shown in individual behavior. Consequently, to what extent voters go for strategic voting and how do the voting outcomes differ given heterogeneous preferences.

Uninformed setting

The voter only has the knowledge about the electorate size, previous distribution of probability of preference ordering, their intensity and self-ordering of preferences and intensity. With this information, probability distributions can be updated by voter with the help of Bayes' rule and simultaneously use this in calculating the probability of becoming vital given strategies of other voters. The voter then computes the expected payoff difference between voting for the most preferred, intermediate and least preferred alternative, given the preferences are self-interested. In the entire QRE analysis, the noise parameter denoted by μ will be concentrated in the range [0.4; 0.8] as it has shown to fit laboratory data in previous experimental studies on voting participation[6].

[5] Goeree and Holt, 2005

[6] Goeree, J.; Holt, C. An explanation of anomalous behavior in models of political participation. *Am. Pol. Sci. Rev.* 2005, *99*, 201–213

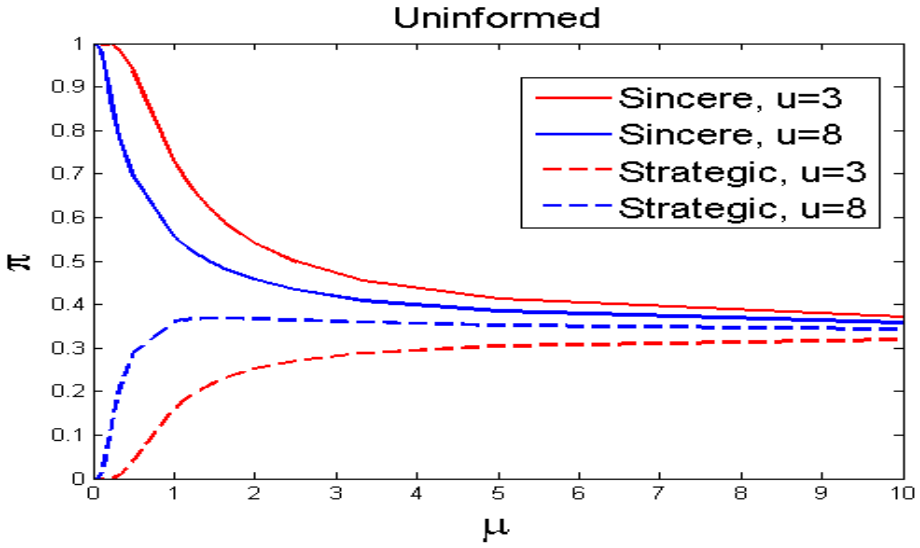
Principal branch of Multinomial Logit Correspondence (MLC) is a technique used to show the likelihood of strategic and sincere voting in a given scenario. Multinomial Logit Equilibrium (MLE) basically depends error values, intermediate option, and the number of people opting for each of the three mentioned options/ preferences. Pool of all MLEs and corresponding error values gives us the MLC. Equation 1 shows the computation behind MLE, showing that the multinomial probability is given by p^i_j which shows that voter '*i*' with preference ordering of (A, B, C) will vote for alternative j i.e. either of the three options A, B, C:

$$p_j^i = \frac{\exp[(u^e j - u^e A)/\mu]}{1 + \exp[(u^e B - u^e A)/\mu] + \exp[(u^e C - u^e A)/\mu]}, \qquad \text{j= A, B, C} \qquad \ldots (1)$$

The base model (*Tyszler & Schram, 2011*) followed in this study shows how the concept of MLC is applied to the problem being researched. Each of the figure 1 to figure 3 shows how the probability of sincere and strategic voting changes corresponding to every error value. This is done by aggregating all possible vote scenarios to individual options. Dominated voting is not shown on the graph.

Figure 1 shows the analysis using principal branch of Multinomial Logit Correspondence where Bayesian Nash equilibrium is the limiting MLE for the scenario when voters are given no information. Figure 1 is an analysis where number of voters are less, N=5 in this study, and depicts the committee size.

Figure 1. Multinomial Logit Correspondence (Uninformed Setting), N=5



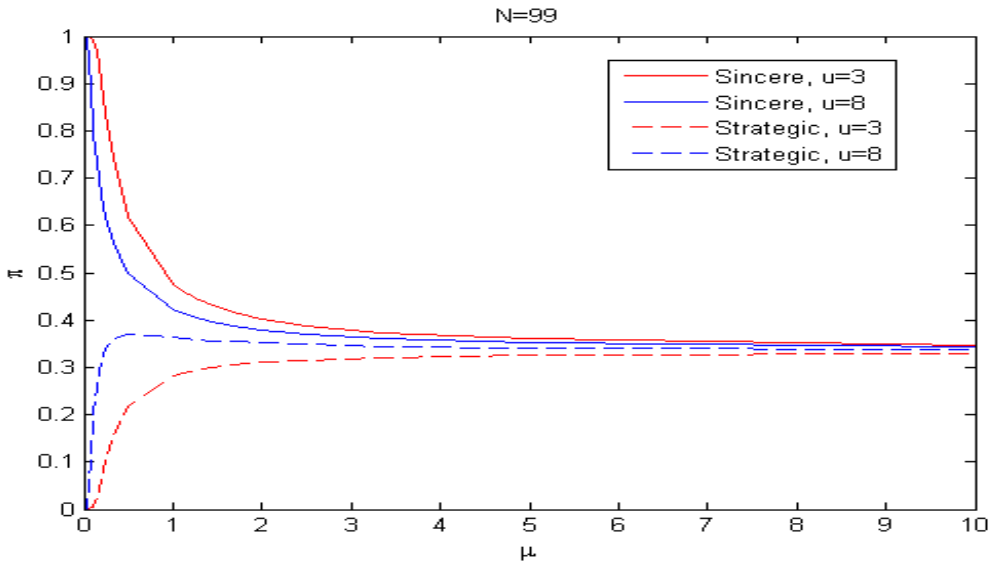
As the chances of error (μ) reduces, the likelihood of sincere voting converges to 1 for all types of voters. Therefore, an analysis of perfect rationality forecasts no distinguishing behavior

among voters assigning different level of utility to the intermediate option and thus for the scenario with no polls prior to the election i.e. the case of incomplete information, limiting MLE is the Bayesian Nash equilibrium with no strategic voting, regardless of μ_M. On the other hand, when the noise becomes infinitely large, voting becomes random and each type of vote i.e. strategic, sincere or dominated occur with equal likelihood; 1/3. For the intermediary cases where individuals show a bounded rational behavior, $0.4 \leq \mu \leq 0.8$ as considered in our study, MLE becomes dependent upon the values assigned by the voters to the intermediate option. Voters with high value assigned to the intermediate option show a greater likelihood of voting strategically, around 38% for $U_M=8$ as compared to around 30% for $U_M=3$.

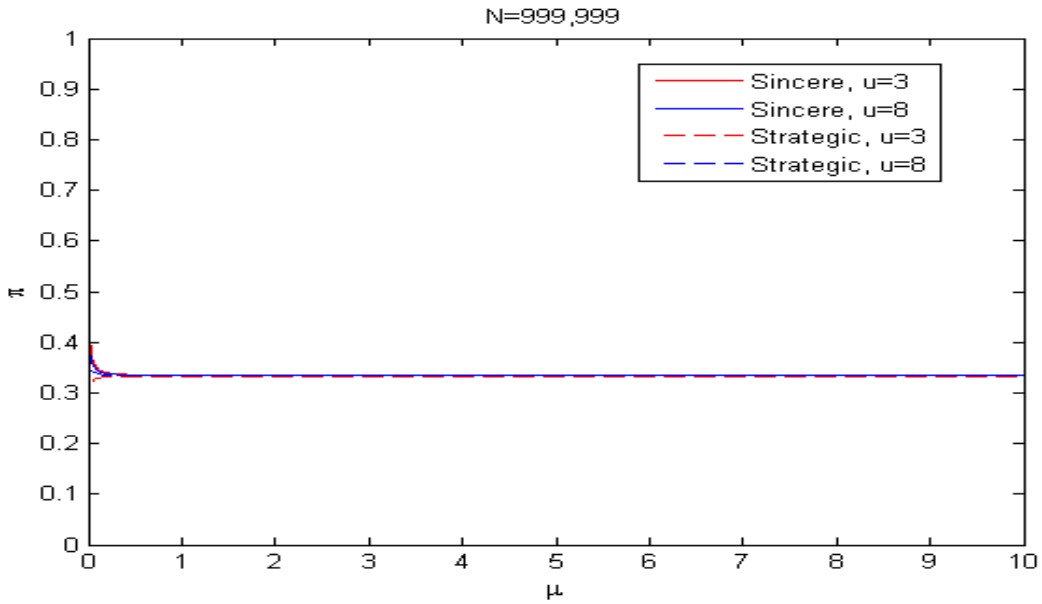
Figure 2 below continues the scenario where voters are uninformed for the case of large electorates, where N=99 depicts the legislature size while N=999,999 depicts the electorate size in large scale elections. Both of these graphs are again simulated on QRE to see the effect of increasing electorate size on the voting outcomes.

Similar inferences can be made by looking at the MLE graphs of legislature sized voting body in figure 2a. Value assigned by voters to the intermediate value makes the difference in results. Strategic voting is seen to be more for $U_M=8$ (approx. 35%) as compared to $U_M=3$ (approx. 30%) and is also seen to be stable throughout the considered μ range. Thus, considerable amount of strategic voting can be predicted in legislature sized groups as well. Lastly, figure 2b shows the likelihood of voting sincerely or strategically in the case of large electorate mostly in correspondence with large scale elections. As seen in the figure, the possibility of one voter being critical, is very small such that the noise behavior dominates the voters' decision so much that even for the smallest values of μ, chances of voting for either of the three alternatives is close to 1/3. Thus, it can be concluded that in large electorates, parameters of model effect the probability of strategic voting for very minor values of noise and individual behavior becomes insignificant. Henceforth, the analysis focuses mainly on committee and legislature sized bodies of voting.

Figure 2. Multinomial Logit Correspondence (Uninformed Settings)
2a. Legislature size, N=99



2b. Large scale elections, N=999,999



Informed setting

Consider the analysis when voters are provided with information, where they know the aggregate preferences distribution and may or may not know the post-election distribution of the preference intensity. The following figures show the Principal branch of Multinomial Logit Correspondence (MLC) for each case.

Figure 3. Average Multinomial Logit Correspondence

Figure 3a. Average Multinomial Logit Correspondence (Partial Information Setting)

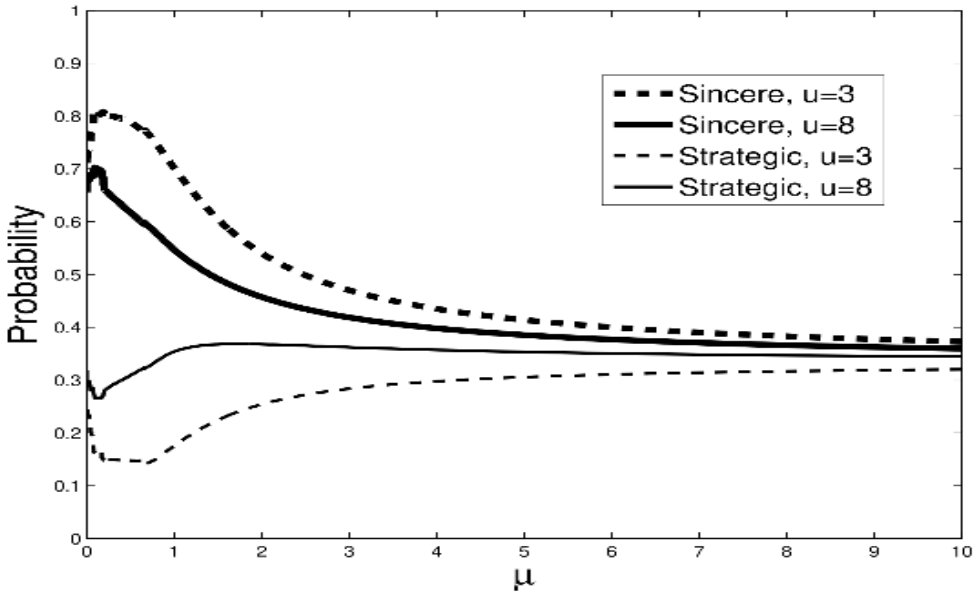
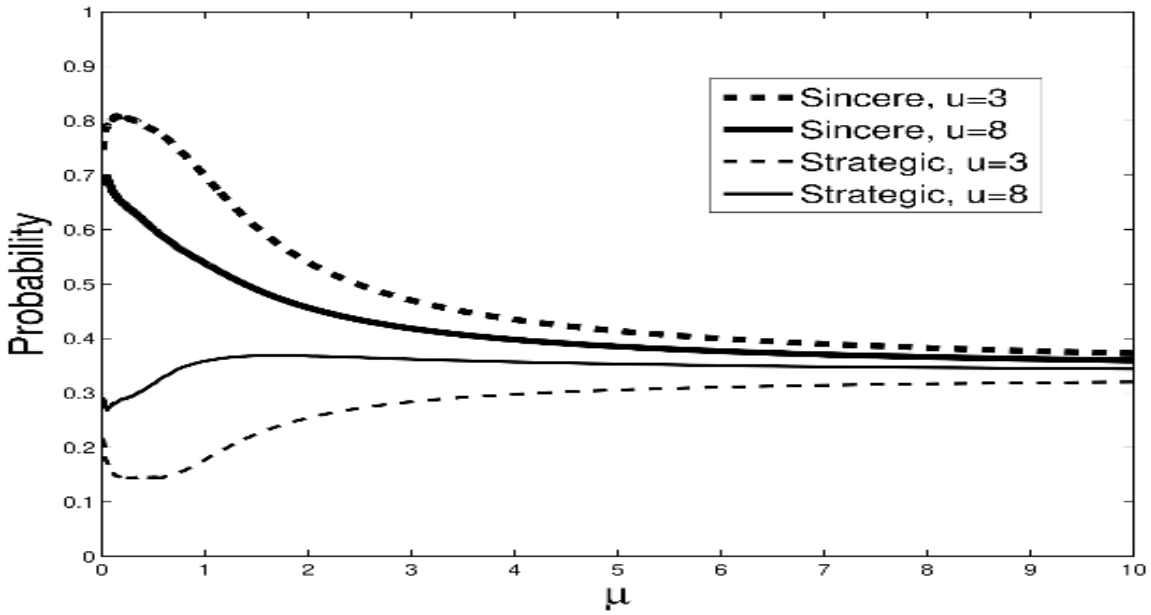


Figure 3b. Average Multinomial Logit Correspondence (Full Information Setting)



The analysis is only done on small electorate size to directly compare with the experimental results. Both, figure 3a & 3b show the mean value of the limiting Nash equilibria across configurations of preference for each case hence depicting the mean behavior across all realizations that are possible weighted by the chance of a realization taking place. Analyzing average behavior helps in comparing with small electorates having varying sizes, where vote for alternative options may be equal or unequal.

Voting sincerely is predicted not to be the mean value of the limiting Nash equilibria across configurations of preferences. For both cases, large variances in strategic voting are predicted between $U_M=8$ and $U_M=3$ when $\mu \in [0.4, 0.8]$.

With perfect rational behavior, limiting MLE analysis forecasts a weighted average of 66%/71% sincere voting and 30%/24% strategic voting for high and low intermediate value, respectively for the case where voters have partial information about the preferences as can be seen in figure 3a. While, for the full information case as shown in figure 3b, where voter knows aggregate preferences distribution as well as the realized distribution of the preference intensity, limiting MLE analysis predicts a weighted average of 70%/76% sincere voting and 29%/22% strategic voting for high and low intermediate value, respectively.

In contrast, for bounded rational behavior limiting MLE analysis predicts a weighted average values of strategic and sincere voting to be nearly the same for both case of informed setting. Limiting MLE analysis predicts a weighted average of around 40%/42% sincere voting and around 37%/29% voting strategically for high and low intermediate value, respectively for both the cases where voters have partial information about the preferences and for full information case where voter knows aggregate preferences distribution as well as the realized distribution of the preference intensity.

3. Empirical Methodology

3.1. Experiment

The sample constitutes of primary data with 180 participants mainly consisting of students of National University of Sciences and Technology (NUST). Each information treatment had 12 sessions making a total of 36 sessions for the entire study, each with ten rounds. Winner of each session having the most number of points was awarded with a tangible benefit and each participant was also given a show up prize. Participants were selected anonymously from different departments of NUST (Engineering, Social Sciences, Management and Biosciences) and different years (first, second etc.) and levels (bachelors, masters etc.) of study to ensure maximum randomization.

Information treatments are analyzed separately to see for the probability of strategic, sincere and dominated voting in each setting while simultaneously analyzing voter ranks. 12 sessions were conducted under each information setting. While, on the other hand, participants are also individually analyzed where age, years of education, gender, occupation, field of study and knowledge of game theory are taken as independent variables to see their effect on the probability of strategic voting.

The basis of experiment is adopted from *Tyszler & Schram, 2011* similar to the model. Its purpose is to study the impact of preference heterogeneity on the type of voting when the relative significance of the intermediate alternative and the intensity of information provided to the voters is differed.

The electorate size is taken to be fixed which consists of 5 voters per session, selected randomly. The session comprises of 10 elections which are called as rounds. Number of rounds are kept unknown from the participants to ensure maximum self-interested behavior in each round. Preference orderings are limited to 3 distinct orderings; [(A, B, C), (B, C, A), (C, A, B)] assigned with identical probability to every subject. All 5 participants are given a different colored paper, which stays same for each round particular to a participant, and choices are hidden to ensure no cheating took place. Preferences are drawn before every election, which are independent across the subjects and elections, and disclosed as per the information setting. The prior realization of the random distribution of preference ordering, including the realizations for intermediate option, is kept the same so that groups can be compared directly. Every voter is required to cast only one vote in every election. Winner is determined through plurality rule with ties broken by equal probability random draw. Winner for each round is given a point and voter having the most number of points at the end of 10 rounds is considered as the winner for the session. Level of information is varied resulting in three treatments.

In all the treatments, distributions from which preference ordering and value of intermediate alternative are drawn is made known to the voters. In addition to this, voters are also aware of their own preference ordering and intermediate value. In the 'uninformed' treatment, voters just know this information when they decide which option to vote for. In the treatment with 'full information' provided to voters in each round, before casting vote, voters are informed about the aggregate preference realization and also the realized distribution of intermediate alternatives. Lastly, 'partial information' treatment lies between full and no information provision to voters. With partial information, voters do not know the realized preference distribution of the intermediate option after every election and only have the knowledge regarding the aggregate preferences. Table 1 further helps in understanding the extent of information provided to the voters. Voters in the partial information treatment are only provided with the information contained in first and last columns of table while simultaneously being aware that values for the intermediate option may vary across voters. If voters are provided with no information, they are only told about the preference ordering according to each option selected and the random realization of preferences (see Appendix). In partial information they

know that as well as which option won at the end of each round i.e. Option A according to table 1, whereas in full information voters know all of that as well as how many people assigned what intermediate value to their selected option e.g. in Table 1, A won since it got 3 votes, with 2 people assigning 8 to their intermediate option and 1 person assigning 3 to the intermediate option.

Table 1. Example of information provided to voters

Preference Ordering	Intermediate Value = 3	Intermediate Value = 8	Total
A B C	1	2	3
B C A	0	1	1
C A B	1	0	1

4. Results and Discussion

4.1. Descriptive Statistics

Analyzing the entire sample while grouping it according to the extent of information provided to each group, several inferences can be made. Table 2 provides the result on the type of voting undertaken in each information group. Average behavior of voters per electorate is mainly taken as the unit of observation.

Table 2. Type of voting undertaken in each information setting

	Sincere	Strategic	Dominated
Un-informed	46.33%	27.17%	26.50%
Partial information	45.17%	26.00%	28.83%
Full information	54.33%	24.67%	21.00%

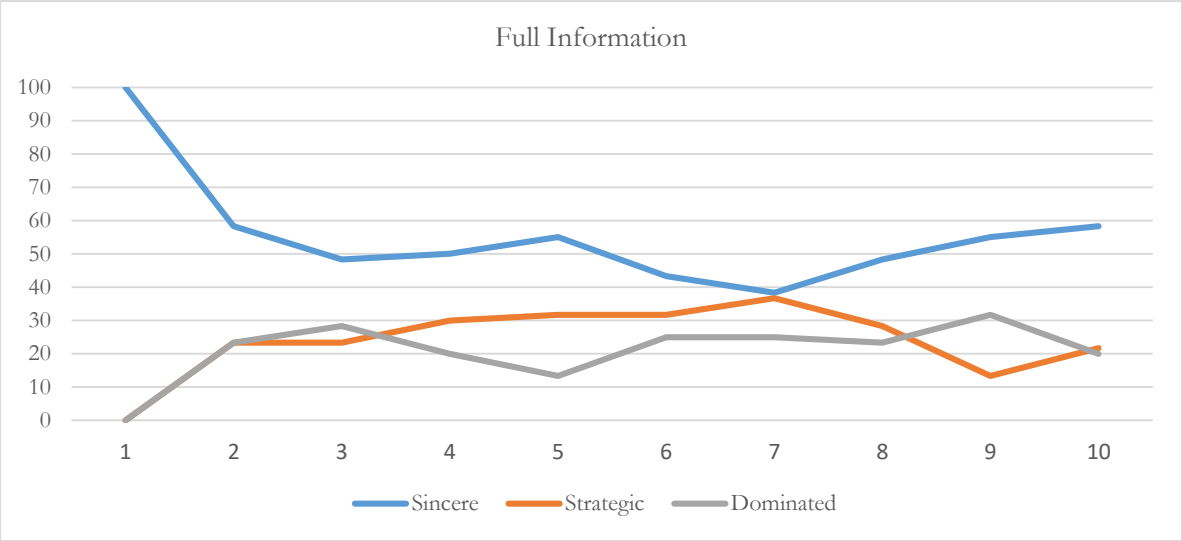
Table 2 shows that in all the settings, probability of sincere voting remains the highest with full information having the highest probability of sincere voting (54.33%) as compared to the other two information settings. On the other hand, partial information setting shows the highest probability of insincere voting, both strategic and dominated, as compared to un-informed and full information settings. Moreover, dominated voting, which is considered as a noisy behavior, is also the highest in partial information setting (28.83%) in comparison to both full information (21.00%) and un-informed (26.50%) setting. The result is also backed up by studies which show that when voters have full information, they are less likely to vote strategically if they believe the others are voting truthfully

(Myatt & Fisher, 2002). Also, when the electorate is divided, sincere voting ought to become the equilibrium strategy *(Ginzburg, 2017)*. While, uninformed voters usually adhere to their preferences due to the limited information and fully informed voters make decisions with maximum available information around, on the contrary, partially informed voters exploit the little available information to make decisions which may not result in expected outcomes.

Figures 4a, 4b & 4c, also analyze the extent of sincere, strategic and dominated voting over the ten rounds. Averages of each round for thirteen sessions in each information setting is calculated and plotted in the graphs.

Figure 4. Proportion of each type of voting over the rounds

4a. Full Information Setting



4b. Uninformed Setting

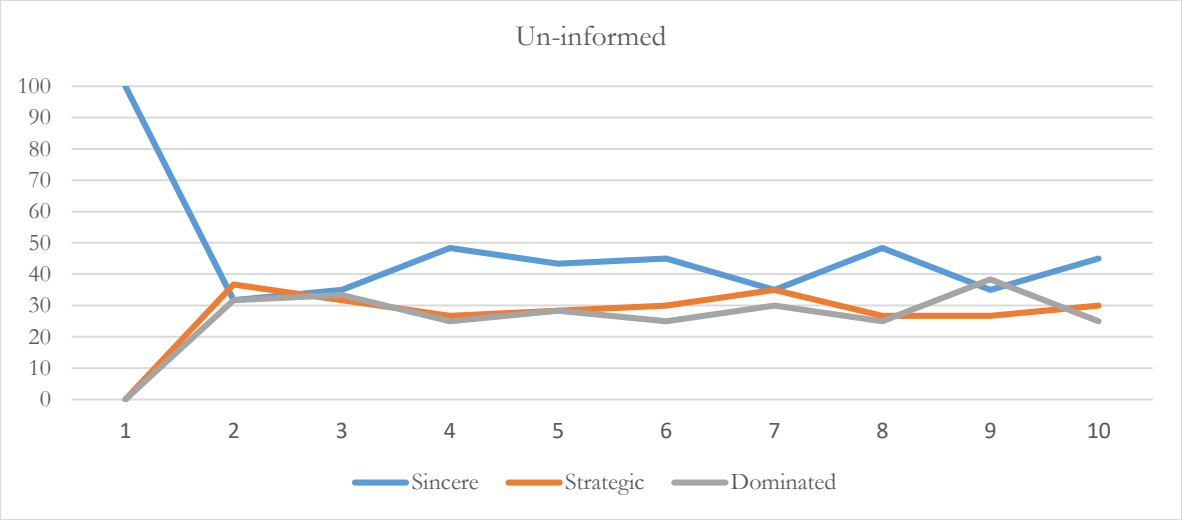
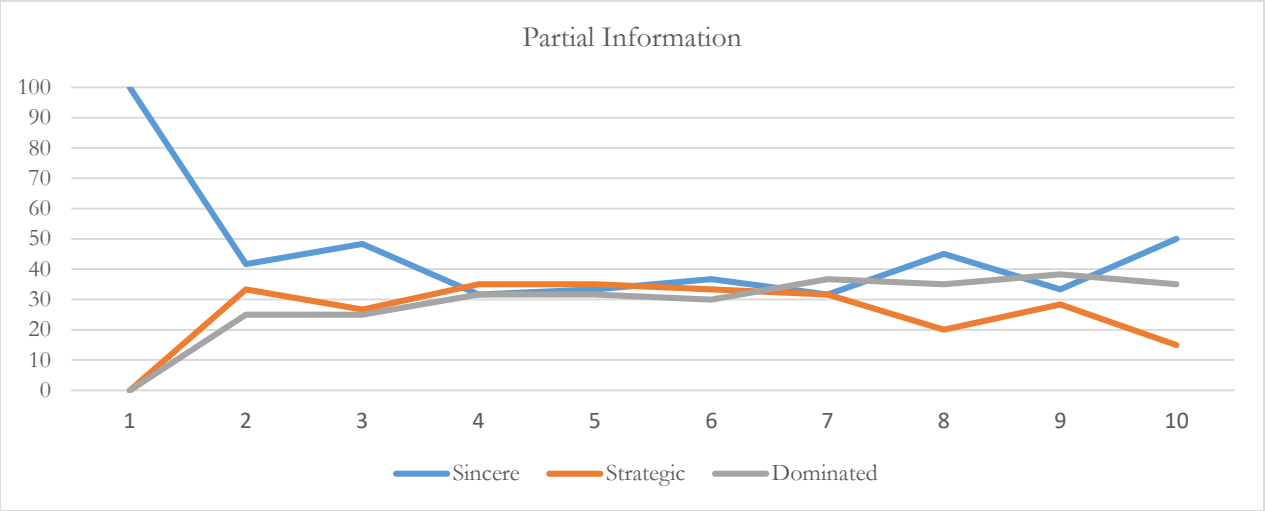


Figure 4c. Partial Information Setting



The graphs reinforce the analysis of above figures showing that for both un-informed and full information settings, sincere voting is almost always above strategic and dominated voting (as supported by behavioral prediction of model as well), whereas in partial information setting, all three sorts of voting behavior overlap especially in the intermediate rounds i.e. rounds 4 to 7. Further analysis of graphs shows that in full information setting, sincere voting distinctly stays above strategic and dominated voting since voters are fully informed and know their preferences clearly keeping in view the surroundings. Whereas, in un-informed setting generally adhere to their preferences due to the unavailability of information. Lastly, partial information setting always serves as an anomaly in the results since voters are not fully aware in real as opposed to their perception hence their decisions do not always result in the best outcome as it is seen to be not according to their preferences. This result is supported by Garratt *et al.* (2019) which show that the transition from no to full information is not monotonic. Where full disclosure of information attains maximum liquidity in market, partial information lessens the liquidity even further than no information disclosure.

Voters are classified keeping in view their preferences and given ranks accordingly. A majoritarian candidate is defined as the candidate receiving the highest number of votes provided all the voters are voting sincerely. Following this, voters are assigned ranks. A rank 1st voter is defined as the one whose most preferred candidate is the majoritarian candidate. Similarly, rank 2nd voter is defined as the one whose most preferred candidate receives second highest votes in sincere polls. And lastly, rank 3rd voter is defined as the one whose most preferred candidate receives the lowest votes in

sincere polls. In the analysis, sincere polls are defined as outcome obtained when all the voters vote sincerely.

Table 3 below shows how the probability of sincere, strategic and dominated voting differs according to the voter ranks when voters are analyzed according to the extent of information they were provided. Hence, the results are categorized according to the information setting.

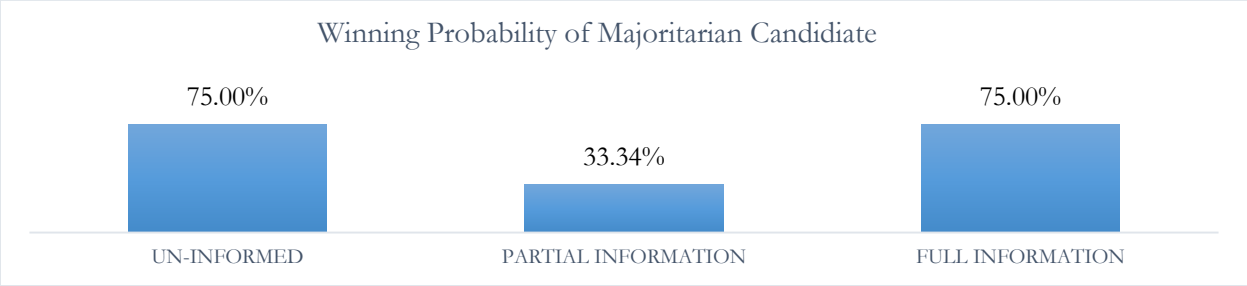
General trend for un-informed and full information settings is that as the rank moves from 1st to 3rd, sincere voting decreases whereas non-sincere voting increases which is taken to be the aggregate of strategic and dominated voting. Henceforth, probability of sincere voting is the seen to be the highest for rank 1st voters whereas probability of strategic voting is seen to be highest for rank 3rd voters. Duverger's Law also predicts that rank 3rd voters will be the most likely ones to vote strategically. However, partial information setting serves as an anomaly in the general results since probability of strategic voting (28.95%) is seen to be the highest for 2nd rank voters and non-sincere voting (55.14%) for 1st rank voters is seen to be the highest compared to other information settings. This again leads to the same understanding that voters may use the little information available to them, to make decisions which may not be true to their preferences.

Table 3. Voting type according to voter ranks

Full Information									
		Ranks							
		1st		2nd		3rd			
Sincere		57.14%		50.83%		41.67%			
Strategic	Non-Sincere	23.81%	42.86%	24.17%	49.17%	31.67%	58.33%		
Dominated		19.05%		25.00%		26.67%			
Partial information									
		Ranks							
		1st		2nd		3rd			
Sincere		44.86%		46.84%		41.67%			
Strategic	Non-Sincere	25.14%	55.14%	28.95%	53.16%	23.33%	58.33%		
Dominated		30.00%		24.21%		35.00%			
Un-informed									
		Ranks							
		1st		2nd		3rd			
Sincere		47.44%		49.38%		28.00%			
Strategic	Non-Sincere	26.15%	52.05%	24.38%	51.88%	44.00%	72.00%		
Dominated		25.90%		27.50%		28.00%			

Figure 5 shows the winning probability of majoritarian candidate for each information setting. The result is a probability analysis of the candidate receiving the highest number of votes in the initial round to the chances of it being the winner in the conclusive round.

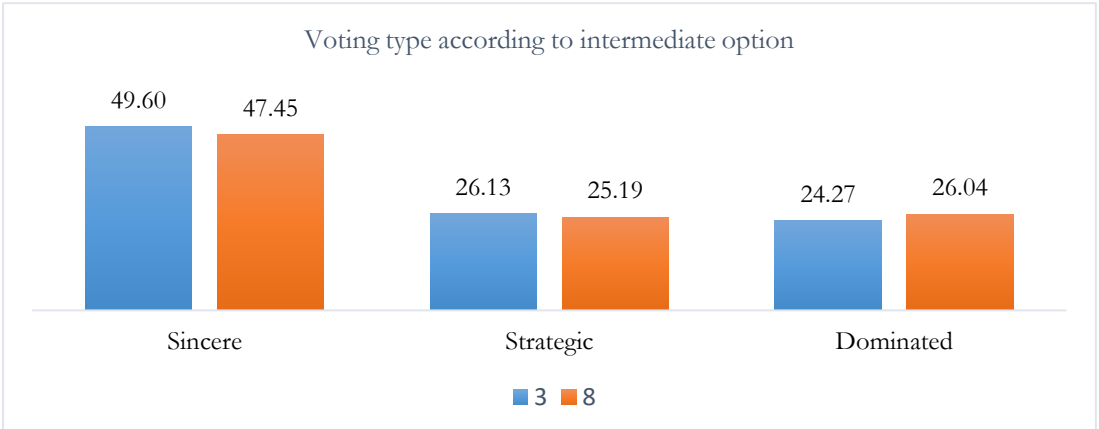
Figure 5. Winning Probability of Majoritarian Candidate



For both un-informed and full information settings, probability of majoritarian candidate winning is as high as 75.00% whereas for partial information setting it is 33.34%. Hence, it reinforces the fact that voters in uninformed and full information settings show higher probability of sincere voting whereas when they are given partial information, they opt for strategic voting.

Voters can differ by the value they assign to their intermediate option which can either take the value of 3 or 8. $U_M = 3$ showing a relatively low importance of individual's intermediate option as compared to the most preferred option and a strong preference intensity. The sample statistics show that proportion of voters opting for an intermediate value of 3 are 42% whereas those opting for an intermediate value of 8 are 58%. So in general there are higher proportion of people who have weak preference intensity between their first two preferred alternatives. The following graph, Figure 6, further looks into how the choice of value for intermediate option or the preference intensity effects the type of voting that is undertaken.

Figure 6. Type of voting according to the intensity of intermediate option



A general trend existing that probability of sincere voting is the highest for both type of voters i.e. those with strong as well as those with weak preference intensity between their highest two ranked alternatives. Strategic voting is slightly higher for voters having strong preference for their highest ranked alternative whereas dominated voting is marginally high for voters having weak preference for their highest ranked alternative. Hence, it can be inferred that voters having weak preference don't mind switching their votes to the other alternative which is also supported by the behavioral predictions of QRE Model.

4.2. Cross Tabulation

For the purpose of analysis, strategic voting is categorized further into three categories for easy comparison and interpretation of results. 0 where strategic voting varies from 0-2 per ten rounds, 1 where it varies from 3-5 per ten rounds and 2 where it varies from 6-10 per ten rounds. Similarly, age and years of education are taken as a continuous variable. Gender is divided into two categories; male and female. Occupation is also divided into two categories; student and working. Field of study is divided into three categories; engineering, management sciences and social sciences. Finally, knowledge of game theory attains the response yes or no. The analysis looks only into the cross tabulations which have significant effect. For each table, numbers in the parenthesis show the column percentage while numbers outside it shows the frequency.

Strategic Voting & Age Given Sample With No Knowledge Of Game Theory

Strategic Voting	Age		Total
	<22	≥22	
0	26 (39.39%)	27 (56.25%)	53 (46.49%)
1	37 (56.06%)	16 (33.33%)	53 (46.49%)
2	3 (4.55%)	5 (10.42%)	98 (7.02%)
Total	66 (100%)	48 (100%)	114 (100%)
Pearson chi2(2) = 6.1509		Pr = 0.046	

The first association is between strategic voting and age. Age is divided into two categories with 22 being the separating age as in Pakistan 22 years is the average age for people getting a Bachelor's degree. Association between strategic voting and age came out to be insignificant. However, when association analysis between the variables was carried out taking only the sample having no knowledge of game theory, the results turned out to be significant. Table 4a show, for voters

having age greater than or equal to 22 years, people opt for lower level of strategic voting as most of the proportion (56.25%) lies in the lowest category whereas for the voters having age less than 22 years, middle category shows that largest proportion (56.06%).

Table 4. Cross Tabulation between strategic voting & age given sample with no knowledge of game theory

Strategic Voting & Years Of Education

Strategic Voting	Years of Education		Total
	<16	≥16	
0	47 (43.12%)	36 (50.70%)	83 (46.11%)
1	58 (53.21%)	28 (39.44%)	86 (47.78%)
2	4 (3.67%)	7 (9.86%)	11 (6.11%)
Total	109 (100%)	71 (100%)	180 (100%)
Pearson chi2(2) = 4.9390		Pr = 0.085	

Next, table 5 analyzes the association between strategic voting and years of education. Years of education is also divided into two categories with 16 being the separating years again taking Bachelor's degree as the bench mark. For years of education greater than 16 years, strategic voting decreases as years of education increase because the table shows 50.70% people opt for the least level of strategic voting. While for years of education less than 16 years, voters mostly go for mediocre level of strategic voting (53.21%). The variables follow the exact same trend when analysis is carried out taking sample with no knowledge of game theory and female sample as seen in table 5a & 5b.

Table 5. Cross Tabulation between strategic voting & years of education

Table 5a. Cross Tabulation between strategic voting & years of education given sample with no knowledge of game theory

Strategic Voting & Years Of Education Given Sample With No Knowledge Of Game Theory

Strategic Voting	Years of Education		Total
	<16	≥16	
0	31 (41.89%)	22 (55.00%)	53 (46.49%)
1	40 (54.05%)	13 (32.50%)	53 (46.49%)
2	3 (4.05%)	5 (12.50%)	8 (7.02%)
Total	74 (100%)	40 (100%)	114 (100%)
Pearson chi2(2) = 6.1936		Pr = 0.045	

Table 5b: Cross Tabulation between strategic voting & years of education given female sample

Strategic Voting & Years Of Education Given Female Sample

Strategic Voting	Years of Education		Total
	<16	≥16	
0	11 (31.43%)	26 (50.00%)	37 (42.53%)
1	23 (65.71%)	21 (40.38%)	44 (50.57%)
2	1 (2.86%)	5 (9.62%)	6 (6.90%)
Total	35 (100%)	52 (100%)	87 (100%)
Pearson chi2(2) = 5.7358		Pr = 0.057	

Summarizing the cross tabulations, it can be seen that voters having greater than or equal to 16 years of education or having greater than or equal to 22 years of age tend to go for lower level of strategic voting i.e. 0, 1 or 2 times in ten rounds and lower proportions of former samples are seen as the extent of strategic voting increases. On the other hand, voters having less than 16 years of education or who are below 22 years of age tend to opt for mediocre level of strategic voting i.e. 3, 4 or 5 times in ten rounds. Studies have found that as age increases, people tend to make less advantageous decisions for themselves *(Fein, McGillivray & Finn 2007)* and comparatively younger people can be more analytical in their choices *(Duke University 2015)*. Lastly, it has also been researched that education enhances a person's decision making capability *(Hyuncheol Bryant Kim, Syngjoo Choi, Booyuel Kim, Cristian Pop-Eleches 2018)* and in this study's context, voters' having higher education may find it more rational to adhere to their sincere choices rather than changing preferences and voting strategically.

5. Conclusion

The paper studied the extent to which people opt for sincere, strategic or dominated voting. It also collected insights on effect of heterogeneity on the voting outcomes and the impact of varying levels of information in explaining observed differences in voting behavior subject to voter characteristics and in general. The model adopted from *Tyszler & Schram 2011, 2013* helped in given predictions for each information setting and the results that can be obtained if the electorate size is scaled up. It showed how the true behavior of voters i.e. bounded rational behavior accounting for errors in decision making deviates from the known perfect rational behavior, where voter tends to stick to original preferences throughout, usually taken as a concrete assumption in most economic models.

The model predicted that as opposed to voters always casting their vote sincerely, when accounting for errors in decision making which may be due to perception bias, distractions, miscalculation, limited computational capability or several other factors, voters do not always end up with sincere voting. Voters are likely to go for strategic voting; however, probability of sincere voting always exceeds that of strategic voting. It also predicts that voters with strict preferences opt for sincerer voting as compared to those with weak preferences. Furthermore, the model also predicts that when the electorate size is scaled up to match the number of large electorate in nation-wide elections, the possibility of one voter being pivotal becomes very small hence individual decisions do not affect the election outcome and probability of voting for either of the alternatives becomes equal.

The results of experimental study reinforce the behavioral predictions from the model. In general, it is analyzed that full information un-informed settings follow the same trends as seen in descriptive statistics whereas observations from partial information settings deviate from the trend, be it the average voting behavior across the rounds, winning probability of majoritarian candidate or the voting behavior according to ranks. As far as ranks are concerned, the general trend shows that for all information setting Rank 1st voters show greater proportion of sincere voting whereas Rank 3rd voter are most likely to go for insincere voting (strategic & dominated). From the Regression results it can be inferred that in un-informed setting, female voters and voters having engineering as educational background both have a positive effect on the probability of strategic voting. Partial information setting shows that voters with greater years of education opt for lower level of strategic voting and lastly, full information setting shows that female voters and voters who are students both have a positive effect on the probability of strategic voting. Cross Tabulation results show various insights of the data which can be summarized as, voters having $\geq$ 16 years of education or $\geq$ 22 years of age tend to opt lower level of strategic voting i.e. 0, 1 or 2 times in ten rounds. On the other hand, voters having $<$ 16 years of education or $<$ 22 years of age tend to opt for mediocre level of strategic voting i.e. 3, 4 or 5 times in ten rounds.

The study in general concludes that economic models resting on the assumption on known perfect rationality may not always result in the best predictions as errors in decision making are generally assumed in human. Taking, the context of this paper, in political choice problems, while rationality predicts sincere voting, bounded rationality show a significant proportion of strategic behavior. Furthermore, limited amount of information always distorts the judgement as compared to no information where people make stick to their preferences and full information where they make decisions based on the best of their knowledge.

Although laboratory experiments, such as the one conducted in this study, are a step towards better understanding of human behavior, they still have some limitations. Few limitations of this study include; small sample size, restricted preference orderings, alternatives had no real preferences attached to them and information in informed settings was provided at a set point in time i.e. after every round.

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Appendix

Vote Page Color:

Name (optional)	
Gender*	
Age*	
Qualification*	
Field of study*	
Occupation*	

Experimental Instructions

Welcome! This is a voting experiment where 5 people are required at a given time to play the game. Each of you has been given a different colored paper, you are first required to fill the table accordingly.

You will be playing various rounds in this experiment. However, the count of rounds taking place will not be revealed. In every round, you will be required to write down your preference ordering on the piece of paper provided to you. In each round, your decision consists of voting for one of the alternatives: A, B or C and your preference ordering ABC, BCA or CAB, respectively. This electorate size is 5 which will be kept fixed during the entire experiment. Every voter will have the same three options to vote from.

You will be choosing the preference ordering according to your likings. In case you chose ABC that means you are giving 10 points to option 'A' and 1 point to option 'C'. However, you can differ in your intensity of preference through the intermediate option by giving it an 8 or a 3. In case you give option 'B', 8 points that means you are indifferent between option 'A' and 'B' where as if you give option 'B', 3 points it means that you want option 'A' to win for sure.

The winner of the round will be the option which receives the highest number of votes (out of 5). In case there is a tie, random draw will take place between the two options. Voters who had given priority to the winner option will receive 1 point. Voter having the most number of points at the end of 10 rounds will be declared the winner and will be awarded a gift.

Random Draw Realizations

Table A. shows the random draw realization for the preference distributions of 10 elections. The same initial set of realizations were used in all electorates. Table A, shows that through random draws, Option A won with 20 votes which was conveyed to every voter in each setting before the start of the game.

Table A. Random Draw Realization for 10 rounds

Summary Statistics

Table B. shows the summary of the quantitative variables incorporated in the study.

Table B. Summary Statistics

Variable	Observations	Mean	Std. dev	Min	Max
Age	180	21.63	2.68	17	35
Years of Education	180	15.25	1.65	13	21
Strategic	180	2.61	1.86	0	9

Gender	Female: 48.33%	Male: 51.67%
Occupation	Student: 93.89%	Working: 6.11%
Study Type	Acturial: 32.22%	Non-Acturial: 67.78%
Game Theory Knowledge	Yes: 36.67%	No: 63.33%

Election	ABC	BCA	CAB
1	2	1	2
2	1	2	2
3	2	1	2
4	3	0	2
5	1	1	3
6	1	3	1
7	3	1	1
8	2	1	2
9	2	3	0
10	3	1	1
Total	20	14	16

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