



## UvA-DARE (Digital Academic Repository)

### Political economics in the laboratory

Tyszler, M.

**Publication date**

2012

**Document Version**

Final published version

[Link to publication](#)

**Citation for published version (APA):**

Tyszler, M. (2012). *Political economics in the laboratory*. [Thesis, fully internal, Universiteit van Amsterdam]. Thela Thesis.

**General rights**

It is not permitted to download or to forward/distribute the text or part of it without the consent of the author(s) and/or copyright holder(s), other than for strictly personal, individual use, unless the work is under an open content license (like Creative Commons).

**Disclaimer/Complaints regulations**

If you believe that digital publication of certain material infringes any of your rights or (privacy) interests, please let the Library know, stating your reasons. In case of a legitimate complaint, the Library will make the material inaccessible and/or remove it from the website. Please Ask the Library: <https://uba.uva.nl/en/contact>, or a letter to: Library of the University of Amsterdam, Secretariat, Singel 425, 1012 WP Amsterdam, The Netherlands. You will be contacted as soon as possible.



tinbergen *institute*

## *Political Economics in the Laboratory*

Marcelo Tyszler

Voting is likely the tool most strongly associated with the idea of democratic decisions, be it at national or local elections, decisions within a parliament, committees, juries or even at company boards. In turn, the outcomes of voting processes potentially affect a large constituency. Therefore, understanding voter behavior is of major interest in a variety of fields. In this thesis I approach voter behavior from the perspective of Political Economics. More generally, I address various aspects of individual behavior in the common arena. Specifically, this thesis investigates the impact of information on the extent of strategic voting, explores the motives behind economic voting and applies a similar toolbox to understand contributions to the public good in a non-trivial scenario. This is done using a combination of theoretical (behavioral modeling) and experimental analysis.

**Marcelo Tyszler** studied Business and Public Administration at the University of São Paulo, Brazil and obtained a Master degree in Public Administration and Government at the Fundação Getúlio Vargas, Brazil. In 2006 he moved to the Netherlands and after graduating in Tinbergen Institute's MPhil programme in 2008 continued his Doctoral studies at the Center for Experimental Economics and Political Decision Making (CREED) of the University of Amsterdam. His research interests include Political Economics, Public Policy and Economic Development, Non-Profit Organizations, Experimental and Behavioral Economics and Bounded Rationality. Currently, Marcelo is a Lecturer at the University of Maastricht.

# POLITICAL ECONOMICS IN THE LABORATORY

ISBN 978 90 361 0263 6

Cover design: Crasborn Graphic Designers bno, Valkenburg a.d. Geul

This book is no. 517 of the Tinbergen Institute Research Series, established through cooperation between Thela Thesis and the Tinbergen Institute. A list of books which already appeared in the series can be found in the back.

# **Political Economics in the Laboratory**

ACADEMISCH PROEFSCHRIFT

ter verkrijging van de graad van doctor  
aan de Universiteit van Amsterdam  
op gezag van de Rector Magnificus  
prof. dr. D.C. van den Boom  
ten overstaan van een door het college voor promoties ingestelde  
commissie, in het openbaar te verdedigen in de Agnietenkapel  
op vrijdag 3 februari 2012, te 10:00 uur

door

**Marcelo Tyszler**

geboren te São Paulo, Brazilië

## **Promotiecommissie**

*Promotor:*

Prof. Dr. A.J.H.C. Schram

*Overige leden:*

Prof. Dr. J.H. Sonnemans

Prof. Dr. J.N. Tille

Prof. Dr. J.R. Tyran

Prof. Dr. B. Visser

Prof. Dr. F.A.A.M van Winden

**Faculteit Economie en Bedrijfskunde**

*para as minhas avós, Rosa e Nésia,  
e meus pais, Dulce e Henrique.*

## Preface

The path that brought me to do my PhD at the University of Amsterdam started in June 2004 in São Paulo, Brazil. At that time I had just started a Master's program in Public Administration and Government at the Fundação Getúlio Vargas and in the mid-year holiday I chose to take the intensive Master's course in Economics, which was offered that year by a Dutch Professor, Arthur Schram, on a topic I had never heard of: Experimental Economics.

By the end of the three very intense weeks (3 hours of classes per day, every day), Arthur and I got along quite well and he told me about the Tinbergen Institute and the possibilities here. As I was concluding my Master's, I successfully applied to the 5 year program (2 year Master's program in Economics plus 3 years of PhD research) at the Tinbergen Institute. Already on my second year I had a desk at CREED (Center for Research in Experimental Economics and Political Decision Maker) where I wrote my Master Thesis under Arthur's supervision.

CREED is certainly a wonderful place to do your PhD. The several people with different levels of experience and research focus provide an optimal and open learning environment hard to be found elsewhere. Along the people I met at CREED during these years I should mention and thank Eva and Michal, my first officemates, Julianna, Roel and Pedro, my following officemates, the other PhD students, Adrian, Jona, Thomas, Julian, Ben, Ailko, Audrey, Yang Yang, the rookies Matze, Anita and Boris, the Professors (assistant, associate and full) Aljaz, Mathijs, Klaus, Frans, Joep, Theo, Gonul and, obviously, Arthur and the one responsible for making everything run smoothly, Karin. I thank also the people I met via the environment of the Tinbergen Institute, the University of Amsterdam, ESA meetings, CREED guests and ex-CREEDers. These include, on a non-exhaustive list, Jeroen, Massimo, Marcos, Adam, Marie, Martijn, Cars, Bas, Marko, Zoltan, Petr, Julia, Marcus, Matija, Deny, Rei, Bernd, Nick, Fujin, Melinda, Robert, Ernesto, Jens, Ana, Martin, Anya, Aniol, and Marta. A special thank is reserved here for my co-authors Jon and Luca, who helped me tremendously with progressing through this thesis.

Spending 5 years abroad, in a place you have never been before and stays at least 10 hours flying away from your home place, is not an easy task for all parts involved. For their understanding and support, I thank my direct family, Henrique, Dulce and Michele,

both my grandmothers, who passed away during these 5 years, Nesia and Rosa, and my other relatives, such as my uncles and aunts Sérgio, Regina, Marisa and Sérgio and their direct families who were always interested in my updates. I thank specially my friends Tatiana, Nathalia and Leo, for keeping in good contact with me, visiting and reminding me of good things from home. On the other side of the story, I thank specially my great (new) friends (and paranymphs) Roel and Clio, for making me feel at home here in the Netherlands. I thank all the people I met via dancing and made my social life really active. They include (also on a non-exhaustive list) Rob, Antonio, Mirjam, Armando, Karin, Mary, Eddy, Erwin, Rene, Krullaine, Remko, Jette, Juliana, Maaïke, Josje, Daiva, Sander, Anya and Marion.

Most of all I would like to thank Rosalie, my most important ‘finding’ during these 5 PhD years. Jokes apart, since we have been together she provides me with great light, support and help giving meaning to the things I do. Also a special thanks to her parents, Martin and Marion, who could not be more welcoming and give me a family feeling also here in the Netherlands.

This thesis is a snapshot of a work in constant progress. It captures 4 research projects in slightly different stages of evolution as of August of 2011 and portrays methods and topics that highly interest me. I will save the contents for the main chapters. It suffices to say that regardless of where my research and/or career moves in the coming years, this thesis (and the 5 years that took to write it) will always be a defining period in my life, which I believe has provided me with the lenses and tools with which I want to see and affect the world.

*Marcelo*  
*Maastricht - October, 2011*



# Contents

|          |   |           |
|----------|---|-----------|
| <b>1</b> | <b>Introduction</b>   | <b>1</b>  |
| <b>2</b> | <b>Information and Strategic Voting</b>                       | <b>5</b>  |
| 2.1      | Introduction . . . . .  | 5         |
| 2.2      | The Model . . . . .   | 9         |
| 2.2.1    | Equilibrium Analysis . . . . .                                | 10        |
| 2.2.2    | Behavioral Predictions . . . . .                              | 21        |
| 2.3      | Experimental Design . . . . .                                 | 22        |
| 2.4      | Results . . . . .   | 23        |
| 2.4.1    | General Overview . . . . .                                    | 23        |
| 2.4.2    | Strategic Voting . . . . .                                    | 25        |
| 2.4.3    | Voter Types . . . . .   | 26        |
| 2.4.4    | Summarizing the Results . . . . .                             | 29        |
| 2.5      | Concluding remarks . . . . .                                  | 29        |
|          | Appendix 2.A Pivotal Probabilities and Asymptotics . . . . .  | 32        |
|          | Appendix 2.B Experimental Instructions . . . . .              | 34        |
|          | Appendix 2.C Realizations of the Random Draws . . . . .       | 36        |
|          | Appendix 2.D MLC for each unique situation . . . . .          | 37        |
|          | Appendix 2.E Limiting MLC for each unique situation . . . . . | 43        |
| <b>3</b> | <b>Strategic Voting and Heterogeneous Preferences</b>         | <b>45</b> |
| 3.1      | Introduction . . . . .  | 45        |
| 3.2      | The Model . . . . .   | 47        |
| 3.2.1    | Theoretical Analysis . . . . .                                | 48        |
| 3.2.2    | Behavioral Predictions . . . . .                              | 54        |
| 3.3      | Experimental Design . . . . .                                 | 54        |
| 3.4      | Results . . . . .   | 56        |
| 3.4.1    | Election Winner . . . . .                                     | 56        |
| 3.4.2    | Aggregate Behavior . . . . .                                  | 57        |
| 3.4.3    | Strategic voting by Rank-Type . . . . .                       | 60        |
| 3.5      | Concluding remarks . . . . .                                  | 62        |

|              |  |            |
|--------------|--|------------|
| Appendix 3.A | Experimental Instructions . . . . .                                | 64         |
| <b>4</b>     | <b>Information and Economic Voting</b>                             | <b>67</b>  |
| 4.1          | Introduction . . . . .   | 67         |
| 4.2          | Literature . . . . .   | 69         |
| 4.3          | Economic Voting and Information Search . . . . .                   | 72         |
| 4.4          | Experimental Design . . . . .                                      | 75         |
| 4.4.1        | Treatments . . . . .   | 78         |
| 4.5          | Predictions . . . . .  | 78         |
| 4.5.1        | Case 1: Pure self interest . . . . .                               | 79         |
| 4.5.2        | Case 2: Other-regarding preferences . . . . .                      | 79         |
| 4.6          | Results . . . . .  | 80         |
| 4.6.1        | Politicians' Behavior . . . . .                                    | 80         |
| 4.6.2        | Voters' Behavior . . . . .   | 83         |
| 4.6.3        | Summary of Results . . . . .                                       | 91         |
| 4.7          | Discussion . . . . .   | 91         |
| Appendix 4.A | Experimental Instructions . . . . .                                | 93         |
| Appendix 4.B | Experimental Screen Shots . . . . .                                | 99         |
| <b>5</b>     | <b>Preference for Efficiency or Confusion?</b>                     | <b>101</b> |
| 5.1          | Introduction . . . . .   | 101        |
| 5.2          | The Experiment . . . . .   | 103        |
| 5.3          | Theoretical Predictions and Estimation Procedure . . . . .         | 104        |
| 5.4          | Results . . . . .  | 107        |
| 5.5          | Conclusions . . . . .  | 111        |
| Appendix 5.A | Maximum Likelihood of $\alpha$ for varying $\mu$ -values . . . . . | 113        |
|              | <b>Bibliography</b>  | <b>123</b> |
|              | <b>Samenvatting (summary in Dutch)</b>                             | <b>125</b> |

# List of Figures

- 2.1 Multinomial Logit Correspondences for Uninformed Voters . . . . . 15
- 2.2 Multinomial Logit Correspondences for Informed Voters . . . . . 17
- 2.3 Average Multinomial Logit Correspondences for Informed Committees . . . 18
- 2.4 Strategic Voting by Voter Types . . . . . 20
- 2.5 Majoritarian Set and Majoritarian Candidate . . . . . 24
- 2.6 Experimental Data and Predictions . . . . . 25
- 2.7 Strategic Voting and Voter Types . . . . . 26
- 2.8 Principal Branch of the MLC . . . . . 37
  
- 3.1 Multinomial Logit Correspondence (Uninformed Setting) . . . . . 49
- 3.2 Multinomial Logit Correspondence (Informed Settings) . . . . . 50
- 3.3 Average Multinomial Logit Correspondence (Informed Settings) . . . . . 51
- 3.4 Strategic Voting by Rank-Type . . . . . 53
- 3.5 Majoritarian Candidate Winning Probability . . . . . 57
- 3.6 Experimental Data and Predictions: Uninformed Treatment . . . . . 58
- 3.7 Experimental Data and Predictions: Informed treatments . . . . . 59
- 3.8 Level of Strategic Voting by Rank-Type . . . . . 61
  
- 4.1 Politicians' After Policy Dispersion . . . . . 82
- 4.2 Total Information Demand . . . . . 83
- 4.3 Voting and Approval Behavior Conditional on Conflicting Situation . . . . 87
- 4.4 Experimental Screen Shots . . . . . 99



# List of Tables

- 2.1 Experimental Design . . . . . 23
- 2.2 Vote Distribution . . . . . 23
- 2.3 Strategic Voting . . . . . 28
- 2.4 Realized Preference Distributions . . . . . 36
- 2.5 Limiting MLC,  $N = 12$  . . . . . 43
  
- 3.1 Example of Information Provided to Subjects . . . . . 55
  
- 4.1 Impact of Tax Rates Across Treatments . . . . . 76
- 4.2 Experimental Treatments . . . . . 78
- 4.3 Politicians' Average Choice . . . . . 81
- 4.4 Proportion of Information Purchased . . . . . 85
- 4.5 Voting Behavior, Marginal Effects . . . . . 88
- 4.6 Approval Behavior, Marginal Effects . . . . . 89
  
- 5.1 Homogeneous population (all rounds) . . . . . 107
- 5.2 Homogeneous population (last 5 rounds) . . . . . 109
- 5.3 Heterogeneous Subjects (all and last 5 rounds) . . . . . 110
- 5.4 Maximum Likelihood of  $\alpha$  for varying  $\mu$ -values . . . . . 114



# Chapter 1

## Introduction

*Voting* is likely the tool most strongly associated with the idea of democratic decisions, be it at national or local elections, decisions within a parliament, committees, juries or even at company boards. In turn, the outcomes of voting processes potentially affect a large constituency. Therefore, understanding voter behavior is of major interest in a variety of fields. In this thesis we approach voter behavior from the perspective of Political Economics. More generally, we will address various aspects of individual behavior in the common arena.

Specifically, this thesis investigates the impact of information on the extent of *strategic voting* (chapters 2 and 3), explores the motives behind *economic voting* (chapter 4) and applies a similar toolbox to understand *contributions to the public good* in a non-trivial scenario (chapter 5). Together, these chapters intend to provide innovative ways to look at important questions in the political economics literature. We believe that our analytical framework is informative not only about the specific environments in which it is used here, but also allows us to develop insights for similar and related policy arenas.

Traditionally, economic science has looked at these problems using a combination of theoretical models, assuming fully rational agents, and applied econometrics. We deviate from the standard approach in both respects, by making use of *behavioral* modeling and experimental methods. By behavioral modeling, we specifically mean modeling the systematic ways in which people deviate from the fully rational agent model. We do so, for example, by assuming some form of bounded rationality. To verify and better understand the implications of behavioral modeling, we bring the study into the economics laboratory. The reason for this is that the environments we study (voting and public goods contributions) are very complex and behavior in these environment is influenced simultaneously by several factors. The experimental laboratory provides a unique possibility to control for and isolate specific aspects of interest. By a combination of theory and experimental methods we try, then, to understand actual behavioral patterns of real economic agents and investigate how the limits of standard economic models can be relevant for (public policy) analysis and help us predict behavioral patterns in other (similar) situations.

Dropping the traditional assumption of full rationality turns out to be very important in understanding behavior. In this thesis, we find strong support for bounded rationality. As an illustration, two chapters (2 and 3) look at a voting game with three candidates in which we vary the intensity of preferences, i.e., how a person's best candidate is compared to her second preferred candidate. Although it is intuitive that the chance of voting for one's best candidate should increase in this distance, a fully rational analysis (i.e., Nash Equilibrium), fails to capture this feature. The reason is that a fully rational agent should always select the best strategy available (thus a *best* response function), regardless of how much 'better' it is. By applying a boundedly rational model (in this case, the Quantal Response Equilibrium, introduced by McKelvey & Palfrey 1995) we switch to a *better* response function, which does react to size differences. Using experimental data, we find strong support for the theoretical analysis both in terms of comparative statics, but also for several of the point predictions. We find, for example, not only that a voter is more likely to vote for her best candidate when the aforementioned distance in preference is larger, but also that in a three-way run, supporters of the least popular candidate are significantly more likely to switch away from their preferred candidate.

The use of experimental methods is also essential. For example, in the chapters on strategic voting (2 and 3) we can manipulate and know, without any noise, peoples' preferences - something that is impossible with observational data. As another example, in chapter 4 we introduce the first experimental environment in which only economic considerations, and no political aspects, can influence voting decisions. Such an environment is the only in which clear causation arguments can be made and in which the voting decision can be made without the many complex layers in which it is usually immersed. We are aware, however, that using the laboratory does not come without a cost. For example, in this thesis the largest electorate contains 15 subjects. More generally, we need to be wary of the external validity of our results. We deal with this first by being upfront about the scope of the analysis and describing it in proper context, second by deriving theoretical extrapolations whenever possible and third, by providing sufficient evidence that the approach is informative for the specific situation so that we can derive valid inferences for related situations.

The use of behavioral modeling and experimental methods allows us also to look at (preference) *heterogeneity* and *complexity*. This thesis explores heterogeneity in (social) preferences in two different ways. Chapters 2 and 3 introduce and manipulate preference heterogeneity with elements of the experimental design, while chapters 4 and 5 try to capture/measure this heterogeneity by observing people's behavior. Chapter 4, for example, investigates and shows how some people demand more information about society and are more likely to vote against their own private interests while others simply support the candidate that is best for themselves. Chapter 5, on a similar vein, show that people can be grouped into those with low or high concerns for society, and that these groups

behave in distinct ways. We observe, also, that as the complexity of the environment increases, people tend to rely on simpler heuristics, or simpler strategies. For example, by increasing the complexity of the model of chapter 2 in chapter 3, we observe that the extent of strategic voting (a more complex strategy) is reduced. In chapter 4 we see that the demand for information about community and national economic indicators is significantly reduced in the most complex scenario, which requires more processing effort from the subjects. This is in line with the general argument in favor of bounded rationality models: since the world is complex, people try to rely on what they perceive as most relevant, or, as chapter 4 reveals, refrain from engaging in complex computations.

This thesis hopes to contribute to the literature on political economics. It reflects important steps into analyzing the specific problems presented here and hopes to be helpful in providing insights for related topics. Elements presented here can also be useful for revisiting theoretical models and incorporating some of the systematic deviations from these models that we observe, improving prediction and policy development.

We now turn to describing briefly each of the remaining chapters of this thesis.

In chapter 2, *Information and Strategic Voting*, we theoretically and experimentally study voter behavior in a setting characterized by plurality rule and mandatory voting, where voters choose from three options. We are interested in the occurrence of strategic voting in an environment where Condorcet cycles may occur. In particular, we focus on how information about the distribution of preferences affects strategic behavior. We also vary the relative importance of the second preferred option to investigate how this affects the strategic vote. Quantal response equilibrium analysis is used to analyze the game and proves to be a good predictor for the experimental data. Our results indeed show that strategic voting arises, the extent of which depends on (i) the availability of information; (ii) the relative importance of the intermediate candidate; (iii) the electorate's relative support for one's preferred candidate; and (iv) the relative position of the plurality-supported candidate in a voter's preference ordering. Our results show that information serves as a coordination device where strategic voting does not harm the plurality-preferred candidate's chances of winning.

In chapter 3, *Strategic Voting and Heterogeneous Preferences*, we study voter behavior in a similar setting. In contrast to chapter 2, voters in the same electorate may now differ in how much they relatively value the three options. This introduces preference heterogeneity in the electorate. Three information conditions are tested: *no information*, in which voters know only their own preference ordering and the own benefits from each option; *aggregate information*, in which in addition they know the aggregate realized distribution of the preference orderings and *full information*, in which they also know how the relative importance given to the options are distributed within the electorate. As a general result, heterogeneity seems to decrease the level of strategic voting in our experiment. We observe however, both theoretically and experimentally that our main

results from chapter 2 are robust to the preference heterogeneity introduced. Moreover, information about the aggregate distribution of preferences seems to be the element that best explains the observed differences in voting behavior.

Despite the vast literature on economic voting, spanning decades, there is little agreement on the influence of economic considerations on approval of the government and vote choice. Part of the reason for this disagreement is the inherent complexity of the political environment. To isolate the effects of economic considerations we develop and present in chapter 4, *Information and Economic Voting*, a laboratory experiment that allows us to vary these considerations at three levels: the individual, community and national economy. Choices by a policymaker directly affect outcomes at each of these levels, allowing us to test for ‘egotropic’, ‘communitropic’, and ‘sociotropic’ voting. Our design allows us to specifically observe which information is considered relevant by voters and to what extent ‘the economy’ matters. Chapter 4 offers what we believe to be the first experimental study to explicitly investigate the question of how multiple levels of economic considerations influence vote choice. We observe significantly positive demand for information, in a setting where standard economic reasoning would predict no information demand and pure egotropic (selfish) voting. We observe that the demand for information decreases with the complexity of the environment and that informed voters vote more sociotropically. Moreover, voters seem more ‘extreme’ in approval surveys than in actual voting.

In chapter 5, *Preference for Efficiency or Confusion?*, we ask whether the hypothesis of preference for (group) efficiency can account for subjects’ contributions in public good games or if this can be attributed to noisy behavior. Using a boundedly rational equilibrium approach, we estimate the relative importance of efficiency concerns relative to noise. Using data from a voluntary contribution mechanism experiment with heterogeneous endowments and asymmetric information, we estimate a quantal response equilibrium extension of a model in which subjects have preference for group efficiency. Under the hypothesis of a homogeneous population most of the over-contribution seems to be explained by noisy behavior. A different picture emerges when we introduce cross-subject heterogeneity in concerns for group efficiency. In this case, a majority of the subjects makes contributions that are compatible with the hypothesis of preference for (group) efficiency. A formal likelihood-ratio test strongly rejects the models not allowing for noise in contributions and homogeneous subjects for the more general QRE extension with heterogeneous preferences for (group) efficiency coupled with noise in subjects’ behavior.

# Chapter 2

## Information and Strategic Voting<sup>1</sup>

### 2.1 Introduction

Since its introduction in ancient Greece, democracy has always been associated with 'government by the people'. A widespread view is that the democratic decision process must honor the desire of the majority (Goldfinger 2004)<sup>2</sup>. Voting is the tool most often used for this purpose. The underlying assumption is that voting correctly aggregates individual preferences. In most democratic countries, we vote at almost every level of social interaction: at faculty meetings; professional organizations; shareholder gatherings; and in national referenda or elections<sup>3</sup>. A sufficient condition for correct aggregation of preferences is that every voter casts a vote for her most preferred alternative<sup>4</sup>. Of course, not everyone does so. For one thing, many people abstain from voting (especially in large scale elections). If abstention is correlated with preferences, the preferences represented by the votes cast no longer mirror those of the electorate (Großer & Schram 2010). For example, Lijphart (1997) argues that low turnout in U.S. elections yields significant underrepresentation of the interests of 'less well-to-do citizens'. Moreover, voters may strategically vote for an alternative that is not ranked highest in their preference ordering (Farquharson 1969). The reason is that any election is not only a manifestation of individual preferences, but also a multi-person decision process (Downs 1957, Riker 1982*a*, Blais & Nadeau 1996). In such a strategic interaction a voter may be more interested in opti-

---

<sup>1</sup>This chapter is based on Tyszler & Schram (2011).

<sup>2</sup>These ideas are apparent, for example, in the Merriam-Webster online dictionary (<http://www.merriam-webster.com/dictionary/democracy>), where 'democracy' is defined as: 1 a: government by the people; *especially*: rule of the majority b: a government in which the supreme power is vested in the people and exercised by them directly or indirectly through a system of representation usually involving periodically held free elections.

<sup>3</sup>Many families even vote on important issues like naming a baby. In fact, patents have been issued to protect procedures for making family decisions (e.g. Wartko 2007).

<sup>4</sup>We do not mean to claim that a "correct aggregation of preferences" in itself maximizes social welfare. It is easy to come up with social welfare definitions that for some distributions of preferences would require choosing an alternative that does not have the most sincere votes. Our goal in this chapter is not to derive social welfare conclusions, however.

mizing the outcome than in stating her own preference<sup>5</sup>.

When considering voting as a multi-person decision process it can be analyzed as a strategic game in which distinct strategies might lead to different outcomes and equilibria can be computed. It has long been recognized that strategic voting may be an equilibrium strategy in committees (Austen-Smith & Banks 1996), legislatures (Riker 1982*a*) and even in large electorates (Fey 1997, Palfrey 1989). Of course, strategic voting equilibria may involve highly complex computations that go beyond the capabilities of most voters. Behaviorally, therefore, voters may rely on simple voting strategies such as always voting sincerely for the most preferred alternative. In addition, some people may object morally to voting strategically (Lehtinen 2007). In the end, the question whether or not voters vote strategically is an empirical one.

Two examples illustrate situations when strategic voting may occur. First, if the most preferred option does not stand a chance, a voter may vote for her second ranked option in an attempt to avoid even worse outcomes. Such behavior is consistent, for example, with Duverger's law<sup>6</sup>. Strategic voting may occur, also, if there is a Condorcet loser<sup>7</sup> supported by a minority while a majority is divided between two other alternatives. In this case, sincere voting would give most votes to the minority preferred alternative (Forsythe et al. 1993, Myatt & Fisher 2002, Gerber, Morton & Rietz 1998). The majority can avoid a victory by the Condorcet loser by coordinating on one alternative. This requires strategic voting by the supporters of one of the two majority alternatives<sup>8</sup>. Our goal is to better understand the occurrence of such strategic voting. We will do so in a combined theoretical and experimental study.

Our study of strategic voting will not include situations with a Condorcet loser, however. Instead, we are interested in a specific environment where we focus on situations where there are Condorcet cycles. In our environment, each of three alternatives (denoted by *A*, *B*, and *C*) has a similar *a priori* chance of winning the election and each voter faces an *a priori* symmetric strategic problem. A cycle occurs because sincere voting can lead to any of the alternatives winning if they are voted on sequentially in pairwise votes. Such situations are considered to be widespread (Kurrild-Klitgaard 2001). For example, Neufeld, Hausman & Rapoport (1994) present an example of cyclical preferences (and cyclical voting) in the 1925 U.S. Senate. Similarly, Gross (1979) presents an example of

---

<sup>5</sup>Such behavior is typically referred to as 'strategic voting' (Riker 1982*a*), or 'tactical voting' (Galbraith & Rae 1989). In this chapter we will use the term 'strategic voting'. We will refer to voting for one's most preferred option as 'sincere voting'.

<sup>6</sup>Duverger's law predicts that in a plurality vote the votes will converge to two candidates, mainly due to the psychological phenomenon of the 'wasted vote'. Voters supporting a candidate with low perceived chances of winning are assumed likely to move their vote to the more preferred option of the leading two (e.g. Fey 1997, Palfrey 1989, Riker 1982*b*).

<sup>7</sup>A Condorcet loser is an alternative that would lose any pairwise vote against any other alternative.

<sup>8</sup>Experimental evidence shows that in the absence of coordination devices (such as polls, shared history, previous elections, or ballot position) the Condorcet loser wins a significant proportion of the elections (Forsythe et al. 1993, Forsythe et al. 1996). For an overview see Palfrey (2006).

cyclical preferences in the 1975 session of the Iowa senate and argues that cyclical voting was finally broken by some senators voting strategically.

An important difficulty in empirically assessing the existence of strategic voting is the fact that it requires knowledge of the voters' preference orderings over the alternatives<sup>9</sup>. One may try to overcome this by eliciting preferences using survey questions (Blais & Nadeau 1996, Blais et al. 2001, Cain 1978, Myatt & Fisher 2002). Such measurement is subject to noise and strategic reporting, however, both effects which would cloud the analysis. More generally, while analyses using observational data from the field allow one to study the occurrence of strategic voting per se, they do not really allow for a systematic study of its causes and consequences. For this purpose, a controlled laboratory environment is much better suited. Controlled experiments yield suitable conditions to observe behavior with preference orderings clearly defined and known to the experimenter, allowing one to directly observe whether or not a vote is sincere. They also allow for controlled information and direct comparative statics analyses by studying changes in voting when altering one characteristic of the environment at a time.

This is why we use laboratory experiments for our empirical analysis of strategic voting. Before doing so, we will first model the situation as a strategic game and analyze this theoretically<sup>10</sup>. In particular, we will derive Quantal Response Equilibria (QRE) and use these to formulate behavioral predictions<sup>11</sup>. QRE have been shown to accurately predict voter behavior before (e.g. Goeree & Holt 2005, Großer & Schram 2010, Levine & Palfrey 2007). QRE has the intuitive advantage that it allows for boundedly rational behavior while at the same time assuming that the error people make declines as the stakes become larger. We will derive such equilibria for the environment we study and show how they predict strategic behavior for voting in groups of various sizes.

The QRE predictions for one specific group size are subsequently tested using our experimental data. Laboratory control will also allow us to measure the impact of changes in the environment on the decision whether or not to vote strategically. Specifically, we are interested in two circumstances that may affect this decision. First, we will study

---

<sup>9</sup>For (indirect) empirical evidence of strategic voting in legislatures, see Clinton & Meirowitz (2004). For large electorates Cain (1978) and Myatt & Fisher (2002) provide empirical evidence from the UK and Blais & Nadeau (1996) and Blais et al. (2001) from Canada.

<sup>10</sup>Voting studies usually focus on either turnout or candidate choice. With the U.S. and most European countries having voluntary voting, much of the literature considers models adapted to this reality (Bendor, Diermeier & Ting 2003, Feddersen & Sandroni 2006, Goeree & Holt 2005, Palfrey 2006). In a strategic setting, the turnout decision is often modeled as a participation game (Palfrey & Rosenthal 1983, Palfrey & Rosenthal 1985), where each voter supports either of the two candidates and decides whether or not to cast a vote. In this setting, voting strategically is a dominated strategy. Therefore a voter decides between 'abstaining' and 'participating and voting sincerely'. As a consequence participation games naturally focus on voter turnout, in particular on the so-called 'voter paradox' (Schram & Sonnemans 1996a, 1996b).

<sup>11</sup>Quantal response equilibrium (QRE) is a solution concept for games developed by McKelvey & Palfrey (1995). QRE is a generalization of Nash equilibrium that allows for errors in decision making (i.e., boundedly rational behavior). Errors are modeled such that decisions that yield higher expected payoffs are made more frequently than less lucrative decisions.

how the relative value attributed to the second preferred option affects voters' decisions. This is important, because, intuitively, voters are more likely to vote strategically when there is little to lose by having their second option chosen. We can test this directly by comparing elections where the value attributed to the second option winning is close to that of the most preferred alternative to elections where a larger difference between first and second option exists.

Second, we will measure the impact of information about others' preferences by comparing elections that are identical in all aspects but one, i.e., the fact that these preferences are known in one case and not in the other. This is important, because whether or not voters vote strategically may depend on how much they know about other voters' preferences. Opinion polls serve to provide such information, which may help voters to coordinate on an alternative and win the election<sup>12</sup>. Voluntary preference revelation in polls may be strategic, however. In order to isolate the effect of information, we therefore opt for a situation in which an opinion poll truthfully reveals the electorate's preferences (as in Großer & Schram 2010). Perfect information about the other voters' preferences will in some of our treatments be made available before the election<sup>13</sup>.

With this information, the decision problem faced by each voter may be even more complex than without. This is because without information all voters face the same *a priori* situation if every preference ordering is equally likely. Assume for the case with information that supporters of the alternative with the largest support (we call this the 'majoritarian alternative') vote sincerely but comprise less than 50% of the electorate. Which voters should then vote strategically? On the one hand, one may think that the supporters of the alternative with the lowest level of support have an incentive to vote strategically to increase their chances. On the other hand, voters for whom the majoritarian alternative is second best may decide to support this to ensure at least this second-best. Whether or not they do so may depend on the relative value they attribute to this option. We will address these issues theoretically and behaviorally in this chapter.

When preferences are not revealed by polls, all voters face the same situation. The QRE prediction is then that all voters have the same probability of voting strategically. For committees, the predicted probability of strategic voting is confirmed by our data. With information about the other voters' preferences, the QRE probability of voting strategically depends on the number of others supporting the same alternative and this

---

<sup>12</sup>An interesting alternative approach would be to consider sequential elections like the U.S. primaries. Then, information about others' preferences may be obtained from previous elections. For example, Morton & Williams (1999) and Morton & Williams (2001) use this to study information asymmetries regarding candidates' identities.

<sup>13</sup>This kind of information can be seen as a 'noiseless' version of an early opinion poll, reflecting more the actual preferences than the intended voting behavior. Early opinion polls are not necessarily a good predictor of the actual election outcome. Opinion polls closer to the election tend to capture more strategic behavior and aim basically at predicting the election outcome. For more, see Brown & Chappell (1999), Erikson & Wlezien (1999), Gelman & King (1993) and McKelvey & Ordeshook (1986).

alternative's rank (in terms of support) within the electorate. It also depends on the relative value attributed to the second most preferred alternative. The experimental results are again in line with the QRE predictions. Two important conclusions for the scenario with information are that (i) a higher frequency of strategic voting is observed, the higher is the relative utility of a voter's second most preferred option; (ii) there is coordination on the victory of the majoritarian alternative.

The remainder of the chapter is organized as follows: Section 2.2 presents the model and theoretical analysis, including equilibrium predictions for various sizes of the voting body. The experimental design is introduced in section 2.3. Section 2.4 presents and analyzes the results and section 2.5 presents concluding remarks.

## 2.2 The Model

Each of  $N$  voters must choose from three alternatives,  $A$ ,  $B$  and  $C$ . Each voter  $i = 1, \dots, N$  has a strict preference ordering over these alternatives and will be required to cast exactly one vote. Plurality rule determines the winner, with ties broken by an equal probability random draw. The assumption of mandatory voting allows us to focus on the voting decision without needing to correct for the interaction with the turnout decision. Moreover, the mandatory rule makes strategic voting more salient, since voters are obliged to decide. Mandatory voting exists in many committees and legislators (Nitzan & Procaccia 1986). For national elections, only a minority of countries have mandatory voting (Gratschew 2001), though it is still prevalent in certain regions, like Latin America.

Voters are assumed to maximize (expected) utility, where a voter's utility is determined by the rank of the elected alternative in her preference ordering. If her preferred, intermediate or least preferred alternative is elected she receives  $u^b$ ,  $u^m$  or  $u^l$  respectively. Without loss of generality we normalize by setting  $u^b = 10$  and  $u^l = 1$ . Then, each voter's preferences are characterized by  $u^m$ , the utility attributed to the intermediate option. Finally, we assume that utility is independent of individuals and options, i.e.,  $u^m$  is the same for every voter<sup>14</sup>. Hence, only the ordering of the three options distinguishes voters from one another.

We further assume that before an election all voters' preferences are determined randomly, independently of previous preferences and of other voter's draws. The own preferences are revealed to the voter by nature before the election. The extent of information about other's preferences is a variable in the model. The setting can be either *uninformed*, in which case voters (aside from their own preference ordering) know only the prior probability distribution of preferences, or *informed*, in which case they know the ex-post realized distribution of preferences for the election concerned. This variable is

---

<sup>14</sup>The model in chapter 3 allows  $u^m$  to vary across voters. The results confirm the conclusions drawn here.

meant to capture the possible publication of (noiseless) pre-election polls, as described in the introductory section.

An electorate is, therefore, characterized by the number of voters, the distribution of preferences,  $u^m$ , and the extent of pre-election information. We define *sincere* voting as a vote for the most preferred option. A *strategic* vote is defined as a vote for the second-ranked alternative in the preference ordering (as in Blais & Nadeau 1996, Blais et al. 2001, Cain 1978). The third option, voting for the least preferred option, will only be considered as noisy behavior, because it is a dominated strategy: there is no circumstance under which this could serve the purpose of expected utility maximization.

Because we are most interested in strategic voting caused by the environment and not so much in specific characteristics of the distinct options, we will focus on a game in which every voter has an *a priori* symmetric problem regardless of his or 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. Preferences are independently and randomly drawn from this set with equal probability for each voter. These preferences will typically form a Condorcet cycle, potentially giving rise to strategic behavior. Moreover, there are no Condorcet losers in our setup. We define  $N_{ABC}$  as the number of voters with preference ordering  $(A, B, C)$  (i.e.,  $u(A) = 10; u(B) = u^m; u(C) = 1$ ), and similarly  $N_{BCA}$  and  $N_{CAB}$ . Note that by construction  $N_{ABC} + N_{BCA} + N_{CAB} = N$ . Finally, we denote the election outcome by a vector  $\mathbf{v} \equiv (v_A, v_B, v_C)$  such that  $v_A + v_B + v_C = N$ , where  $v_k$  denotes the number of votes for option  $k$ .

### 2.2.1 Equilibrium Analysis

Typically, multiple Nash equilibria exist in voting games. Take, for example, a situation in which  $N = 3K$  ( $K \geq 3$ ) and each preference ordering is equally represented ( $K$  voters each) while there is complete information. Then, all situations are Nash equilibria in which voters in exactly two groups vote sincerely and the voters in the remaining group all vote strategically. The election outcome would be, for example,  $\mathbf{v} = (0, 2K, K)$  and since no voter is pivotal, no one can benefit from deviating. Another Nash equilibrium is where only one group votes sincerely, with the other two voting strategically. Again, nobody is pivotal. Sincere voting by all may also be an equilibrium. Such voting behavior leads to an expected payoff of  $(u^b + u^m + u^l)/3 = (11 + u^m)/3$ . If there are equal numbers of voters for each preference ordering each voter is pivotal, however. Voting strategically will therefore tip the balance to the own second preferred option and yield payoff  $u^m$ . As long as  $u^m \leq (11 + u^m)/3$ , everyone voting sincerely is a Nash Equilibrium<sup>15</sup>. To tackle the

---

<sup>15</sup>It is also possible to find equilibria in which members of the same group act differently. Take the same example with  $K$  even and  $K \geq 6$ . Assume two groups voting sincerely. If the remaining group has half of its members voting sincerely and the remaining voting for their second most preferred alternative the voting outcome could be  $\mathbf{v} = (K, K/2, 3K/2)$ . Once again nobody is pivotal and this is an equilibrium.

multiple equilibria problem one can employ an equilibrium selection device. We will show below, that the equilibrium approach adopted here has as a spinoff that it constitutes such a refinement in the sense that it selects specific Nash equilibria as a special case.

For a variety of political choice problems, a so-called Quantal Response Equilibrium (QRE; McKelvey & Palfrey 1995) has been shown to be a better predictor of individual choices than Nash equilibrium (Goeree & Holt 2005). For example, Levine & Palfrey (2007) show that it can account for the (seemingly irrational) high turnout rates in large scale national elections, where Nash predicts unrealistically low turnout. To find the QRE for our environment, we start by considering the expected utility derived from voting for distinct options. Consider, for example, voter  $i$  with preference ordering  $(A, B, C)$ . The expected payoff from voting for option  $A$ , denoted by  $u_A^e$ , depends on what other voters do. It is a function of the probabilities with which other voters (with the same or other preferences) vote for the three options. Similarly, the expected utility from voting for  $B$  and  $C$ ,  $u_B^e$  and  $u_C^e$ , depend on these probabilities. Nash equilibrium analysis assumes that  $i$  will vote for the alternative that gives her the highest expected utility, i.e., she gives the best response to others' voting probabilities.

In contrast, a QRE analysis allows for the possibility that  $i$  may make an error in deciding what to vote for. One way to allow for error is by adding a stochastic term to the expected utility functions, yielding expected utilities  $u_A^e + \mu\varepsilon_A$ ,  $u_B^e + \mu\varepsilon_B$  and  $u_C^e + \mu\varepsilon_C$  for options  $A$ ,  $B$ , and  $C$ , respectively. In these terms,  $\mu \geq 0$  is an error parameter and the  $\varepsilon$  terms are i.i.d. realizations of random variables. This parameterization is general enough to capture different sources of noise, as for example, distractions, perception biases, miscalculations or limited computational capability (Goeree & Holt 2005).

A voter will still vote for the option with the highest expected utility but this is now a stochastic event. For example, she will vote for  $A$  if  $u_A^e + \mu\varepsilon_A > u_B^e + \mu\varepsilon_B$  and  $u_A^e + \mu\varepsilon_A > u_C^e + \mu\varepsilon_C$  or

$$\varepsilon_B - \varepsilon_A < \frac{u_A^e - u_B^e}{\mu} \text{ and } \varepsilon_C - \varepsilon_A < \frac{u_A^e - u_C^e}{\mu} \quad (2.1)$$

Specification of the distribution functions of  $\varepsilon_A$ ,  $\varepsilon_B$ ,  $\varepsilon_C$  yields the probability that  $i$  will vote for option  $A$  (and similarly for  $B$  or  $C$ ). Assuming that the  $\varepsilon$ 's follow the extreme value type 1 distribution, the (multinomial) probability that  $i$  will vote for option  $j$ ,  $p_j^i$ , is given by:

$$p_j^i = \frac{\exp [u_j^e / \mu]}{\sum_{l=A,B,C} \exp [u_l^e / \mu]}, \quad j = A, B, C \quad (2.2)$$

Next, recall that the probabilities of other voters choosing  $A$ ,  $B$ , or  $C$  enter the expected utility terms in the right hand side of (2.2). A full specification for all voters then equates a vector of  $(3N)$  voting probabilities on the left hand side to a vector of functions of the

same probabilities on the right hand side. A QRE (more specifically, a ‘multinomial’ logit equilibrium, MLE) is defined as vector of probabilities that when entered on the right hand side yields itself on the left hand side.

In our framework, the MLE will depend on  $\mu$ ,  $u^m$ ,  $N_{ABC}$ ,  $N_{BCA}$ , and  $N_{CAB}$ , as well as on the fact whether or not the latter three numbers are known to the voters. To understand the role of the error parameter  $\mu$ , note that

$$\lim_{\mu \downarrow 0} p_j^i = \begin{cases} 0 & , \text{ if } u_j^e < \max_k \{u_k^e\} \\ 1 & , \text{ if } u_j^e = \max_k \{u_k^e\} \text{ and } u_l^e < u_j^e, l \neq j \end{cases} \quad (2.3)$$

(and  $\lim_{\mu \downarrow 0} p_j^i$  is  $1/K$  if  $K$  options ( $K = 2, 3$ ) yield equal maximum expected utility).

It follows directly from (2.3) that as noise diminishes to zero, the option with the highest expected utility is chosen, i.e., the MLE converges to a Nash equilibrium (see McKelvey & Palfrey 1995). Similarly,

$$\lim_{\mu \rightarrow \infty} p_j^i = \frac{1}{3}, j = A, B, C \quad (2.4)$$

which shows that behavior converges to pure randomization as noise increases to infinity.

For any positive and finite value of  $\mu$  it is possible to compute MLE. We call the collection of MLE and correspondent  $\mu$  values the ‘Multinomial Logit Correspondence’ (MLC). Except for the limit case where  $\mu$  approaches infinity, there need not be a unique MLE. It is possible, however, to identify a unique branch of the MLC that starts from the limit at  $\mu = \infty$  and continuously converges to a unique Nash Equilibrium as  $\mu \downarrow 0$  (McKelvey & Palfrey 1995, Theorem 3, item 3). This is called the ‘Principal Branch’ and the corresponding Nash Equilibrium the ‘limiting Multinomial Logit Equilibrium’ of the game<sup>16</sup>.

Using the Quantal Response model with the multinomial logit specification has several advantages: (i) it provides a refinement selecting precisely one of the multiple Nash equilibria (i.e., the limiting MLE); (ii) it takes bounded rationality seriously by introducing noise in the individual choice problem; (iii) the principal branch has the intuitive characteristic that players of the same type play symmetric strategies; (iv) in line with intuition, for all finite  $\mu$  the MLE probability of choosing an option is increasing in the expected payoff differences with other options. The expected payoff difference will vary with the extent of information and the realized distribution<sup>17</sup> but it only includes situations where the voter’s choice makes a difference, since for every non-pivotal situation the payoff difference will be 0.

This last point can be illustrated with an example. As can be easily seen, the right

<sup>16</sup>Except for very special cases, the principal branch needs to be computed numerically. In order to trace it we use the Homotopy Approach as outlined by Turocy(2005, 2010).

<sup>17</sup>See appendix 2.A for details of the computations.

hand side of equation (2.2) can be rewritten in terms of expected payoff differences, taking voting sincerely as the reference strategy. For example, for a voter with preference ordering  $(A, B, C)$ , we write:

$$\begin{aligned}
 p_A^i &= \frac{1}{1 + \exp[(u_B^e - u_A^e)/\mu] + \exp[(u_C^e - u_A^e)/\mu]} \\
 p_B^i &= \frac{\exp[(u_B^e - u_A^e)/\mu]}{1 + \exp[(u_B^e - u_A^e)/\mu] + \exp[(u_C^e - u_A^e)/\mu]} \\
 p_C^i &= \frac{\exp[(u_C^e - u_A^e)/\mu]}{1 + \exp[(u_B^e - u_A^e)/\mu] + \exp[(u_C^e - u_A^e)/\mu]}
 \end{aligned} \tag{2.5}$$

The expected utility difference of voting for option  $j$  instead of  $k$ ,  $u_j^e - u_k^e$ , is a weighted sum of the utility differences between voting for  $j$  or  $k$  for all possible combinations of votes by other voters (denote by  $-i$ ):  $u_j^e - u_k^e = \sum_{-i} P_{-i}(u_j^{-i} - u_k^{-i})$ , where  $P_{-i}$  denotes the probability that a particular configuration of other voters' choices occurs and  $u_j^{-i}(u_k^{-i})$  gives the expected utility obtained from choosing  $j(k)$  in situation  $-i$ . Though there are an extreme number of situations  $-i$ , for most of them  $i$ 's vote will not affect the outcome. In those situations,  $u_j^{-i} = u_k^{-i}$  so they do not add to the expected utility difference. Therefore, in (2.5) the voter takes into account only the relevant pivotal situations. An important consequence is that the probabilities in (2.5) converge to  $1/3$  as the electorate becomes infinitely large. The intuition is that for infinitely large electorates it no longer matters what any single voter does, and random noise dominates the voter's choice. We will further discuss this, below. For more details see appendix 2.A.

### Uninformed Setting

Consider first the situation without information about other voters' preferences. The voter knows only the prior distribution of probabilities, the electorate size, the value of the intermediate option and her own preference. Knowing her own preference she can update the probability distribution using Bayes' rule and use this to calculate the probability of being pivotal given others' strategies. Subsequently, she can compute her expected payoff differences between voting sincerely, strategically or for the least preferred alternative.

This rather complicated computation is easiest understood by an example. Consider the case in which  $N = 12$ . For a given voter, the most likely distributions among the other voters are  $(3, 4, 4)$ ,  $(4, 3, 4)$  and  $(4, 4, 3)$ , where the first number indicates the number of other voters with the same preference, and the other two the number in the remaining groups. If she believes that all others are voting sincerely this voter considers herself to be pivotal in all three situations (in the first she can create a tie, in the latter two she can break a tie). In the first situation her sincere vote would create a three-way tie and

voting strategically would give the victory to her second most preferred candidate. Voting sincerely may be profitable, depending on the value of the intermediate option<sup>18</sup>. For the other two situations voting sincerely is always a best response, since the voter would be decisive in favor of her most preferred candidate. Considering only these three situations voting sincerely would likely be a best response. In fact, considering all pivotal situations with their respective probabilities it can be shown that voting sincerely is more profitable than voting strategically. In fact, all players voting sincerely constitutes a Bayesian-Nash Equilibrium, regardless of the intermediate preference parameter  $u^m$ .

This Bayesian Nash equilibrium is the limiting MLE of the game of incomplete information. Figure 2.1 shows the corresponding Multinomial Logit Correspondences for three sizes of the voting body:  $N = 12$ , 99, and 999,999<sup>19</sup>. These are intended to be representative for committees, legislatures, and electorates, respectively. We consider two values for the intermediate option: high ( $u^m = 8$ ) and low ( $u^m = 3$ ).

Note that for  $\mu \downarrow 0$ , the probability of sincere voting converges to 1 for all  $N$ . Hence, for the case of incomplete information (no polls) the limiting MLE is the Bayesian Nash equilibrium without strategic voting, irrespective of  $N$  and  $u^m$ . At the other extreme, when noise dominates behavior ( $\mu \rightarrow \infty$ ), the vote becomes a random choice and voting sincerely, strategically or for the dominated option each occur with probability 1/3. For the intermediate cases where rationality is somewhat bounded ( $\mu \in (0, \infty)$ ), the MLE probabilities of voting depend on the size of the voting body and on the value attributed to the intermediate option. Previous estimates of  $\mu$  using data from voting experiments yield values between 0.4 and 0.8<sup>20</sup>. We will therefore focus some of our discussion on this range of  $\mu$ -values.

Consider the small (committee size) voting body where  $N = 12$  shown in panel 2.1(a). Here the probabilities of voting for the distinct options strongly depend on both  $\mu$  and  $u^m$ . First note that it takes a high value of  $\mu$  for voting for the dominated action (not shown in the graph) to be likely. For situations where random noise does not dominate behavior ( $\mu < 1$ ) the probability of voting for the third option is less than 10% and the choice is basically between voting sincerely or strategically<sup>21</sup>. For most levels of noise, the equilibrium level of strategic voting strongly depends on the value attributed to the

---

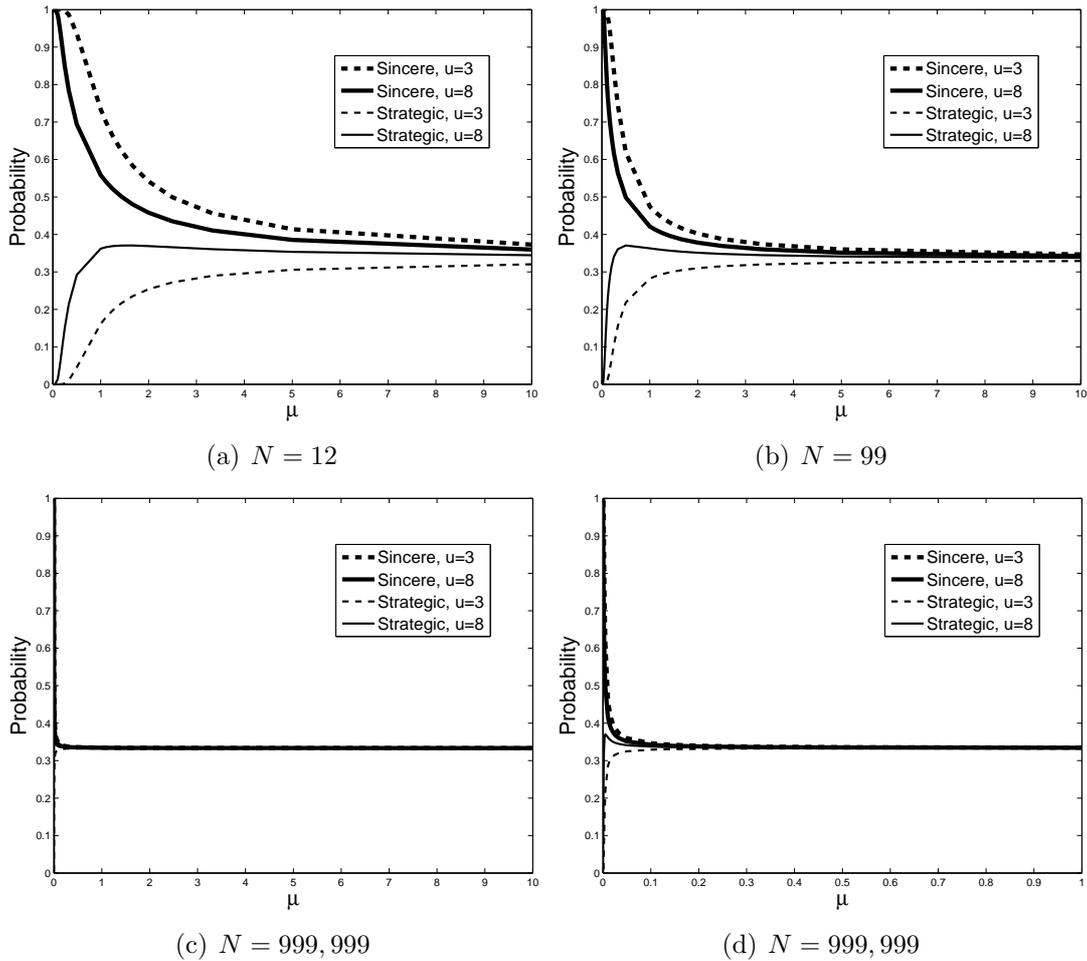
<sup>18</sup>In this particular situation, voting sincerely will be strictly profitable if  $(u^b + u^m + u^l)/3 > u^m \Leftrightarrow u^m < 5.5$ , where we use the normalization  $u^b = 10$  and  $u^l = 1$ . Therefore if the intermediate option is low enough, voting sincerely and creating a tie is the best response. If it is high enough, voting strategically is the best response.

<sup>19</sup>We chose  $N = 99(999,999)$  for legislature (electorate) sized voting bodies in order to allow for the possibility of an equal split of preferences.

<sup>20</sup>Goeree & Holt (2005) use data on the participation game reported by Schram & Sonnemans(1996a, 1996b) and find a maximum likelihood estimate of 0.8 for early rounds and 0.4 for late rounds. Tyszler (2008) reports an ML estimate of 0.55 using Brazilian data from a pilot experiment similar to the experiment reported in this chapter.

<sup>21</sup>For  $u^m = 8$ , for example, when  $\mu = 1$ , the MLE probability of voting sincerely is 0.56 and of voting strategically it is 0.36. Hence, the probability of voting for the dominated option is 0.08.

Figure 2.1: Multinomial Logit Correspondences for Uninformed Voters



*Notes.* Lines show the principal branch of the MLC for high ( $u^m = 8$ ) and low ( $u^m = 3$ ) values of the intermediate option. In panels (a), (b), and (c), the size of the voting body ( $N$ ) is 12, 99, and 999,999, respectively. Panel (d) zooms in on the large electorate case for  $\mu \in [0, 1]$ .

second preferred option,  $u^m$ . For  $u^m = 8$ , the probability of voting strategically exceeds 0.25 for a wide range of  $\mu$ -values. The intuition is that although the limiting (Bayesian Nash) equilibrium is to vote sincerely, one does not lose too much by choosing the second-best. Therefore, an ‘error’ to the best response is not very costly and more likely to occur in the MLE. Focusing on  $\mu$ -values between 0.4 and 0.8 we observe that the equilibrium probability of a strategic vote is more than three times as high for a high intermediate utility than for  $u^m = 3$ . For  $u^m = 8$  the model predicts that approximately 30% of the voters will vote strategically for these  $\mu$ -values.

For legislature-size voting bodies (panel 2.1(b)) similar results are obtained, though the MLE probability of choosing the dominated alternative increases to approximately 0.2 for  $\mu = 1$ . Once again, the probability of voting strategically depends strongly on the intermediate utility. For  $\mu$  between 0.4 and 0.8 this probability is more or less stable around 0.36 when  $u^m = 8$  and increases from approximately 0.19 to 0.28 for  $u^m = 3$ . Hence, the equilibrium predicts substantial strategic voting, even in legislature-size groups.

Finally, panels 2.1(c) and (d) show the multinomial logit correspondences for the probability of voting strategically or sincerely in large electorates (approximately 1 million voters). Here, the probability of being pivotal is so small that the noise term dominates the voters’ decisions. Even for low values of  $\mu$ , the probability of voting for any of the three options is close to 1/3. Only for values of  $\mu < 0.1$  can we distinguish between probabilities for the distinct options. It is important to note at this stage that it is not our goal to explain strategic voting in large electorates with this model. One could easily adapt the model and arrive at non-random equilibrium probabilities of sincere voting<sup>22</sup>. In the current setup, we conclude that in large electorates significant effects of our model parameters on the probability of strategic voting are only observed for very low levels of noise. In the following analyses we will therefore focus only on committee and legislature size voting bodies<sup>23</sup>.

### Informed Setting

Consider next the game with full information. Start with an example with equal share, which can serve as a comparison to the *a priori* expected situation for uninformed voters in figure 2.1. Figure 2.2 plots the principal branch of the MLC for small ( $(N_{ABC}, N_{BCA}, N_{CAB}) = (4, 4, 4)$ ) and medium sized ( $(N_{ABC}, N_{BCA}, N_{CAB}) = (33, 33, 33)$ ) voting bodies. In these

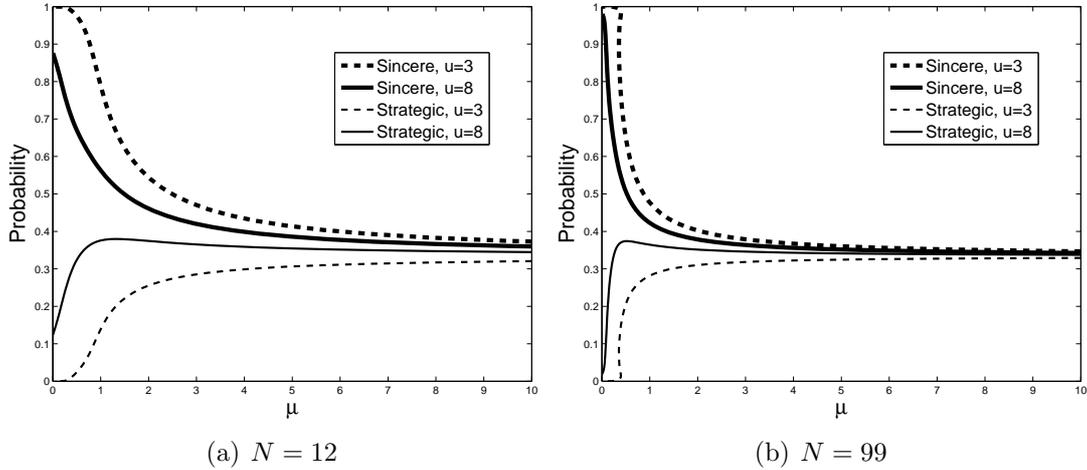
---

<sup>22</sup>For example, there is no need to assume that error is equally likely for all options. Intuitively, it would seem that the utility gained from the dominated alternative winning is much less prone to noise than the utility of having the most favored alternative win. Similarly, there is no reason why noise in small voting bodies would have the same distribution as in large electorates. Finally, noise need not be the same across voters. Adapting the model in any of these ways could lead to results that differ from those presented here.

<sup>23</sup>There is also a practical reason for doing so. Many of the equilibria that follow cannot be computed for very large  $N$ .

cases all voters' circumstances are again perfectly symmetric. In comparison to the previous case, however, information about others' preferences removes the uncertainty.

Figure 2.2: Multinomial Logit Correspondences for Informed Voters



Notes. Lines show the principal branch of the MLC for high ( $u^m = 8$ ) and low ( $u^m = 3$ ) values of the intermediate option. In panel (a)  $(N_{ABC}, N_{BCA}, N_{CAB}) = (4, 4, 4)$  and in panel (b)  $(N_{ABC}, N_{BCA}, N_{CAB}) = (33, 33, 33)$ .

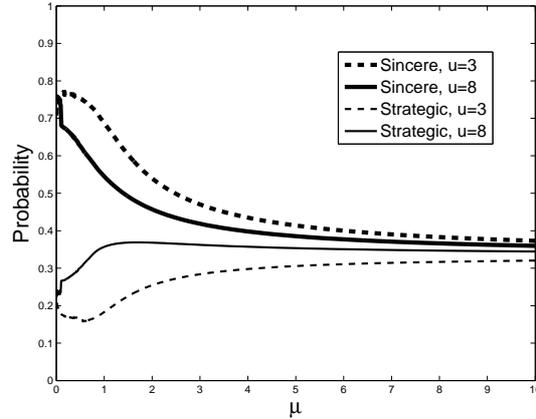
Note that in both cases, the Nash equilibrium of sincere voting is still the limiting MLE when the intermediate option is relatively unattractive ( $u^m = 3$ ). For  $u^m = 8$ , the probability of strategic voting converges as  $\mu \downarrow 0$  to 0.12 for  $N = 12$  and to 0.02 for  $N = 99$ , however. In this case, the MLE therefore converges to mixed strategy Nash equilibria with (small) positive probabilities of voting strategically. Otherwise, the results are quite similar to the uninformed case. For the small committee ( $N = 12$ ), the probabilities of voting for the dominated option are small for  $\mu < 1$  and large differences in strategic voting are predicted between  $u^m = 8$  and  $u^m = 3$  when  $\mu \in [0.4, 0.8]$ . The medium sized legislatures ( $N = 99$ ) are also very comparable. In the informed case, for  $\mu$ -values between 0.4 and 0.8 the MLE probability of a strategic vote is approximately 0.38 when  $u^m = 8$  and increases from close to 0 to 0.26 for  $u^m = 3$ .

Of course, the equal split case is just one of the many distributions of preferences that may be realized (and revealed). In cases where the revealed distribution is unequal, one may expect patterns very different from the uninformed case of figure 2.1. In appendix 2.D we present the MLC graphs for all possible realizations in the small committee case ( $N = 12$ ). Appendix 2.E provides a table with the Nash equilibria selected by the limiting MLE for each realization. Figure 2.3 presents the weighted average of these MLCs, where the weights are given by the probabilities that specific realizations of the preference distribution will occur<sup>24</sup>. Therefore, the equilibria in figure 2.3 may be considered to

<sup>24</sup>The graph for  $N = 99$  cannot be derived due to computational limitations related to the large number of possible preference configurations. The  $N = 12$  case is interesting because it represents the case used in our laboratory experiments.

represent average behavior across multiple committee votes with complete information.

Figure 2.3: Average Multinomial Logit Correspondences for Informed Committees



(a)  $N = 12$

*Notes.* Lines show the weighted average of the principal branches of the MLCs for high ( $u^m = 8$ ) and low ( $u^m = 3$ ) values of the intermediate option. The average is across all possible combinations of preference orderings, weighted by the probabilities with which they occur.

Note that the average of the limiting Nash equilibria across preference configurations is not to vote sincerely. The limiting MLE predicts a weighted average of 73%/76% sincere voting and 24%/22% strategic voting for low and high intermediate value, respectively. Starting with very small  $\mu$ , the roles are reversed: the MLE predicts more strategic voting when the intermediate value is high. Large differences in strategic voting are predicted between  $u^m = 8$  and  $u^m = 3$  when  $\mu \in [0.4, 0.8]$ .

In order to further structure the analysis, a few definitions are useful:

**Definition 2.1** *The **Majoritarian Set** is the set of alternatives with the highest number of votes if all voters vote sincerely.*

**Definition 2.2** *The **Majoritarian Candidate** is the (set of) alternative(s) with the highest number of votes if voting is restricted to the Majoritarian set and all voters vote sincerely.*

Note that if the Majoritarian Set is singleton it equals the Majoritarian Candidate. If it contains two elements (i.e., two options receive equal sincere support, the third receives less) than the Majoritarian Candidate is the option from the Majoritarian Set that gives highest utility to the supporters of the third option. The Majoritarian Candidate is unique, except for the case when all preferences are equally represented, e.g.,  $(N_{ABC}, N_{BCA}, N_{CAB}) = (4, 4, 4)$ .

For any distribution of preferences we now first classify voters based on the rank of their most preferred candidate.

**Definition 2.3** *The **Rank-Type** of a voter is given by:*

**Rank 1<sup>st</sup>:** *Voter whose most preferred candidate is the Majoritarian Candidate.*

**Rank 2<sup>nd</sup>:** *Voter whose most preferred candidate is second in the (sincere) polls.*

**Rank 3<sup>rd</sup>:** *Voter whose most preferred candidate is third in the (sincere) polls.*

By ‘sincere polls’ we mean the ranking that occurs if all voters vote sincerely<sup>25</sup>. Duverger’s law suggests that the Rank 3<sup>rd</sup> voters will be the ones most likely to vote strategically. However, the incentive to do so will depend on the position of the Majoritarian Candidate in their preference ordering. For example, consider  $(N_{ABC}, N_{BCA}, N_{CAB}) = (5, 4, 3)$ . The Majoritarian Candidate is  $A$  and the voters with preference ordering  $CAB$  are Rank 3<sup>rd</sup>. If voters with preference  $ABC$  vote sincerely, the Rank 3<sup>rd</sup> voters have no reason to vote strategically because their least preferred candidate will probably not win anyway. In contrast, the Rank 2<sup>nd</sup> voters (with preference  $BCA$ ) may vote strategically in an attempt at a majority coalition with the Rank 3<sup>rd</sup>. Instead of the Rank-Type, the probability of strategic voting may therefore be determined by the benefits that the Majoritarian candidate, the *a priori* likely winner, gives to other voters than Rank 1<sup>st</sup>. We therefore define:

**Definition 2.4** *The **Incentive-Type** of a voter is given by:*

**(Majoritarian) Supporter:** *Voter with the Majoritarian Candidate as the most preferred alternative.*

**(Majoritarian) Compromiser:** *Voter with the Majoritarian Candidate as the second most preferred alternative.*

**(Majoritarian) Opposer:** *Voter with the Majoritarian Candidate as the least preferred alternative.*

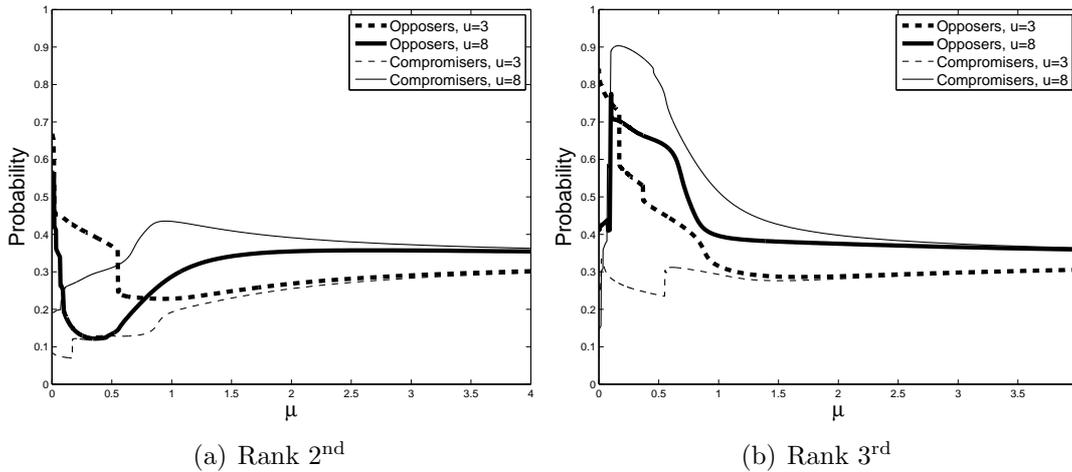
Note that the Rank 1<sup>st</sup> and Supporters are by construction the same group. On the other hand Rank 2<sup>nd</sup> (Rank 3<sup>rd</sup>) can be either Opposers (Compromisers) or Compromisers (Opposers). We can then identify four combination of Rank-Types and Incentive-Types other than Rank 1<sup>st</sup>. Figure 2.4 plots the weighted average of the Principal Branch of the MLC for these 4 sets<sup>26</sup>.

First note that different types play distinct strategies. In the Nash equilibrium (as  $\mu \downarrow 0$ ) Opposers tend to vote strategically. When ranked 3<sup>rd</sup> with a low intermediate value, the Nash equilibrium probability is highest (almost 0.85). Irrespective of rank and intermediate value, Opposers vote more strategically than Compromisers in this limiting

<sup>25</sup>We deal with ties as follows. In case all three preference orderings are equally likely, all voters are ranked 1<sup>st</sup>. If the Majoritarian Set consists of two elements, supporters of the Majoritarian Candidate are ranked 1<sup>st</sup>, supporters of the other candidate in the set are ranked 2<sup>nd</sup> and the remaining voters are ranked 3<sup>rd</sup>. If the Majoritarian Set is singleton and the two other preference orderings have equal support, all voters not supporting the Majoritarian Candidate are ranked 2<sup>nd</sup>.

<sup>26</sup>Separate graphs for each unique situation are available upon request.

Figure 2.4: Strategic Voting by Voter Types



*Notes.* Lines show the weighted average of the principal branches of the MLCs, distinguishing between high ( $u^m = 8$ ) and low ( $u^m = 3$ ) values of the intermediate option in combination with a voter's Incentive-Type. Rank 2<sup>nd</sup> voters are shown in panel (a) and Rank 3<sup>rd</sup> voters in panel (b). Only the equilibrium probabilities of voting strategically are shown. 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<sup>nd</sup> are not included in the graph (cf. fn 25).

MLE<sup>27</sup>. When there is noise, in particular when  $\mu \in [0.4, 0.8]$ , Rank 3<sup>rd</sup> voters vote mostly strategically in the MLE<sup>28</sup>. The Incentive-Type matters as well, however. When  $u^m = 3$ , Rank 3<sup>rd</sup> voters are more likely to vote strategically if they are Opposers than if they are Compromisers. The reverse holds for  $u^m = 8$ .

The latter result is in line with intuition. When they are Compromisers, Rank 3<sup>rd</sup> voters second choice is the Majoritarian Candidate. A strategic vote is likely to be successful because supporters of this candidate rarely vote strategically. For the high importance of the intermediate option, the benefits of a strategic vote are relatively high. When they are Compromisers, Rank 3<sup>rd</sup> voters are therefore likely to vote strategically. When they are Opposers, a strategic vote is an attempt to collaborate with the Rank 2<sup>nd</sup> voters, who themselves are Compromisers. The attraction of a strategic vote is diminished by the fact that the voters it supports are themselves inclined to vote strategically for the Majoritarian Candidate, decreasing the probability of success.

With a low importance of the intermediate option, the interpretation is more complex. First, note that in this case Rank 3<sup>rd</sup> voters vote less strategically anyway. When Rank 2<sup>nd</sup> voters are Compromisers, the appeal for a strategic vote is lower than when the importance of the intermediate option is high. Therefore, in equilibrium, they settle less for a compromise, which creates a chance for the Rank 3<sup>rd</sup> voters (Opposers) to vote

<sup>27</sup>Not shown in the figure is that in the selected Nash equilibrium, supporters have relatively low probabilities of voting strategically (between 0.05 and 0.17).

<sup>28</sup>The exception is the group of Rank 3<sup>rd</sup> Compromisers facing low intermediate value. The MLE for this group is approximately 0.3 for these  $\mu$ -values.

strategically by supporting the option most preferred by the Rank 2<sup>nd</sup> voters. When Rank 3<sup>rd</sup> voters are Compromisers, Rank 2<sup>nd</sup> voters are Opposers. A strategic vote by the latter means voting for the option most preferred by the Rank 3<sup>rd</sup> voters. The incentive for Rank 3<sup>rd</sup> voters to compromise in this situation is low, especially when together with Rank 2<sup>nd</sup> voters they have a strong majority over the Supporters. This reasoning implies an increased probability of a strategic vote by Rank 2<sup>nd</sup> voters (Opposers) and a decreased probability for Rank 3<sup>rd</sup> voters (Compromisers).

## 2.2.2 Behavioral Predictions

The experiments to be described below study strategic voting in committee-size voting bodies. Based on  $\mu \in [0.4, 0.8]$ , the analysis of the Principal Branch of the MLC yields the following behavioral predictions for  $N = 12$ :

1. Without information, the probability of strategic voting is increasing in the importance of the intermediate option (figure 2.1(a)).
2. With full information the probability of strategic voting is increasing in the importance of the intermediate option (figure 2.3).
3. When the value of the intermediate option is low, there will be more strategic voting with information than without (figure 2.1(a) vs. figure 2.3)
4. With full information Rank 3<sup>rd</sup> voters vote more strategically (on average) than other Rank-Types (figure 2.4).
5. With full information and a low value for the intermediate option Rank 3<sup>rd</sup> voters are more likely to vote strategically if they are Opposers than if they are Compromisers (figure 2.4(b)).
6. With full information and low value for the intermediate option Rank 2<sup>nd</sup> voters are more likely to vote strategically if they are Opposers than if they are Compromisers (figure 2.4(a)).
7. With full information and low value for the intermediate option, Opposers are more likely to vote strategically than Compromisers (follows from 5 and 6).
8. With full information and high value for the intermediate option Rank 3<sup>rd</sup> voters are more likely to vote strategically if they are Compromisers than if they are Opposers (figure 2.4(b)).
9. With full information and high value for the intermediate option Rank 2<sup>nd</sup> voters are more likely to vote strategically if they are Compromisers than if they are Opposers (figure 2.4(a)).

10. With full information and high value for the intermediate option, Compromisers are more likely to vote strategically than Opposers (follows from 8 and 9).

Our experimental data will allow us to test these MLE predictions. In turn, this will provide an indication of the ability of the MLE to predict strategic voting, which will allow us to better assess its predictions for larger voting bodies.

## 2.3 Experimental Design

Twelve sessions were run at the CREED laboratory at the University of Amsterdam, during November and December 2008. 288 student subjects participated, allowing for 24 independent electorates. Each session lasted about one and a half hours. In addition to a show-up fee of €7, subjects were paid €0.05 per experimental point. Average earnings were €20.46, including the show-up fee. The experiment was computerized using *z-tree* (Fischbacher 2007). Instructions can be found in appendix 2.B. The experimental design aims at studying the impact on voting behavior of the relative importance of the intermediate option and the extent of information. A full 2x2 combinatorial design therefore requires four treatments. All variations were made across subjects.

The electorate is fixed during a session and consists of 12 voters. Each electorate faces 40 independent elections. In every election, there are three possible 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 before every election. Draws are independent across subjects and elections. Every individual is informed about his or her own preferences before each election. All this is common knowledge. Every experimental electorate experienced the same realization of the random draws (cf. Appendix 2.C), enabling a perfect comparison across electorates.

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. If the winner is the highest ranked option a subject is paid 10 points and for the lowest ranked 1 point. The value of the intermediate option is constant for a given electorate and is set to be either 3 or 8 according to the treatment. In the informed treatments, participants know the aggregate induced preferences of all other voters in the electorate in each round, before casting their vote. Specifically, they are told for each of the three preference orderings how many other voters were appointed to it. After each election, the aggregate voting outcome is shown to all subjects. Table 2.1 summarizes the design.

For each cell, we have observations from six electorates. In addition, in August 2007,

Table 2.1: Experimental Design

|                            |   | <i>Information</i>                      |   |
|----------------------------|---|---|---|
| <i>Intermediate option</i> | Low Importance ( $u^m = 3$ ), Uninformed  | Low Importance ( $u^m = 3$ ), Informed  | High Importance ( $u^m = 8$ ), Informed |
|                            | High Importance ( $u^m = 8$ ), Uninformed | High Importance ( $u^m = 8$ ), Informed |   |

two pilot sessions were run at Fundação Getúlio Vargas, São Paulo, Brazil<sup>29</sup>. We used data from this pilot to obtain an out-of-sample estimate of the MLE parameter  $\mu$ , for which we found  $\mu = 0.55$ . Using the analysis of section 2.2, this provides us with specific MLE predictions for our experimental data.

## 2.4 Results

We start with a general overview of voters' choices and election outcomes in section 2.4.1. Then, we study in more detail the occurrence of strategic voting across treatments in 2.4.2 and choices by distinct types in 2.4.3. In section 2.4.4 we summarize our findings. Unless indicated otherwise, throughout this section our statistical tests will be non-parametric using average numbers per electorate as units of observation.

### 2.4.1 General Overview

For a first impression of the data, table 2.2 shows for each treatment the distribution of votes across options. Because the labels  $A$ ,  $B$ , and  $C$  have no real content, we aggregate votes for most preferred, intermediate, and least preferred option.

Table 2.2: Vote Distribution

|                            |           | <i>Information</i> |          |          |                 |          |          |
|----------------------------|-----------|--------------------|----------|----------|-----------------|----------|----------|
|                            |           | <i>Uninformed</i>  |          |          | <i>Informed</i> |          |          |
| <i>Intermediate option</i> | $u^m = 3$ | 1: 0.936           | 2: 0.049 | 3: 0.015 | 1: 0.806        | 2: 0.169 | 3: 0.025 |
|                            | $u^m = 8$ | 1: 0.798           | 2: 0.192 | 3: 0.010 | 1: 0.740        | 2: 0.245 | 3: 0.015 |

*Notes.* Numbers give the fractions of voters in the treatment denoted by the combination of column and row that voted for, respectively, the (1:) most, (2:) intermediate and (3:) least preferred options.

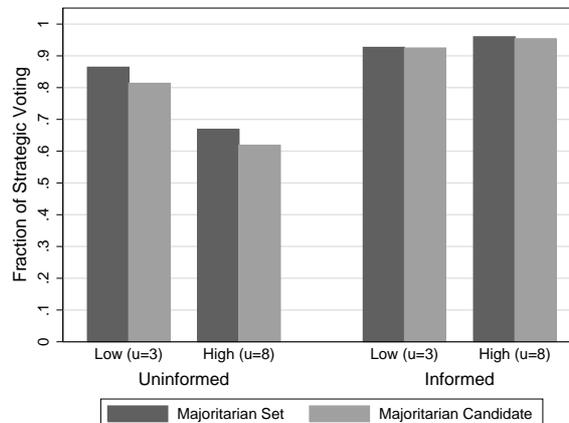
A first thing to note is that we very rarely see subjects voting for the dominated, least preferred option. Second, strategic voting (voting for the intermediate option) is highest (almost 25%) when the intermediate value is high and subjects are informed

<sup>29</sup>Two differences with the experiments described here is that the electorate size in the pilot was 15 voters and that the variation in information was made within subjects. Two electorates participated in the pilot.

about the preference distribution<sup>30</sup>. A Kruskal-Wallis test shows that both the fraction of sincere voting and the fraction of strategic voting differ significantly across the four treatments (for sincere voting:  $\chi^2 = 18.12$ ,  $p < 0.01$ ,  $N = 24$ ; for strategic voting:  $\chi^2 = 17.49$ ,  $p < 0.01$ ,  $N = 24$ ). Pairwise comparisons will follow below. This shows that the combination of information and the value attributed to a voter's second-best candidate significantly affect the decision whether or not to vote strategically. We will analyze the determinants of strategic voting in more details, below.

Before doing so, we consider the election outcome. In particular, figure 2.5 shows, across treatments, the fraction of elections where the winner was in the Majoritarian Set or was the Majoritarian Candidate<sup>31</sup>. The figure shows that without information both the Majoritarian Set and the Majoritarian Candidate are better predictors of the election outcome when the intermediate value is low. This is in line with intuition because behavioral prediction 1 is that less strategic voting is to be expected when  $u^m = 3$  which in turn will improve the chances of the Majoritarian Candidate. Moreover, information leads to strong coordination around the Majoritarian Candidate, which wins over 93% of the elections.

Figure 2.5: Majoritarian Set and Majoritarian Candidate



*Notes.* Bars show for each treatment the fraction of election outcomes that are, respectively in the Majoritarian Set or equal to the Majoritarian Candidate.

<sup>30</sup>Moreover, strategic behavior is not concentrated in a few subjects. A between subjects heterogeneity analysis shows very low variability (the standard deviation is smaller than 0.03), indicating that aggregate average behavior is a good indicator of individual behavior.

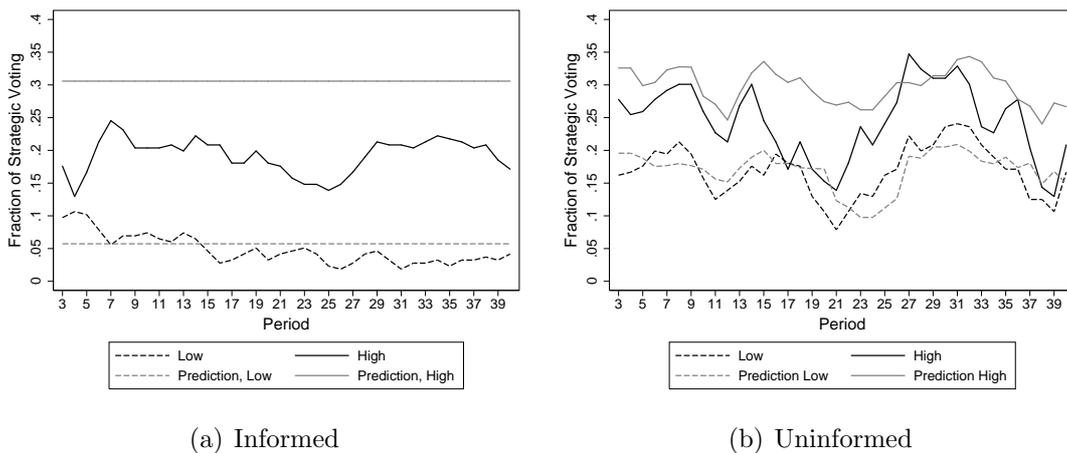
<sup>31</sup>In case of ties (where a winner was randomly chosen), we did the following. For the Majoritarian Set, if one of the tied options was not in the set and the other was, we counted this as a 0.5 success. For the Majoritarian Candidate we counted the winner as 0.5 in case we observed a tie with one other candidate and 0.33 in case of a three-way tie.

## 2.4.2 Strategic Voting

For each treatment figure 2.6 shows the fraction of strategic votes across rounds. It also includes the MLE predictions based on the value for estimated with the pilot data (cf. section 2.3). A first, general, impression from the figure is that the MLE predictions for low intermediate values fare quite well. For both the uninformed and the informed cases, the data are close to the prediction. For high intermediate values, the observations appear to be somewhat lower than predicted.

Comparing across treatments, we observe more strategic voting when the intermediate value is high than when it is low. The difference is statistically significant for both informed and uninformed voters (in both cases, Mann-Whitney (*MW*) rank-sum tests:  $Z = -2.882$ ,  $p < 0.01$ ,  $N = 12$ ). This is in support of behavioral predictions 1 and 2 of section 2.2.2. In short, even though the observed extent of strategic voting when  $u^m = 8$  is somewhat lower than predicted by MLE, the comparative static prediction that it is higher than for  $u^m=3$  does find (strong) support in our data.

Figure 2.6: Experimental Data and Predictions



*Notes.* Lines show the 3-period moving average of the fraction of strategic votes in the uninformed (panel (a)) and informed (panel (b)) sessions. Dashed (solid) lines refer to low (high) intermediate values. Light lines show the 3-period moving average MLE predictions. Note that in the informed case (panel (a)) the MLE prediction in a round depends on the realized distribution of preferences.

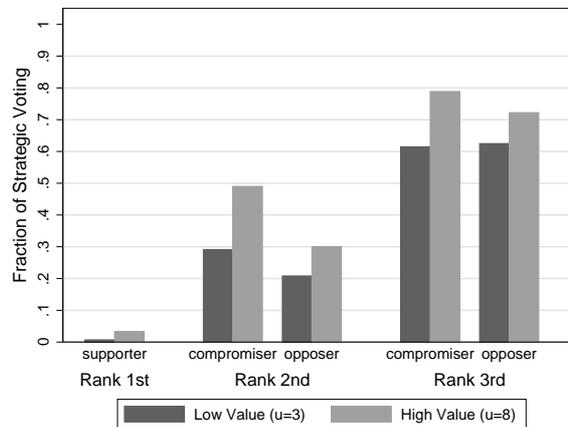
A comparison of panels 2.6(a) and (b) shows whether information affects strategic voting. For low intermediate value, information is predicted to boost strategic voting (cf. behavioral prediction 3). More specifically, MLE predicts the average fraction of strategic votes to be 0.06 and 0.16, respectively, for uninformed and informed voters. We observe fractions equal to 0.05 when voters are uninformed and 0.17 when they are informed (cf. table 2.2). In support of behavioral prediction 3, the observed increase is statistically significant (*MW*,  $Z = -2.882$ ,  $p < 0.01$ ,  $N = 12$ ). For high intermediate values, we observe on average 0.19 and 0.25 of the voters doing so for the uninformed and

informed cases, respectively, where 0.31 is predicted for both cases. This difference is not statistically significant ( $MW$ ,  $Z = -1.761$ ,  $p = 0.09$ ,  $N = 12$ ).

### 2.4.3 Voter Types

Next, we consider the variation of strategic behavior across voter types (i.e., Rank-Types and Incentive-Types) distinguished in section 2.2.1. Figure 2.7 shows this for the treatment with information (without information, voters do not know their own type, of course). We clearly observe that Rank 3<sup>rd</sup> voters are most likely to vote strategically. In fact, they vote more often strategically than sincerely. In contrast, Rank 1<sup>st</sup> voters basically never vote strategically and Rank 2<sup>nd</sup> voters vote strategically often, but less than half of the time.

Figure 2.7: Strategic Voting and Voter Types



*Notes.* Bars show for the informed treatment the fraction of votes that were strategic. Voter types are distinguished along the horizontal axis and the intermediate value treatments by the color of the bar.

When the intermediate value is low, the difference between strategic voting of Rank 3<sup>rd</sup> types and Rank 2<sup>nd</sup> types is statistically significant (Wilcoxon ( $W$ ) signed-rank tests: Rank 3<sup>rd</sup> Opposers vs. Rank 2<sup>nd</sup> Opposers and Rank 3<sup>rd</sup> Compromisers vs. Rank 2<sup>nd</sup> Compromisers both have  $Z = -2.201$ ,  $p = 0.03$ ;  $N = 6$ ). Moreover, both Rank 3<sup>rd</sup> and Rank 2<sup>nd</sup> types vote strategically significantly more often than Supporters do (in both cases:  $W$ ,  $Z = -2.201$ ,  $p = 0.03$ ;  $N = 6$ ). The exact same results are obtained for the treatment with high intermediate value<sup>32</sup>. These results provide strong support for the fourth behavioral prediction that Rank 3<sup>rd</sup> voters are most likely to vote strategically.

The fifth and sixth behavioral predictions relate to the case with low intermediate value and predict that, respectively, Rank 3<sup>rd</sup> and Rank 2<sup>nd</sup> voters will vote more strategically

<sup>32</sup>The reason why the test statistic always has the same value is that in all tests, the ranks are unanimous across the 6 electorates for any comparison. 6 out of 6 positive ranks gives  $Z = 2.201$  and  $p = 0.028$  in the Wilcoxon test.

if they are Opposers than if they are Compromisers. Because in two out of six electorates we observe Rank 3<sup>rd</sup> Compromisers voting more strategically than Rank 3<sup>rd</sup> Opposers, we cannot support behavioral prediction 5 ( $W, Z = -0.314, p = 0.75, N = 6$ ). For the same comparison with Rank 2<sup>nd</sup> voters, we observe only one electorate with the right sign, though this is not enough to create a statistically significant test result in the wrong direction ( $W, Z = -1.572, p = 0.12, N = 6$ ). While the Incentive-Type does not appear to have an effect when considered in interaction with the Rank-Type, it may when viewed in isolation. Behavioral prediction 7 is that Opposers will vote more strategically than Compromisers for low intermediate value. We observe the opposite, however: less strategic voting by Opposers (0.29) than by Compromisers (0.44). The difference is statistically significant ( $W, Z = -1.992, p = 0.05, N = 6$ ), a clear rejection of prediction 7. This is no surprise, since behavioral prediction 7 is a direct consequence of behavioral predictions 5 and 6 which were not supported by our data.

Next, the eighth and ninth predictions are that for high intermediate value, respectively, Rank 3<sup>rd</sup> and Rank 2<sup>nd</sup> voters will vote more strategically when they are Compromisers than when they are Opposers. In both cases, the prediction is supported in five out of six electorates. For Rank 3<sup>rd</sup> voters, this is not enough to render statistical significance ( $W, Z = -1.153, p = 0.25, N = 6$ ). For Rank 2<sup>nd</sup> voters, the difference is statistically significant, however ( $W, Z = -1.992, p = 0.05, N = 6$ ). Finally, behavioral prediction 10 is that Compromisers will vote more strategically than Opposers for high intermediate value. This is indeed observed in our data, where the fraction of strategic votes is 0.63 and 0.38, respectively. The difference is statistically significant ( $W, Z = -2.201, p = 0.03, N = 6$ ), in support of the prediction.

All of the previous tests have been univariate and based on average results per electorate. To increase the power of the tests we can consider the data as deriving from a panel where every participant votes in 40 elections. We do so by conducting a probit regression explaining the individual choice to vote at a particular election, with random effects at the electorate level. Table 2.3 presents the estimated marginal effects. We have added a variable indicating the period number (divided by 10) to see if any learning is taking place (which there is not). We also added a dummy variable indicating elections where one of the options was supported by an absolute majority, because in this case strategic voting may simply be seen as futile. This was the case in 27.5% of the elections. The results show that the probability of voting strategically is 3.5 percentage points lower in these rounds, when the intermediate value is high (the effect for low value is statistically insignificant). Other factors remain important, however.

The results also show that, irrespective of the intermediate value, Rank 2<sup>nd</sup> and Rank 3<sup>rd</sup> voters are both more likely to vote strategically than Supporters (the category absorbed in the constant term), and that Rank 3<sup>rd</sup> voters are most likely to vote strategically. This confirms the results from our univariate analyses. In fact, Rank 3<sup>rd</sup> voters have a

Table 2.3: Strategic Voting

|  | Intermediate Value                |                                   |
|--|-----------------------------------|-----------------------------------|
|  | Low ( $u^m = 3$ )                 | High ( $u^m = 8$ )                |
| Constant (coefficient)                           | -2.677**                          | -1.947**                          |
| Period/10  | 0.006                             | 0.003                             |
| Simple Majority                                  | 0.013                             | -0.035*                           |
| Compromiser                                      | 0.148                             | 0.306**                           |
| Opposer  | 0.079                             | 0.207**                           |
| Rank 2 <sup>nd</sup>                             | 0.207**                           | 0.247**                           |
| Rank 3 <sup>rd</sup>                             | 0.542**                           | 0.567**                           |
| Rank 2 <sup>nd</sup> x Opposer                   | 0.002                             | -0.056                            |
| Rank 3 <sup>rd</sup> x Opposer                   | 0.059                             | 0.019                             |
| test Rank 2 <sup>nd</sup> = Rank 3 <sup>rd</sup> | $\chi^2 = 53.5$ ( $p < 0.001$ )** | $\chi^2 = 48.8$ ( $p < 0.001$ )** |
| test Compromiser=Opposer                         | $\chi^2 = 0.34$ ( $p = 0.559$ )   | $\chi^2 = 0.74$ ( $p = 0.390$ )   |
| test Rank 2 <sup>nd</sup> : Compromiser=Opposer  | $\chi^2 = 8.53$ ( $p = 0.004$ )** | $\chi^2 = 32.9$ ( $p < 0.001$ )** |
| test Rank 3 <sup>rd</sup> : Compromiser=Opposer  | $\chi^2 = 0.220$ ( $p = 0.641$ )  | $\chi^2 = 1.78$ ( $p = 0.182$ )   |

*Notes.* The table presents the results of a random effects probit regression model where the dependent variable is a dummy indicating whether or not voter  $i$  in electorate  $j$  voted strategically in election  $t$ . Formally, it gives the marginal effects derived from the regression model  $Pr_t^{ij} = \Phi(X_t^{ij}\beta + \mu^j)$  where  $Pr_t^{ij}$  gives the probability that  $i$  of  $j$  votes strategically in  $t$ .  $\Phi$  denotes the cumulative normal distribution and  $X$  is the vector of independent variables described in the first column of the table.  $\mu^j$  is a (white noise) electorate-specific error that corrects for the dependencies across individual decision in the same group. The independent variable ‘Simple Majority’ is a dummy variable indicating situations where one of the preference orderings had an absolute majority of at least 7. The independent variables with an ‘x’ between variables indicate interaction terms. To avoid the dummy trap, the variable indicating Rank 1<sup>st</sup> voters (i.e., Supporters) has been left out of the regression. The tests depicted in the last two rows test equality of the estimated coefficients. Our results are not sensitive to the choice of quadrature points; when varying these points all differences are smaller than  $10^{-8}$ .

\*(\*\*) denotes statistical significance at the 5% (1%)-level.

54-57%-points higher probability of voting strategically than Supporters. The effect of Incentive-Type is lower. With low intermediate value it does not matter statistically whether one is Supporter, Compromiser, or Opposer. When  $u^m = 8$ , both Compromisers and Opposers vote strategically more often than Supporters do, but the difference between the two is statistically insignificant. Compromisers have a 31%-point higher probability of voting strategically than Supporters do.

The results for the interaction between Rank-Type and Incentive-Type, by and large, again support the conclusions from the univariate analyses. One difference is that for  $u^m = 8$ , the difference between Rank-2<sup>nd</sup> Compromisers and Opposers is now statistically significant. Note that this effect has the opposite sign than that predicted by Behavioral Prediction 6, however.

#### 2.4.4 Summarizing the Results

In general, the Quantal Response model predicts behavior in the experimental setting quite well. Data support the behavioral predictions at the aggregate level as well as the comparative statics for our treatments (which vary information and intermediate value). In particular, we observe that (i) with and without information, the probability of strategic voting is increasing in the importance of the intermediate option; (ii) with low intermediate value, there is more strategic voting with information than without; (iii) there is no statistically significant effect of information when the intermediate value is high.

When considering behavior disaggregated per type of voter, the predictive power of the MLE decreases. Our data do support the prediction that (iv) with full information Rank 3<sup>rd</sup> voters are more likely to vote strategically than Rank 2<sup>nd</sup> voters (and both more often vote strategically than Rank 1<sup>st</sup> do). Moreover, we observe that (v) Compromisers vote more strategically than Opposers and both more than Supporters, MLE predicts this comparative statics only for high intermediate value. MLE does predict specific patterns for combinations of voter ranks and voter types (Behavioral Predictions 5-10) but we find only limited support for these detailed predictions.

## 2.5 Concluding remarks

We have studied a voting environment characterized by the regular occurrence of Condorcet cycles in preferences. Voters are faced with the decision of voting sincerely or strategically. Voters know their own preference, but may or may not have information about the distribution of preferences across the electorate. When this information is available, certain characteristics of this distribution (such as the rank of the support for one's most preferred candidate or the relative position of the plurality-preferred candidate in

one's preference ordering) may become important elements in determining what to vote for. The way such factors affect the probability of voting strategically is captured quite well by the predictions derived by adding bounded rationality to a standard utilitarian voting model and deriving the Multinomial Logit Equilibrium (MLE).

Our goal has been to establish whether or not people vote strategically, and what factors affect the probability of doing so. For this purpose we excluded one of the obvious candidates for strategic voting, i.e., situations with a Condorcet loser. Instead, we have created an environment in which options are *a priori* symmetric and where Condorcet cycles are likely to occur. In this environment, one that is regularly observed in the field, a strategic vote aims at securing one's second-preferred option as opposed to trying to have the most-preferred option win. Our boundedly-rational equilibrium model (the Quantal Response Equilibrium) allowed us to derive theoretical predictions on strategic voting. In this way, the equilibrium analysis provides an important tool for understanding the strategic vote. In the end, whether or not voters vote strategically is an empirical question, however. For this, our experiments have proved to be important. Laboratory control has allowed us to provide precise answers to this question. We know exactly when a subject in the experiment votes strategically and when she does not. By varying model parameters one at a time, we have been able to trace the causality between changes in these parameters and the vote. This has allowed us to establish that voters vote more strategically when the relative value of the second-preferred option increases but that knowing the distribution of preferences makes strategic voting more likely if this relative value is low.

Laboratory control has also allowed us to study in detail who votes strategically. We find strong evidence for the (intuitive) MLE prediction that voters who prefer the candidate with the largest support (the 'Majoritarian Candidate') will sincerely vote for this candidate. For strategic voting by other voters, there are two characteristics of their preferences that may play a role. First, it may matter whether a voter has the Majoritarian Candidate as a second or third preferred option. In the former case, she may decide to vote strategically in an attempt to help the supporters of this candidate to obtain a majority. Second, it may matter how a voter's most preferred candidate ranks in a poll where everyone votes sincerely. If this rank is lowest in the polls, the voter may vote strategically believing that her most preferred candidate does not stand a chance. Our data show that the second argument is more important than the first. Though a voter's personal ranking of the Majoritarian Candidate does affect the probability of voting strategically, the ranking of one's most preferred candidate in the electorate is more important. Compared to a supporter of the Majoritarian Candidate, a supporter of the lowest ranked candidate has a more than 50%-point higher probability of voting strategically.

Of course, a downside of using laboratory experiments is that we were forced to re-

strict the analysis to committee-size voting bodies. The confirmation of the main MLE-predictions for committees does give some confidence in their predictions for larger voting bodies, however (see Levine & Palfrey 2007 for a similar argument with respect to voter turnout experiments). Moreover, there is ample empirical evidence (reviewed in section 2.1 and footnote 9) that substantial strategic voting takes place even at national elections. Hence, the question is not whether strategic voting takes place, but what the causes and effects of strategic voting are. Our design and results pertain to this question.

In the introduction to this study, we argued that a sufficient condition for correct aggregation of preferences is that every voter casts a vote for her most preferred alternative. If this occurs, the winner is in the set of Majoritarian Candidates 100% of the time. In our experiment, we observe this 72-88% of the time with uninformed voters and 93-96% of the time when voters know each others' preferences (cf. figure 2.5). From our laboratory results, we therefore conclude that opinion polls revealing the distribution of preferences are sufficient for voting to correctly aggregate preferences in this way<sup>33</sup>. With such opinion polls, the plurality's desire is usually honored, even when some voters vote strategically. We conclude that in both our theory and experiments information works as a coordination device around the victory of the Majoritarian Candidate. Summarizing our answer to the main research question, information impacts voting behavior by increasing strategic behavior in some situations, differentiating voting patterns across types, and promoting a higher chance of victory for the Majoritarian Candidate.

---

<sup>33</sup>Of course, if this is the case, it may create an incentive to strategically misreport preferences in a poll. This is a topic that can easily be studied in future experiments.

## Appendix 2.A Pivotal Probabilities and Asymptotics

In this appendix we show how the probabilities of voting for various options depends on the probabilities of being pivotal in various situations and how this yields the conclusion that these probabilities converge to  $1/3$  as the size of the electorate increases to infinity.

The (multinomial) probability that a voter  $i$  with preference ordering  $(A, B, C)$  will vote for option  $j = A, B, C$ , is denoted by  $p_j^i$ , and given by equation (2.5), which we summarize by

$$p_j^i = \frac{\exp [(u_j^e - u_A^e) / \mu]}{1 + \exp [(u_B^e - u_A^e) / \mu] + \exp [(u_C^e - u_A^e) / \mu]} \quad , \quad j = A, B, C \quad (2.6)$$

Recall that the expected utility difference of voting for  $j$  instead of  $k$ ,  $u_j^e - u_k^e$  is a weighted sum of the utility differences between voting for  $j$  or  $k$  for all possible combinations of votes by other voters ( $-i$ ). For example:

$$u_A^e - u_B^e = \sum_{-i} P_{-i} (u_A^{-i} - u_B^{-i}) \quad (2.7)$$

where  $P_{-i}$  denotes the probability that a particular configuration of other voters' choices occurs and  $u_j^{-i}(u_k^{-i})$  gives the utility obtained from choosing  $j(k)$ . A configuration of other voters' choices depends on the configuration of their preferences and on their choices conditional on their preferences.

There are  $\binom{N+1}{2}$  possible preference configurations for other voters. Each will take the form  $(N - 1_{ABC}, N - 1_{BCA}, N - 1_{CAB})$ , and will occur with (multinomial) probability:

$$P_{(N-1_{ABC}, N-1_{BCA}, N-1_{CAB})} = \frac{(N-1)!}{(N-1_{ABC})! (N-1_{BCA})! (N-1_{CAB})!} \left(\frac{1}{3}\right)^{(N-1)} \quad (2.8)$$

In each of these, the probabilities of various configurations of the others' votes depends on their strategies, i.e., the probabilities with which they vote for  $A$ ,  $B$ , or  $C$ . These then determine the probabilities that  $i$  will be pivotal. For all non-pivotal situations  $u_A^{-i} = u_B^{-i} = u_C^{-i}$ . It follows directly from (2.7) that only pivotal probabilities are relevant in determining the expected utility differences in (2.7).

To illustrate, consider the configuration of other voters preferences  $(N-1, 0, 0)$ , i.e., all other voters have preference ordering  $(A, B, C)$ , which occurs with probability  $P_{(N-1, 0, 0)} = (1/3)^{N-1}$ . For simplicity, consider only quasi-symmetric strategies<sup>34</sup>. One of the pivotal situations faced by a voter with preference  $(A, B, C)$  is a tie between  $A$  and  $B$ . This

---

<sup>34</sup>Quasi-symmetric strategies are strategies that are equal for all players with the same preferences and information and facing the same environment (e.g. Palfrey & Rosenthal 1983).

occurs with probability:

$$P_{A=B|(N-1,0,0)} = \sum_{i=\lceil \frac{N-1}{3} \rceil}^{\lfloor \frac{N-1}{2} \rfloor} \frac{(N-1)!}{i!i!(N-1-2i)!} \left(p_A^{(A,B,C)}\right)^i \left(p_B^{(A,B,C)}\right)^i \left(p_C^{(A,B,C)}\right)^{(N-1-2i)} \quad (2.9)$$

where  $P_{A=B|(N-1,0,0)}$  denotes the probability that a tie occurs between  $A$  and  $B$  conditional on the distribution of others' preferences being  $(N-1,0,0)$ , and  $\lceil x \rceil$  ( $\lfloor x \rfloor$ ) indicates the rounding up (down) of  $x$ . Note that the sum is restrained to consider only situations where  $C$  receives fewer votes than  $A$  and  $B$  or a three-way tie, i.e., a vote for  $A$  is decisive in favor of  $A$  while a vote for  $B$  is decisive in favor of  $B$ .

One can derive pivotal probabilities as in (2.9) for all configurations of voter preferences and strategies and substitute them for  $P_{-i}$  in (2.7) (whilst neglecting all  $P_{-i}$  for non-pivotal situations). Note that as  $N$  increases each pivotal probability as in (2.9) converges to 0. As a consequence, the difference in expected utility in (2.7) converges to 0 and the probability of voting for any specific option in (2.6) converges to  $1/3$ .

## Appendix 2.B Experimental Instructions

In this appendix we provide a transcript of the instructions for the treatment with high intermediate value and full information. The paragraph denoted in italics was omitted in the treatment without information. Note that there were 24 subjects (thus, 2 independent electorates) in the laboratory in any given session.

### 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 fol-

lowing:

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 **8 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. Therefore, your preference ordering will often change from one round to another. Before you cast your vote, you will be informed of your preference ordering for that round. We advise that at the start of every round you take a moment to check this preference ordering.

*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. In addition, you will also know your own preference ordering for the round, of course.*

### **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.

## Appendix 2.C Realizations of the Random Draws

Table 2.4 shows the realizations of the random draws for the preference distributions for the 40 elections. The same realizations were used in all electorates.

Table 2.4: Realized Preference Distributions

| Election | ABC | BCA | CAB | Majoritarian Set | Majoritarian Candidate |
|----------|-----|-----|-----|------------------|------------------------|
| 1        | 4   | 5   | 3   | B                | B                      |
| 2        | 1   | 4   | 7   | C                | C                      |
| 3        | 3   | 5   | 4   | B                | B                      |
| 4        | 3   | 4   | 5   | C                | C                      |
| 5        | 2   | 6   | 4   | B                | B                      |
| 6        | 7   | 2   | 3   | A                | A                      |
| 7        | 6   | 3   | 3   | A                | A                      |
| 8        | 4   | 5   | 3   | B                | B                      |
| 9        | 3   | 6   | 3   | B                | B                      |
| 10       | 1   | 7   | 4   | B                | B                      |
| 11       | 5   | 1   | 6   | C                | C                      |
| 12       | 6   | 4   | 2   | A                | A                      |
| 13       | 4   | 3   | 5   | C                | C                      |
| 14       | 3   | 3   | 6   | C                | C                      |
| 15       | 2   | 9   | 1   | B                | B                      |
| 16       | 4   | 2   | 6   | C                | C                      |
| 17       | 7   | 3   | 2   | A                | A                      |
| 18       | 2   | 4   | 6   | C                | C                      |
| 19       | 4   | 1   | 7   | C                | C                      |
| 20       | 3   | 1   | 8   | C                | C                      |
| 21       | 4   | 4   | 4   | ABC              | ABC                    |
| 22       | 5   | 5   | 2   | AB               | A                      |
| 23       | 2   | 5   | 5   | BC               | B                      |
| 24       | 4   | 4   | 4   | ABC              | ABC                    |
| 25       | 3   | 4   | 5   | C                | C                      |
| 26       | 4   | 5   | 3   | B                | B                      |
| 27       | 4   | 3   | 5   | C                | C                      |
| 28       | 2   | 6   | 4   | B                | B                      |
| 29       | 5   | 4   | 3   | A                | A                      |
| 30       | 4   | 3   | 5   | C                | C                      |
| 31       | 2   | 4   | 6   | C                | C                      |
| 32       | 8   | 1   | 3   | A                | A                      |
| 33       | 2   | 7   | 3   | B                | B                      |
| 34       | 2   | 6   | 4   | B                | B                      |
| 35       | 3   | 5   | 4   | B                | B                      |
| 36       | 5   | 5   | 2   | AB               | A                      |
| 37       | 10  | 2   | 0   | A                | A                      |
| 38       | 5   | 1   | 6   | C                | C                      |
| 39       | 2   | 2   | 8   | C                | C                      |
| 40       | 5   | 5   | 2   | AB               | A                      |

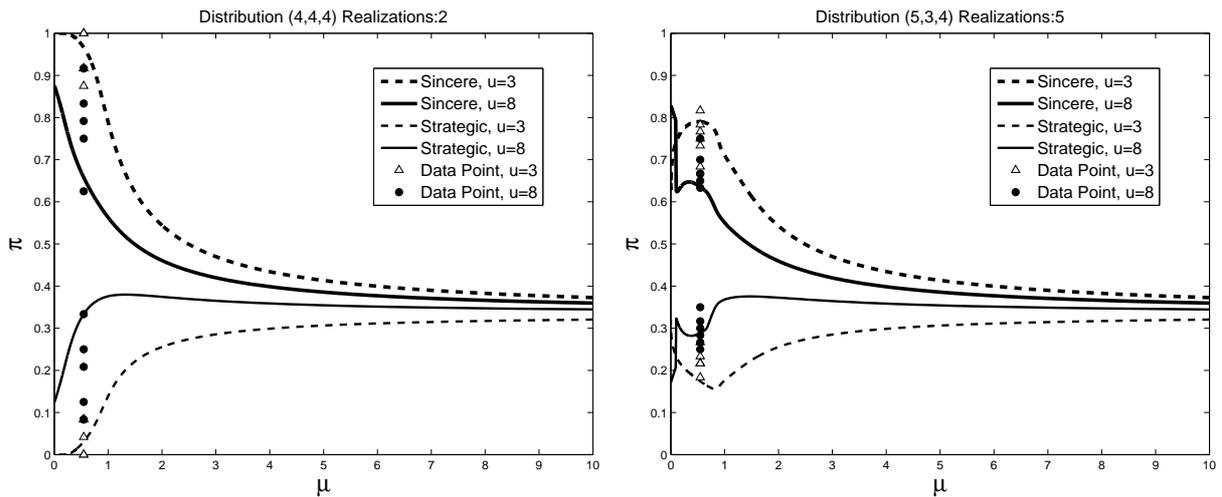
*Notes.* This table shows for each election how many voter had preference ABC, BCA and CAB. Majoritarian Set and Majoritarian Candidate are indicated according to definitions 2.1 and 2.2, respectively.

## Appendix 2.D MLC for each unique situation

In this appendix we present graphs of the Principal Branch of the Multinomial Logit Correspondence (MLC) for  $N = 12$  and  $\mu \in [0, 10]$ . We present all the 31 unique distributions regarding quasi-symmetric strategies<sup>35</sup>. In some cases, the principal branch contains “backward bending” portions, i.e., the branch does not always moves monotonically w.r.t. to  $\mu$ . This leads to multiple equilibria. In order to select one of the equilibria in these cases<sup>36</sup> we applied a “first-pass criteria”.<sup>37</sup> In the “first-pass” criteria we select the first equilibrium computed on any given  $\mu$  when tracing the correspondence from  $\mu = \infty$  toward  $\mu = 0$ . The intuitive reasoning is that if any learning process applies, it is more reasonable to assume that it moves from more to less noisy behavior than the other way around.

The graphs also show average behavior per experimental electorate, plotted over  $\mu = 0.55$ , the value used for deriving predictions.

Figure 2.8: Principal Branch of the MLC



<sup>35</sup>Consider the distributions: (5, 4, 3) and (3, 4, 5). In both cases, the players from the group with 5 voters have as second most preferred option the most preferred option of players from the group with 4 voters. Similarly these voters have as their second most preferred option the most preferred option of players from the group with 3 voters, who, in turn, have as their second most preferred option the most preferred option of the players from the group with 5 voters. Therefore, both distribution have identical MLC when comparing groups by size.

<sup>36</sup>Selection of one equilibrium per distribution is necessary for weighted average computations.

<sup>37</sup>Full graphs are available upon request.

Figure 2.8: Principal Branch of the MLC (cont.)

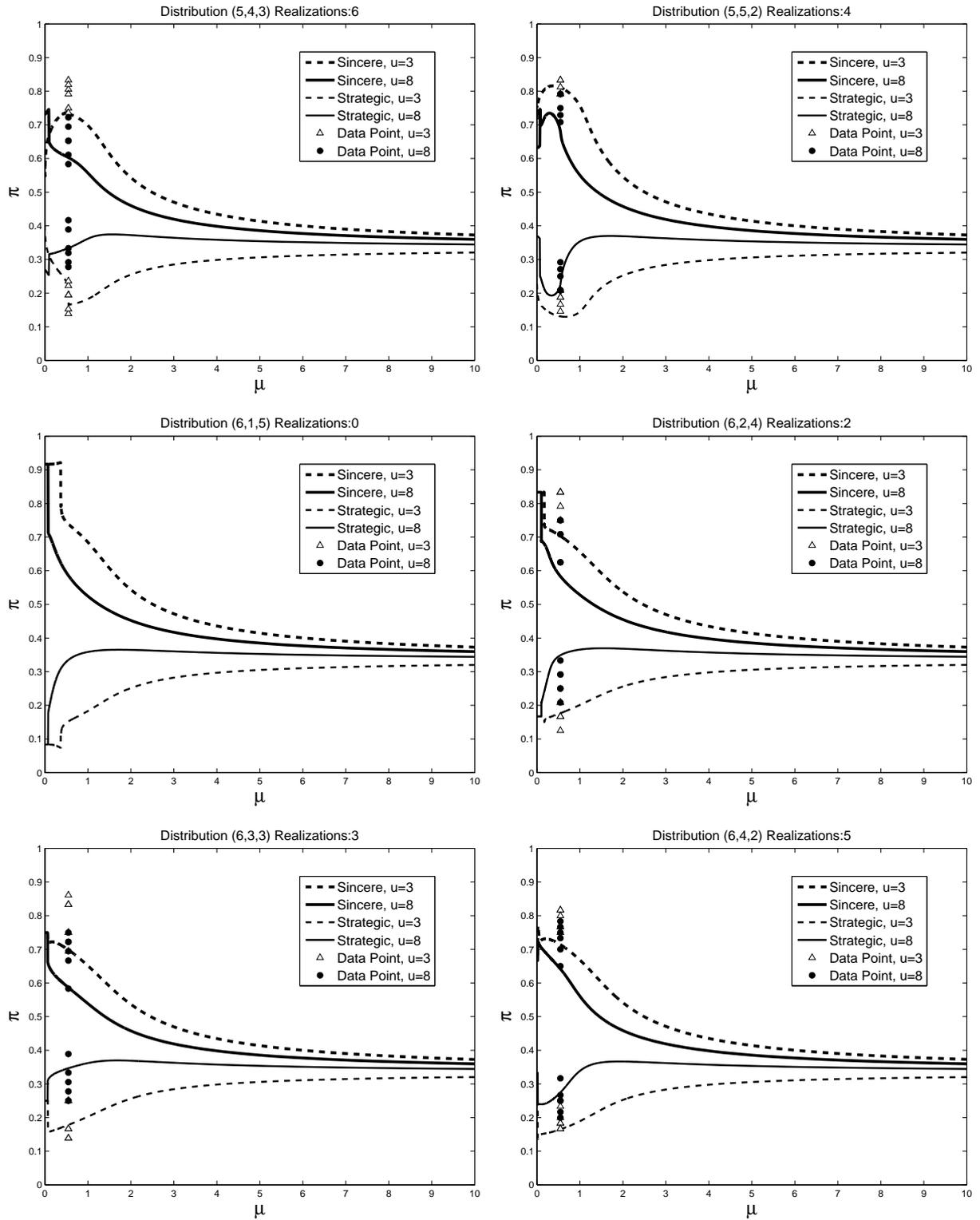


Figure 2.8: Principal Branch of the MLC (cont.)

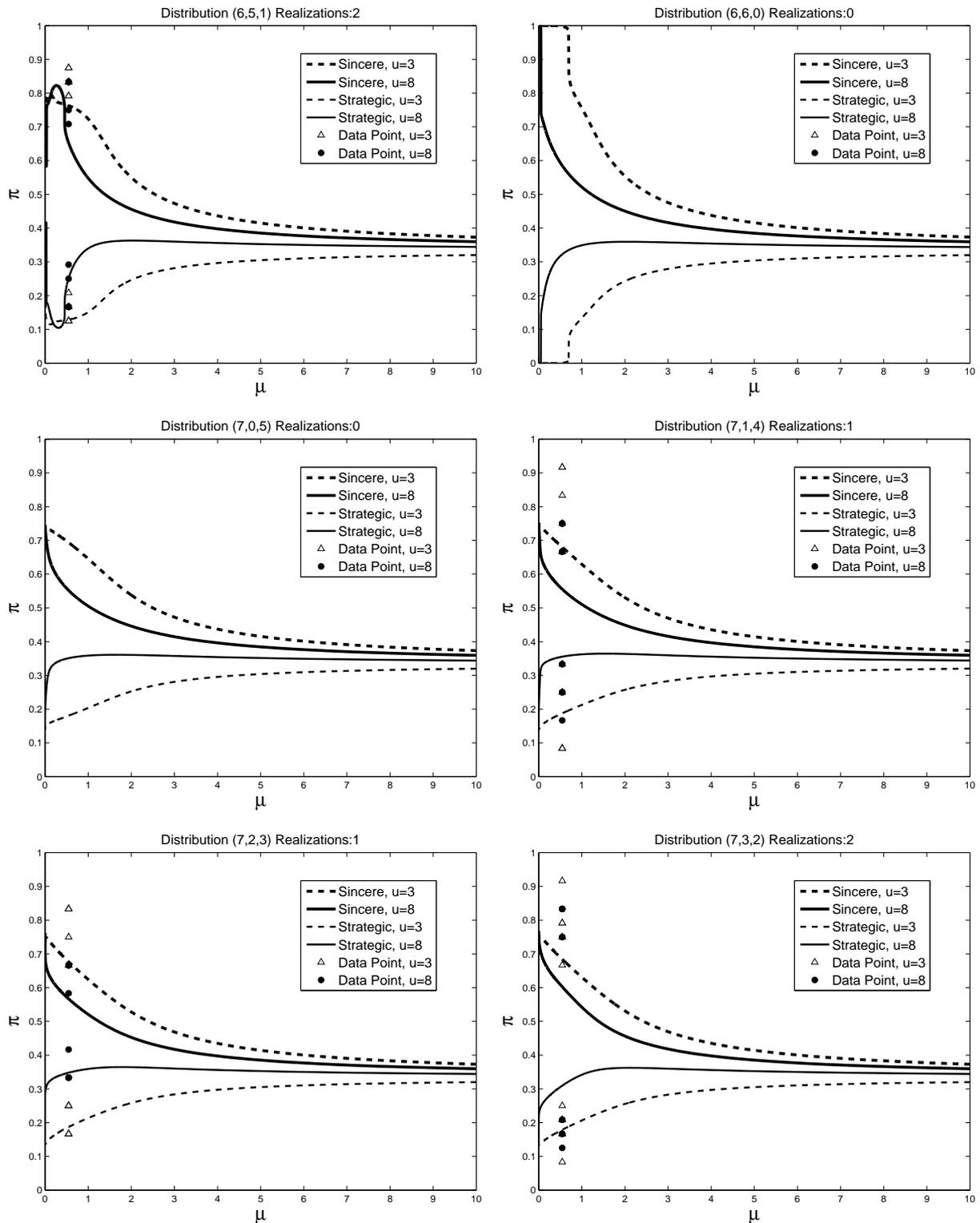


Figure 2.8: Principal Branch of the MLC (cont.)

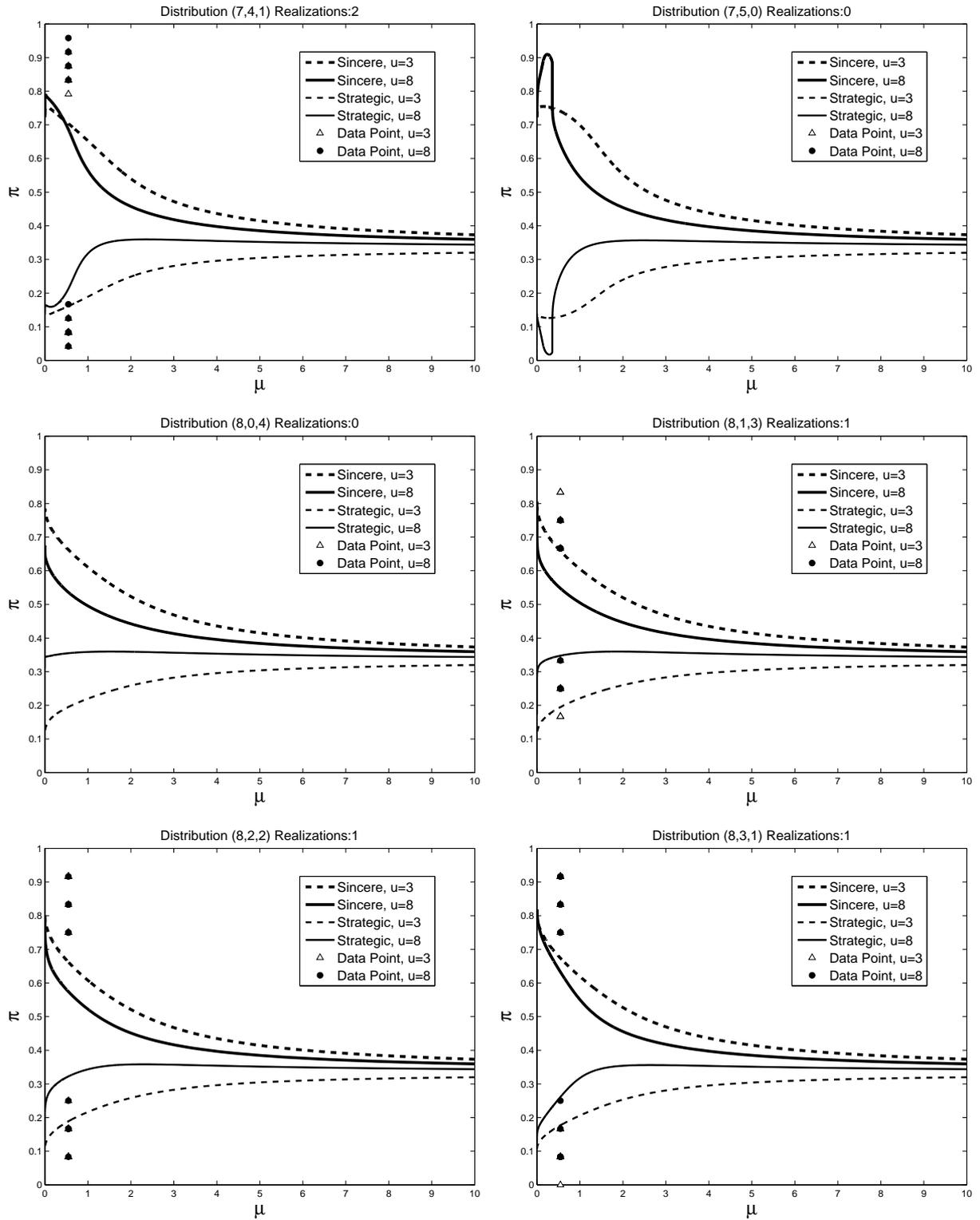


Figure 2.8: Principal Branch of the MLC (cont.)

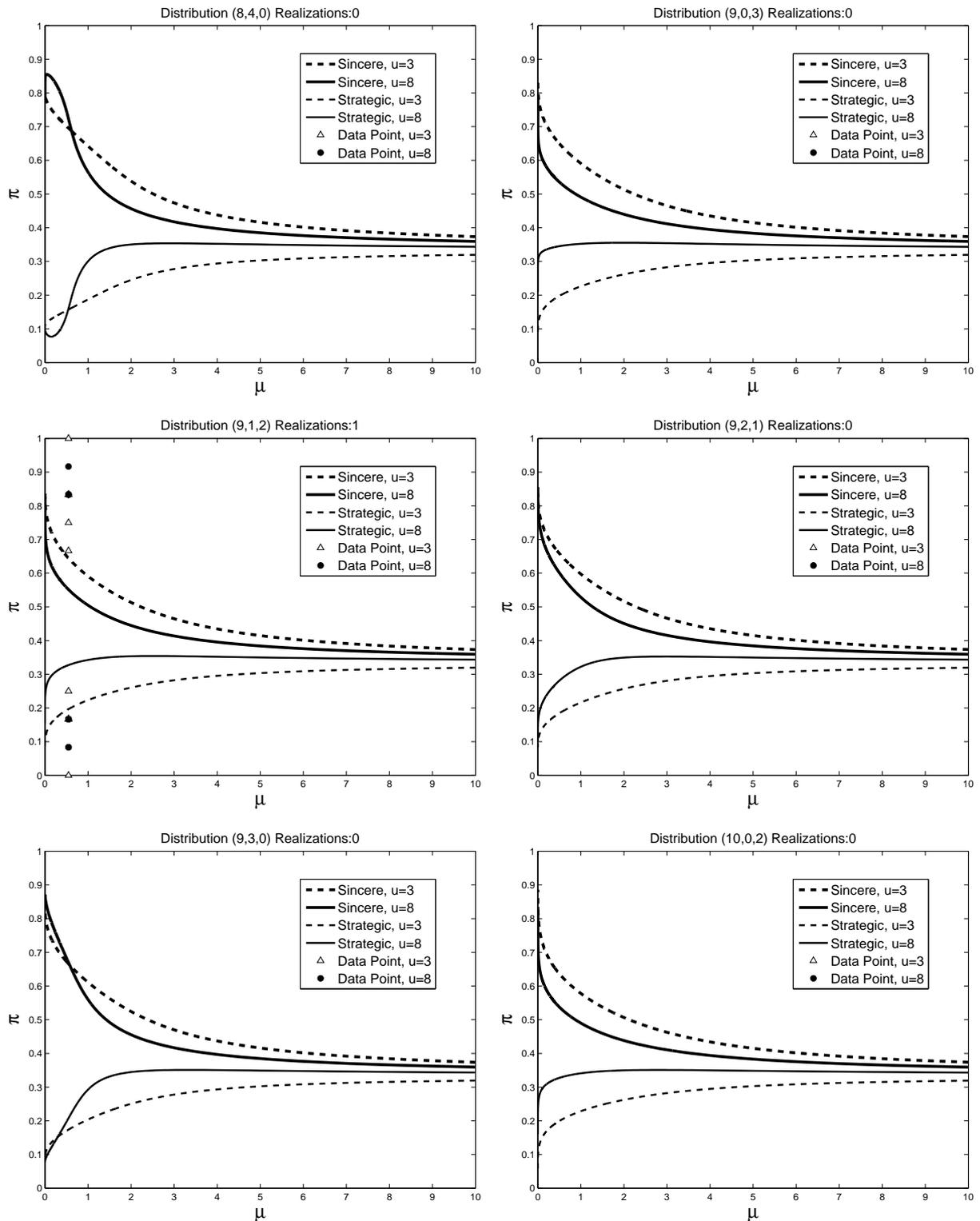
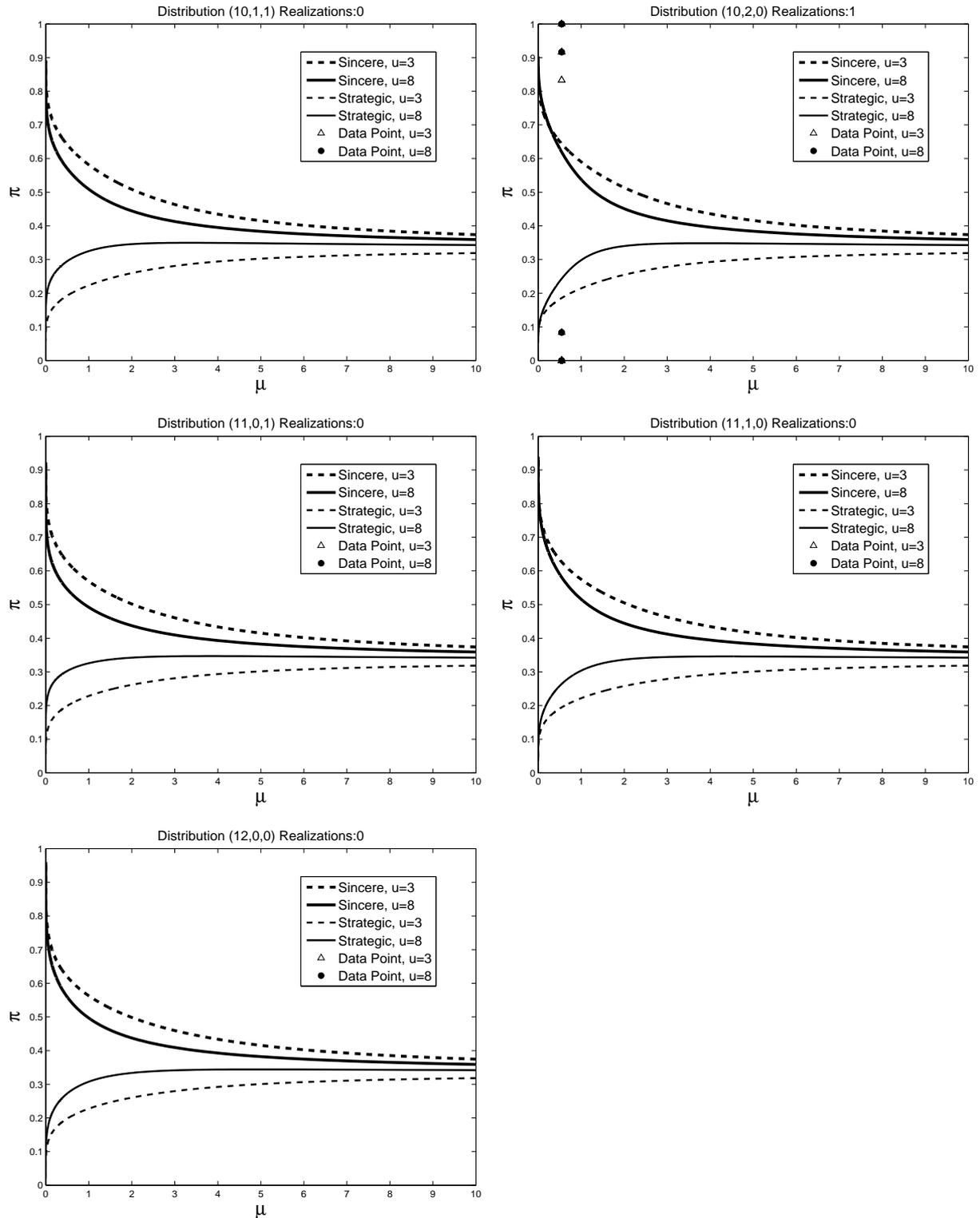


Figure 2.8: Principal Branch of the MLC (cont.)



## Appendix 2.E Limiting MLC for each unique situation

This appendix presents the limiting MLC ( $\mu = 10^{-6}$ ) for each unique situation for the informed setting (cf. fn 35).

Table 2.5: Limiting MLC,  $N = 12$ 

| Group 1 | Group 2 | Group 3 | Sincere   |           | Strategic |           | Third Option |           |
|---------|---------|---------|-----------|-----------|-----------|-----------|--------------|-----------|
|         |         |         | $u^m = 3$ | $u^m = 8$ | $u^m = 3$ | $u^m = 8$ | $u^m = 3$    | $u^m = 8$ |
| 4       | 4       | 4       | 1         | 0.8767    | 0         | 0.1233    | 0            | 0         |
| 5       | 3       | 4       | 0.671     | 0.8295    | 0.3158    | 0.1705    | 0.0132       | 0         |
| 5       | 4       | 3       | 0.5865    | 0.7289    | 0.3994    | 0.2711    | 0.0141       | 0         |
| 5       | 5       | 2       | 0.7572    | 0.6293    | 0.2316    | 0.3707    | 0.0111       | 0         |
| 6       | 1       | 5       | 0.9167    | 0.9167    | 0.0833    | 0.0833    | 0            | 0         |
| 6       | 2       | 4       | 0.8333    | 0.8333    | 0.1667    | 0.1667    | 0            | 0         |
| 6       | 3       | 3       | 0.75      | 0.75      | 0.25      | 0.25      | 0            | 0         |
| 6       | 4       | 2       | 0.6667    | 0.6667    | 0.3333    | 0.3333    | 0            | 0         |
| 6       | 5       | 1       | 0.5833    | 0.5833    | 0.4167    | 0.4167    | 0            | 0         |
| 6       | 6       | 0       | 1         | 1         | 0         | 0         | 0            | 0         |
| 7       | 0       | 5       | 0.7222    | 0.7222    | 0.1389    | 0.1389    | 0.1389       | 0.1389    |
| 7       | 1       | 4       | 0.7222    | 0.7222    | 0.1389    | 0.1389    | 0.1389       | 0.1389    |
| 7       | 2       | 3       | 0.7222    | 0.7222    | 0.1389    | 0.1389    | 0.1389       | 0.1389    |
| 7       | 3       | 2       | 0.7222    | 0.7222    | 0.1389    | 0.1389    | 0.1389       | 0.1389    |
| 7       | 4       | 1       | 0.7222    | 0.7222    | 0.1389    | 0.1389    | 0.1389       | 0.1389    |
| 7       | 5       | 0       | 0.7222    | 0.7222    | 0.1389    | 0.1389    | 0.1389       | 0.1389    |
| 8       | 0       | 4       | 0.778     | 0.6708    | 0.1111    | 0.3098    | 0.1109       | 0         |
| 8       | 1       | 3       | 0.778     | 0.8058    | 0.1111    | 0.1724    | 0.1109       | 0.0218    |
| 8       | 2       | 2       | 0.778     | 0.7807    | 0.111     | 0.1351    | 0.1109       | 0.0506    |
| 8       | 3       | 1       | 0.7781    | 0.801     | 0.111     | 0.1241    | 0.1109       | 0.075     |
| 8       | 4       | 0       | 0.7781    | 0.781     | 0.111     | 0.1097    | 0.1109       | 0.1093    |
| 9       | 0       | 3       | 0.8348    | 0.7907    | 0.0836    | 0.2087    | 0.0816       | 0.0007    |
| 9       | 1       | 2       | 0.8353    | 0.8266    | 0.0832    | 0.1537    | 0.0815       | 0.0197    |
| 9       | 2       | 1       | 0.8357    | 0.8555    | 0.0829    | 0.1019    | 0.0814       | 0.0426    |
| 9       | 3       | 0       | 0.8359    | 0.8497    | 0.0827    | 0.0778    | 0.0813       | 0.0725    |
| 10      | 0       | 2       | 0.8861    | 0.8349    | 0.0587    | 0.1602    | 0.0551       | 0.0049    |
| 10      | 1       | 1       | 0.8871    | 0.8922    | 0.0579    | 0.087     | 0.055        | 0.0208    |
| 10      | 2       | 0       | 0.8877    | 0.9031    | 0.0574    | 0.053     | 0.0549       | 0.044     |
| 11      | 0       | 1       | 0.9293    | 0.9127    | 0.037     | 0.0788    | 0.0338       | 0.0085    |
| 11      | 1       | 0       | 0.9305    | 0.939     | 0.0359    | 0.0348    | 0.0337       | 0.0262    |
| 12      | 0       | 0       | 0.9651    | 0.9605    | 0.0179    | 0.023     | 0.017        | 0.0165    |

*Notes.* This table shows for each possible unique realization of the preference distribution the average probability of voting sincerely, strategically or for the third option, conditional on the value of the intermediate option. These values are computed using a tracing procedure (Turocy 2005, 2010) and reporting the outcome when  $\mu = 10^{-6}$ .



# 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<sup>rd</sup> 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<sup>nd</sup> 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. Pref-

erence 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.

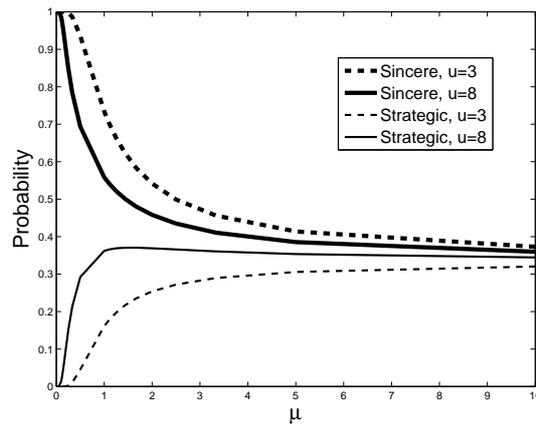
Knowing the own preference values the voter can update the probability distributions using Bayes' rule and use this to calculate the probability of being pivotal given others' strategies. Then, she can compute the expected payoff differences between voting for her best, second best or for the least preferred 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)<sup>1</sup> for the game without information. As in chapter 2, for the noise parameter  $\mu$  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).

---

<sup>1</sup>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).

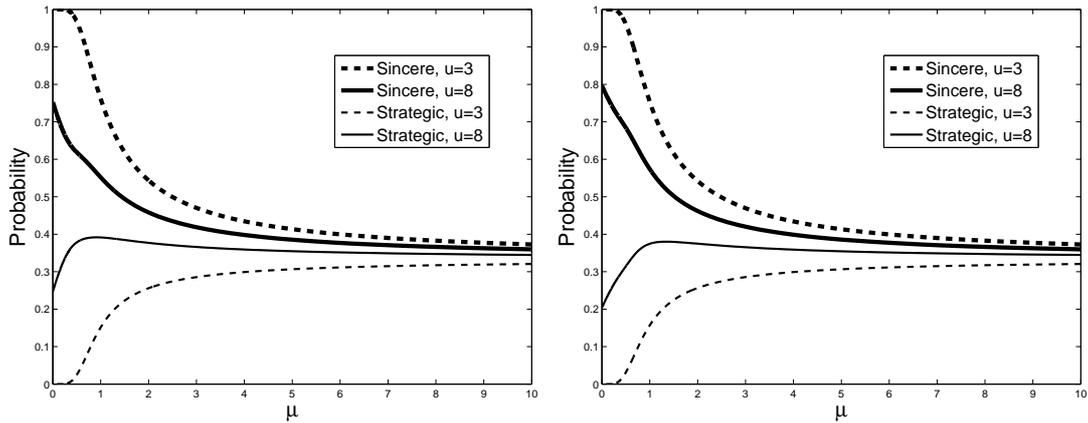
Recall that as  $\mu$  decreases behavior converges to a Bayes-Nash Equilibrium in which all voters vote sincerely. Therefore a full rational analysis would predict no difference in behavior when the value of the intermediate option varies. However, for almost all positive levels of  $\mu$ , the equilibrium 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)<sup>2</sup>. 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

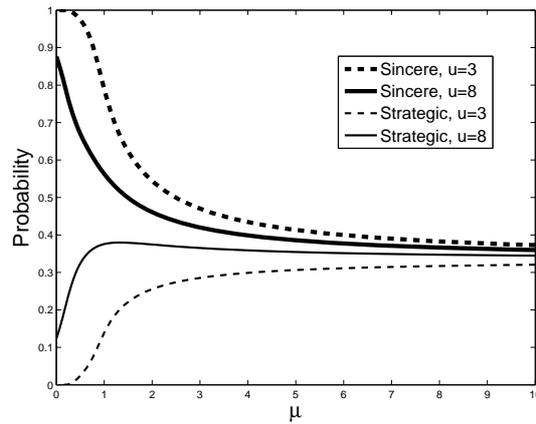
<sup>2</sup>Recall that this is also the *a priori* expected situation for the full information homogeneous case.

Figure 3.2: Multinomial Logit Correspondence (Informed Settings)



(a) Aggregate Information

(b) Full Information

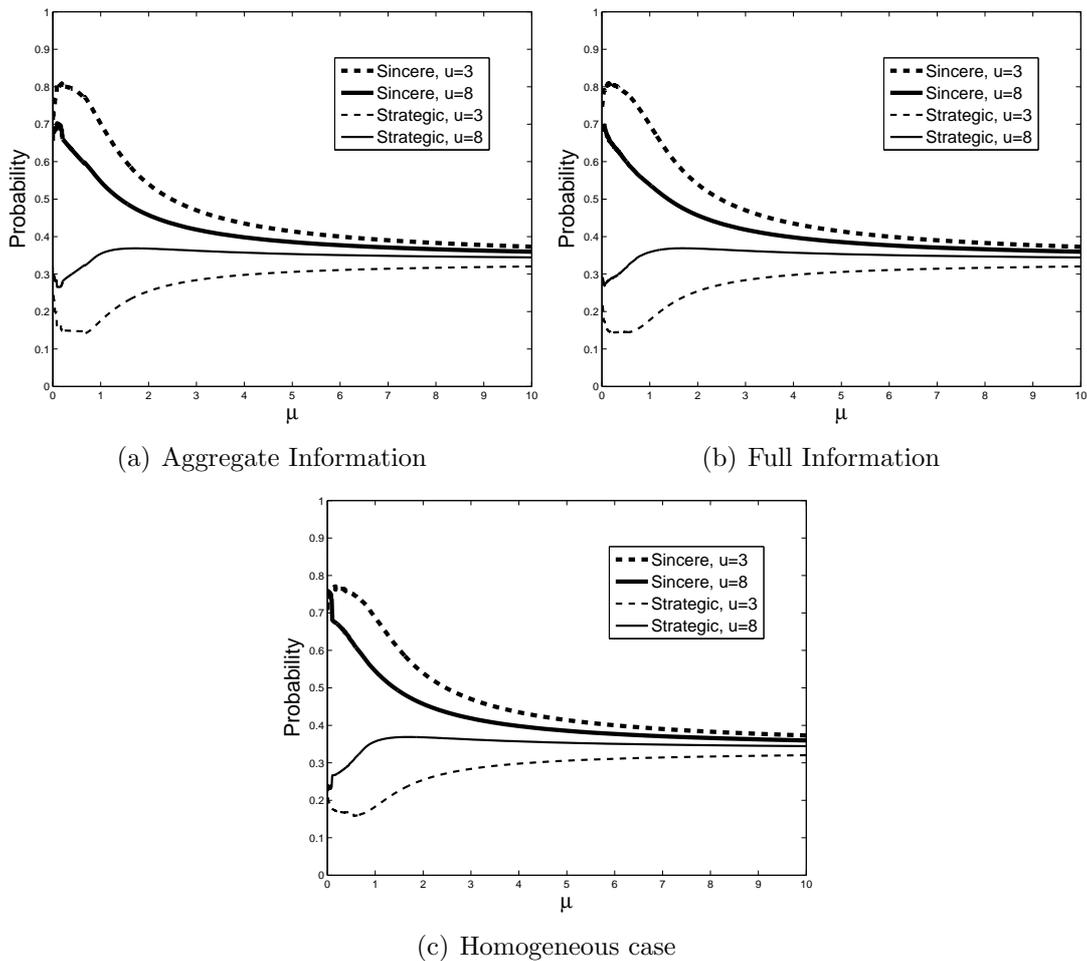


(c) Homogeneous case

*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)



*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, namely 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<sup>3</sup> and intensity of preferences. It includes the homogeneous cases for completeness<sup>4</sup>.

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<sup>nd</sup> under homogeneous preferences). Next, notice that as the literature suggests<sup>5</sup>, Rank 3<sup>rd</sup> 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<sup>rd</sup> 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<sup>nd</sup> 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.

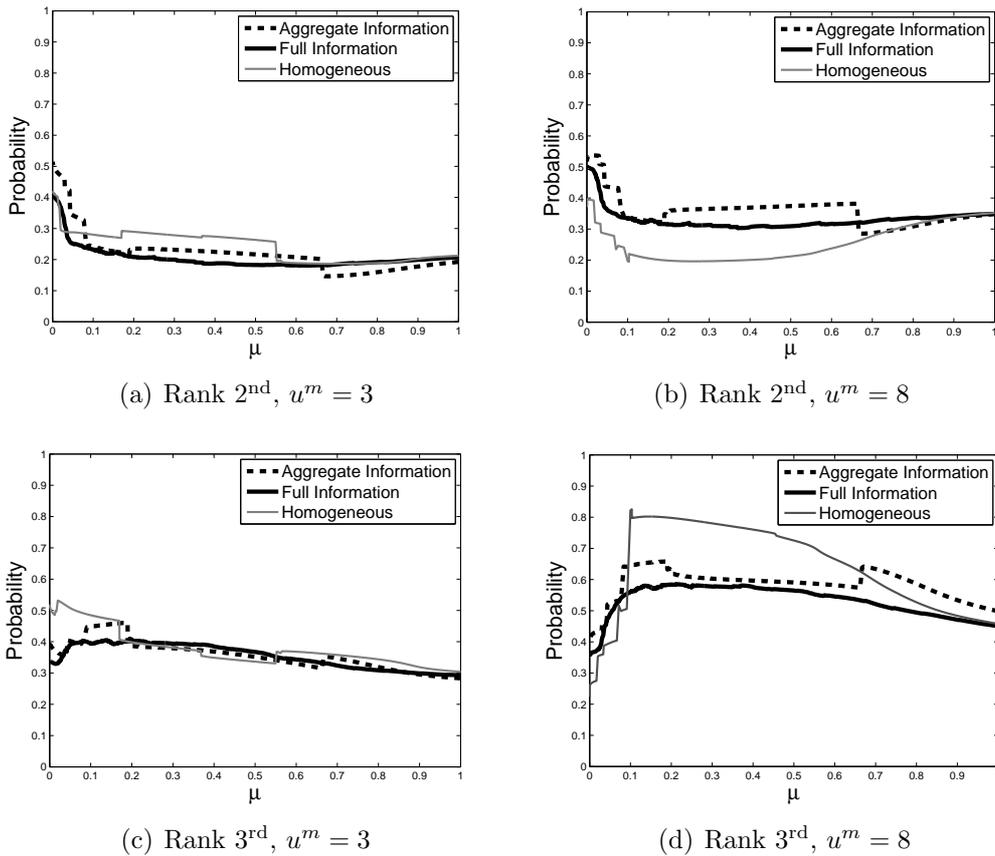
---

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

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

<sup>5</sup>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



*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<sup>nd</sup> 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<sup>rd</sup> voters vote more strategically than other Rank-Types (Figure 3.4).
7. Heterogeneity decreases the probability of strategic voting of Rank 3<sup>rd</sup> voters with high intermediate value (Figure 3.4).
8. Heterogeneity increases the probability of strategic voting of Rank 2<sup>nd</sup> 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<sup>6</sup> allowing for 17 independent elec-

<sup>6</sup>Subjects that participated in the homogeneous sessions were not allowed to take part in the new set

torates<sup>7</sup>. 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<sup>8</sup>.

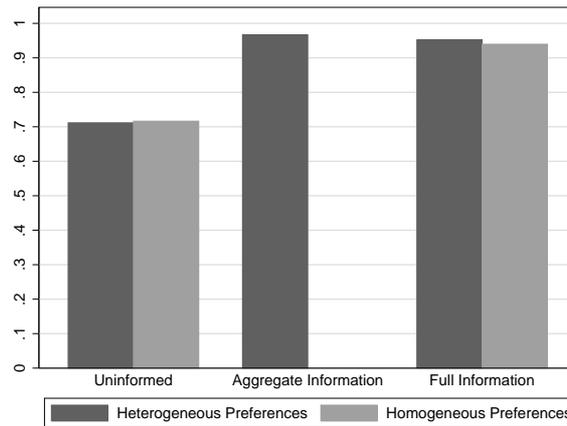
Notice that for the homogeneous treatments the addition of information increases the winning probability of the majoritarian candidate by 0.22 percentage points. To check for the effect of preference heterogeneity, we compare the homogeneous and heterogeneous treatments with no information and full information (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 sessions.

---

<sup>7</sup>There were 5 *uninformed* electorates, 6 electorates with *aggregate information* and 6 electorates with *full information*.

<sup>8</sup>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.

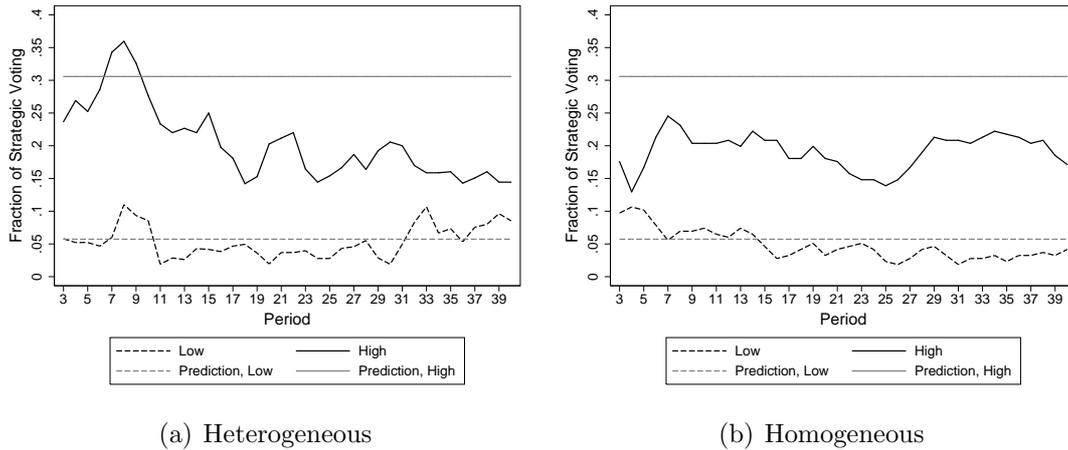
Next, we will consider in more detail the voting patterns in distinct treatments.

### 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



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.

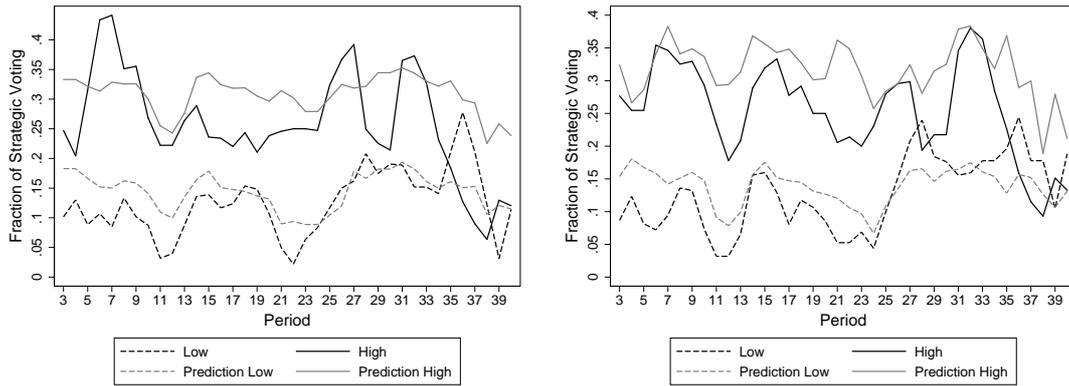
Also important to notice is that behavior is very much in line with the equilibrium predictions of the Quantal Response Equilibrium model. Observations for  $u^m = 3$  are close to the predicted level for both the homogeneous treatment and heterogeneous treatments for  $\mu = 0.55^9$ . For  $u^m = 8$ , 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-

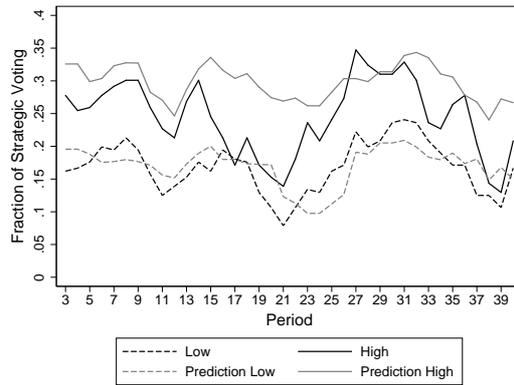
<sup>9</sup>This parameter value comes from a pilot maximum likelihood estimation of  $\mu$ . For reference check section 2.3.

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.

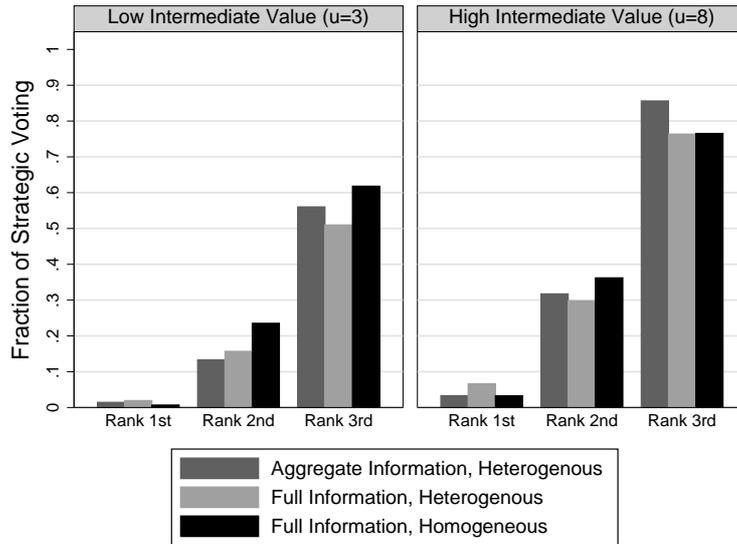
Finally, behavioral prediction 5 concerns the comparative static of strategic behavior in the uninformed treatments versus the informed treatments. As predicted for the heterogeneous treatments, this average is higher with information. The differences are statistically significant (for low intermediate 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<sup>rd</sup> voters are most likely to vote strategically. The differences are significant when comparing to both Rank 2<sup>nd</sup> and Rank 1<sup>st</sup> 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<sup>st</sup> 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<sup>nd</sup> voters and reduce it for Rank 3<sup>rd</sup> voters (behavioral predictions 7 and 8). The general result is, if any, a reduction in the strategic voting probability for Rank 2<sup>nd</sup> voters<sup>10</sup> and no reduction for Rank 3<sup>rd</sup> voters<sup>11</sup>. Moreover, with the exception of Rank 3<sup>rd</sup> 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<sup>rd</sup> 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.

<sup>10</sup>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,  $u = 8$ :  $p = 0.0771$ .

<sup>11</sup>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<sup>rd</sup> 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<sup>nd</sup> (against prediction) and Rank-3<sup>rd</sup> (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 hetero-

geneity 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 fol-

lowing:

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.

# Chapter 4

## Information and Economic Voting<sup>1</sup>

### 4.1 Introduction

During the 1992 U.S. presidential campaign, one of the key arguments by the Clinton campaign was that President George H. W. Bush had not handled the economy well. To that end, Clinton campaign strategist James Carville used a white board in the campaign headquarters to remind staffers to stay on message. The list read:

1. Change vs. more of the same
2. The economy, stupid
3. Don't forget health care

While economic conditions had surely mattered in previous elections, it was Carville's catch phrase that has inspired bumper stickers, political cartoons, and commentary over the past two decades and is likely to do so for many years to come. Of course, in any particular election, especially at the national level, there is a multitude of salient issues. Yet, whether there is a war or domestic social movement, whether the electorate is polarized or unified, the state of the economy is always a pertinent campaign issue to at least one of the major parties. However, while the idea that the economy matters now borders on conventional wisdom, the definitions of 'the economy' used both in popular and academic literature vary widely.

Following the "Responsibility Hypothesis" (e.g. Lewis-Beck & Paldam 2000), it is understood in the literature that voters hold the government responsible for 'the economy'. Two common interpretations tend to dominate the discussion. First are national economic conditions, namely whether the country is in a state of recession or expansion, with voters traditionally looking upon the former with disfavor. While any given leader can only have limited influence over growth or decline, responsibility for such conditions

---

<sup>1</sup>This chapter is based on joint work with Jon Rogers (Florida State University).

is often attributed to officials, particularly presidents and/or prime ministers. The second common interpretation of ‘the economy’ is that voters reward or punish leaders for personal financial circumstances. The choices of politicians rarely result in the direct gain or loss of employment for an individual, but it would not be a stretch to categorize the unemployed as frustrated and to speculate that such frustration would be directed at elected officials.

Still, there are many other potential economic issues to be considered. For one, economic conditions are not uniformly distributed across geographic areas. Regional or local declines could have a similar effect as a national recession. As an example, while much of the United States experienced relatively strong growth during the 1990’s and early 2000’s, the economies of the traditional steel and manufacturing regions of the Midwest (including cities like Detroit and Cleveland) declined along with their industries. Thus, while voters in much of the U.S. may have been pleased with economic conditions during the 1996 presidential campaign, those in regions directly harmed by expanded free trade policies may have been far less so. For these voters, local economic conditions may have outweighed national level interests.

Economic voting has received much academic consideration as well, and while a formal literature review is left for the next section, suffice it to say that there is no consensus on the extent to and level at which the economy matters in vote choice. While the topic has been frequently studied, observational studies are limited in their explanatory power, due to the complexity of national level campaigns. The solution we offer is to take the question into the laboratory. To this end, we offer what we believe to be the first laboratory experiment to investigate what level of economic information voters seek and how that information translates into vote choice. Our experimental data provide evidence that even where egotropic (self-interested) motives prevail, non-trivial levels of sociotropic behavior persist. The evidence also points out that voters seek mostly national level information and once the complexity of their environment increases, they seek less information and rely on simpler strategies. The data indicate that, relatively, richer voters react more to national level indicators while poorer voters react more to the community level. Finally, we observe voters voicing more ‘extreme’ social preferences in approval than in voting rounds.

After the literature review in the next section, we develop a theoretical background on the connection between economic voting and information search (section 4.3). Section 4.4 presents the experimental design, which is followed by a set of predictions (section 4.5) to be tested. Sections 4.6 and 4.7 present and then discuss the results of our experiment on economic voting.

## 4.2 Literature

In the long and storied study of voting, economic voting has taken on several different meanings. These include pocketbook (egotropic) voting and sociotropic; each can occur in either a retrospective or prospective manner.

Egotropic voting refers to a voter's own economic experience while sociotropic voting refers to the rewarding or punishing of politicians based on the performance of the macro economy (Nannestad & Paldam 1994). From the perspective of egotropic voting, voters attribute improvements in personal finances (Fiorina 1978), loss of employment (or inability to find a job) (Grafstein 2005), or outstanding debt problems to the current administration. As may seem obvious, improved conditions are associated with greater levels of support for leaders. At the opposite end of the spectrum, a sociotropic voting perspective would argue that voters prefer politicians under whose leadership the nation enjoys higher rates of economic growth (Lewis-Beck & Rice 1984, Lewis-Beck & Tien 1996), lower rates of inflation (Norpoth 1996), lower consumer prices (Arcelus & Meltzer 1975, Lepper 1974), or an otherwise stronger economy according to leading economic indicators (Wlezien & Erikson 1996). Kinder & Kiewiet (1979) further argue that voters may have preconceptions as to which party is better suited to handle national economic problems. Whatever the problems in question may be, the argument is sociotropic in nature.

As pointed out by Nannestad & Paldam (1994), the voting-popularity function literature also struggles with the egotropic vs. sociotropic debate in its goal to build micro foundations. The macro voting-popularity function is an aggregation of the micro voting-popularity functions. Aggregating the micro functions into the macro under an assumption of egotropic voting requires a different process than under sociotropic voting. As the authors explain, assuming egotropic voting, this aggregation should be done in the same way as macro aggregations are done from individual variables. However, under sociotropic voting, this aggregation requires an extra layer of averaging, namely the perception of each individual about the macro economy. The voting-popularity function usually takes two main variables, one reflecting unemployment and another reflecting growth/inflation. Nannestad & Paldam (1994) highlight that whereas the individual experience of growth/inflation should be very similar to the macro experience, since these variables are *per se* an average, the individual experience of unemployment is certainly not. Thus the assumption of egotropic or sociotropic voting would lead to different versions of the macro voting-popularity function. The authors also highlight how this interacts with the retrospective (past experiences) or prospective (expectations) assumptions. While the previous distinction is clear under retrospective voting, in prospective voting past experience can only enter as an indication of the future, and thus the distinction between an egotropic or sociotropic aggregation becomes less clear and more complex.

It is also not clear how voters perceive the national economic conditions. Duch, Palmer & Anderson (2000) argue that perceptions of the national economy are conditioned by local conditions, personal finances, political attitudes, and demographics. That is, voters believe that they are voting sociotropically, but have a biased perception of the true state of the macro economy. As such, there is really a mix of both sociotropic and egotropic voting and one can not truly be isolated from the other. Hetherington (1996) finds that negative media coverage influenced voters' retrospective assessment of the macro economy prior to the 1992 election.

Even accepting an understanding of what is meant by 'the economy', there is no consensus about how it will affect a voter's choice. For example, some see an asymmetry between the opposition and those in power. Duch & Stevenson (2011) find, among other things, that opposition groups can successfully hurt public perception of economic conditions, but the incumbent cannot do the opposite. Bloom & Price (1975) argue that congressional members of the president's party are punished during economic bad times, but not rewarded during good times. Further, there is disagreement as to whether voters are rewarding presidents for past behavior or attempting to forecast future economic conditions. As MacKuen, Erikson & Stimson (1992) termed it, are voters 'peasants,' voting retrospectively or 'bankers' voting prospectively? These authors find that the electorate votes as if anticipating future economic events and raises or lowers its approval preemptively. Swank (1990) points out that bad economic conditions can turn out to be good for leaders if voters perceive them as more capable of handling the problems than the the opponents.

In a sophisticated treatment of economic voting, Gomez and Wilson (2001, 2007) assert a theory of heterogeneous attribution. In their theory, low sophisticates assume that the national economy is under the control of the president. They attribute both good and bad economic conditions to the performance of the president and reward/punish accordingly. Thus low sophisticates vote sociotropically. High sophisticates, in contrast, understand that the economy is incredibly complex and that there is little connection between the president's actions and the national economy. These high sophisticates do however, recognize connections between policies set by the national government and personal economic circumstances. Thus high sophisticates are more likely to vote egotropically.

While the economic voting literature has generally considered sociotropic and egotropic motives, there is an additional possibility, often addressed in the legislative politics literature. This is a preference for pork barrel (or redistributive) policies (Lowi 1964). Traditionally, electorally motivated legislators responsible to a particular district are argued to engage in credit claiming (Mayhew 1974) in order to reap the rewards of 'bringing home the bacon.' Yet, there may be reason to believe that the executive, not just local representative, receives credit or blame for local conditions. It has been shown that citizens have certain expectations as to a federal government response to natural disasters

(Chamlee-Wright 2010) and blame for a lack of short or long term (local) economic recovery may be attributed to the president, rather than only to the relevant legislator(s). For example, as mentioned earlier, the manufacturing areas of the Midwestern United States suffered higher unemployment after the ratification of the North American Free Trade Agreement (NAFTA) than other U.S. regions. As this is likely to have reduced approval rates among those who lost their jobs, this may also have affected the opinions of those who saw colleagues, friends, and neighbors harmed by the policy. Thus a degree of empathy, in-group solidarity, or preferences for community strength may result in a level of economic voting that is neither egotropic nor sociotropic, but ‘communitropic’.

Though the question of the influence of economic conditions on vote choice has received much attention, little has been resolved. It is now generally considered to be common knowledge that the economy matters, but no consensus exists regarding what level of information (personal, community, or national) is most relevant, if there is heterogeneity in type of economic voting across various circumstances, and whether any such voting is occurring retrospectively or prospectively. While these are all important questions, a complete coverage is beyond the scope of this chapter. We will focus on one particular issue, i.e., the question of what level of information is most relevant.

Part of the trouble in the literature may be that all previous studies have been conducted using observational data. While the endeavor to study behavior in actual elections is laudable, campaigns are long, complex, and revolve around myriad issues. The economy is only one of many (allegedly) salient campaign issues. Further, there are many potential indicators of economic conditions at each level: employment, income, inflation, GDP, inequality, debt, and so forth. A finding or non-finding may be entirely contingent upon which measure is employed in the analysis and at what point in the campaign.

As a further complication, any claim of economic voting at the various levels assumes that voters are aware of the state of the economy. The key distinction here is that voters must be aware of the true state and vote accordingly, rather than based on biased perceptions of economic conditions. Duch, Palmer & Anderson (2000) find that perceptions of the state of the national economy are conditioned by a number of factors, including political attitudes. One could argue that voters with such biased attitudes are not attempting to reward or punish incumbents for economic performance, but rather have already decided upon a vote choice and are attempting to justify their preference. In this sense, it is difficult to gage the actual effect of the economy.

Due to the complexities of modern presidential campaigns which almost certainly lead to omitted variable bias in observational studies, it is useful to turn to laboratory experimentation in order to isolate a society from all considerations except those of economic conditions at the various levels. This is the contribution made in the present chapter. In a setting without parties, personalities, scandals, or social, foreign, and defense policies, it is possible to directly examine what level of economic information is relevant in vote

choice. Indeed only in the laboratory, where all else is controlled, is it possible to have confidence in causation.

It is also important to take account of the information voters actively seek in the course of elections. Lau & Redlawsk (2006), in their use of dynamic information boards, took an important step towards helping us understand information processing during political campaigns. While these experiments were carried out with hypothetical candidates and non-incentivized subjects, they do show subjects choosing what information they wish to view. Nevertheless, economic policies were only a small subset of the potentially salient issues in determining vote choice. In order to test theories of economic voting in as clean an environment as possible, further isolation is required.

### 4.3 Economic Voting and Information Search

Assuming, for a moment, that the economy truly does matter in determining vote choice, what level of information is relevant and what causes a voter to seek information at one level as opposed to another? That is, once all social and political considerations are controlled for and only economic factors remain, what causes economic conditions at the personal, community, or national level to become most salient in approval decisions and vote choice? To gain purchase on economic voting, we must understand how the actions of politicians affect the economy.

While in the voting-popularity function literature (for a review see, e.g., Nannestad & Paldam 1994), unemployment, along with growth and inflation are the most important economic variables, in a more basic model, politicians choose two things that directly affect these variable as well as other economic conditions: tax rates and redistributive policies. Taxes directly remove income from all voters and redistributive policies (e.g. welfare programs, public works, and pork barrel programs) directly benefit a subset of voters. Effectively, politicians are choosing how much to tax society and to whom tax revenues should be reallocated.

Voters, on the other hand, are not homogeneous. Some possess greater financial resources than others. Typically, voter income is not distributed uniformly within or between communities. Some areas have a high concentration of poor voters and only a few rich voters. Others have a more even distribution, while relatively few have a high concentration of rich voters, with few poor voters. Voters in these different areas may prefer distinct policies.

We first consider egotropic considerations, i.e., voters that care only about their own direct economic welfare. In order to evaluate a politician's performance at this level, the voter needs only to know her net benefits from the policies (how much better or worse off she is, after taxation and redistribution). For example, although typically poor (rich) voters tend to support higher (lower) taxes, under purely personal considerations, it does

not matter to a voter if a change in welfare comes primarily from changes in taxation or redistribution, nor the effects of these policy changes on other voters and/or communities in the nation.

Moving to the community level, beyond personal considerations, some voters may prefer policies that provide the greatest net benefit to members of their community, even if they personally do not receive the greatest possible benefits. For example, a single wealthy voter in a predominantly low income community may tolerate higher taxes, knowing that her neighbors will benefit or that the community will otherwise improve. As an example, while a rich voter might not use public transit, she might want the government to provide it, to the benefit of her many neighbors who would. She could not and would not provide public transit by herself, but she accepts higher taxes because everyone pays them and her own contribution to the public good is a relatively small portion of the total. Such pro-social preferences may induce voters to vote in a manner contrary to their personal incentives, to the benefit of their neighbors. This ‘communitropic’ voting would require knowledge of how much better or worse off a set of policies makes the average member of the community. At this level however, the pro-social behavior does not extend beyond the own community. A purely communitropic voter cares only about the welfare of her own community, not directly for her own or for the welfare of the nation.

At the ‘highest’ level is the potential for sociotropic voting, where voters care not about their personal conditions or those of neighbors, but rather about what is best for the country as a whole. Such voters believe that their community is just one of many and that the welfare of the country is more important than what matters to a particular community or individual. Certain policies tend to be associated with stronger economic growth, which is good for all. While such policies may not be the best for a particular individual or community, they are good for the country as a whole and do the greatest good for the greatest number of people. In this sense, the sociotropic voter would need to know how much better or worse off the average voter is made by a set of policies.

It is one thing to say that egotropic, communitropic, and sociotropic voting reflect the behavior of latent classes of voter. However, what induces such behavior and where might we see voters seeking certain types of information? If all voters were equally wealthy, then all would be equally affected by taxes. Assuming that politicians can target only communities and not individual voters, this would make egotropic and communitropic voting equivalent and almost impossible to differentiate. However, society is not homogeneous. All communities, no matter how similar neighbors are to one another, have some degree of heterogeneity. There is also a significant degree of heterogeneity between communities. This inter- and intra-community heterogeneity may explain preferences across the various levels and therefore also the degree and type of information search.

As the income distribution within a community becomes more heterogeneous, an individual voter’s personal financial circumstances tell her less and less about the conditions

faced by her neighbors. In the purely homogeneous case, if she is pleased with her finances, then she could assume that her compatriots are equally well off. Notwithstanding, where there is a greater degree of dispersion, voters would need a greater amount of information if they are to assess how well or badly off neighbors are made by a set of policies.

In a similar respect, where communities are precisely equal to one another, economic conditions in one community are informative about conditions in other communities, but not in the same way as with intra-community homogeneity. If government policies are having a negative effect in one community, but a positive effect overall, then they are benefiting some other set of communities. Where there is some degree of inter-community heterogeneity, voters would need to seek much information in order to make this sort of assessment. However, in a very complex environment, attaining and processing such information would be quite difficult, suggesting that a voter might instead revert to a more simple strategy. Since the simplest strategy is based on the most convenient information (personal circumstances), high degrees of heterogeneity might lead to greater levels of egotropic voting or simply uninformed voting. In the end, whether this occurs is an empirical question that we aim at clarifying on further sections of this chapter.

This raises, however, another interesting point. There is a meaningful difference between uninformed voting and informed egotropic voting. Some voters will only care about the end result of government policies. Are they net beneficiaries of the policies or not? They do not need to know what exactly the government is doing to know whether or not they are happy about their personal conditions. On the other hand, informed egotropic voters care not only about their net benefits or losses, but also about their potential benefits or losses. Such voters need a great deal of information, not only about national policies, but also about how the government is treating other communities. Even if a voter is a net beneficiary of a set of policies, she might receive fewer benefits than members of other communities, and become jealous. The welfare of other communities might become a point of reference against which to compare her own welfare.

For some voters, engaging in zero information search may be rational. Those unlikely to benefit from any set of policies have less incentive to expend time and effort seeking information. But with observational studies, there is no way to determine with any degree of certainty how well informed any individual is about economic conditions, how much information was sought, and what information was attained freely (i.e., information attained through every day life, like whether or not one has a job). Surveys, which generally seek to study many political concepts, are logically limited in the number of questions that can be asked. For that reason, it is useful to seek the control offered by a laboratory environment, the design of which we explain in the following section. We then combine the theoretical considerations discussed here with the experimental design and present specific predictions.

## 4.4 Experimental Design

The experimental design creates a stylized democratic society, capturing the essential elements introduced in the previous sections. It consists of 3 communities of 5 voters each and 2 politicians. Voters are randomly assigned to a community and endowment, with both remaining fixed throughout the experiment. Endowments can be low (100 ECUs) or high (500 ECUs). This composition allows for enough variation within and between communities allowing us to verify the impact of income distribution on the search patterns for information. Initially, one of the politicians is randomly selected to be in office and the other is assigned to be a candidate seeking to replace the incumbent. The incumbent receives a fixed salary of 500 ECUs while the candidate receives a salary of 100 ECUs. Experimental points are converted at the rate of 500 ECUs per US\$.

The incumbent's initial task is to select a tax rate. Due to the public good nature of government expenditure there is an efficiency gain,  $g$ . However, due to other aspects such as deadweight losses and government inefficiencies there is also an efficiency loss,  $l$ . Specifically, tax revenues are given by  $TaxRevenue = (w * t) * [(1 + g) - t * l]$ , where  $w$  is the nation's aggregate endowment (i.e., tax base) and  $t$  the tax rate. Tax revenues are thus generated following a format similar to a Laffer Curve. In the experimental design  $g$  is set to 0.40, implying a 40% efficiency gain over the collected taxes, and  $l$  is set to 1, implying an inefficiency effect that increases in proportion to the increase in the tax rate. Table 4.1 illustrate the tax revenue functions for the various treatments, to be described in the following subsection. Note that at 20% the net welfare is maximized and at 40% it breaks even. At 70% the politician maximizes the tax revenue under her control.

The incumbent must then divide the tax revenue among the 3 communities. Within each community, the amount provided is shared equally among its members. The incumbent's plan is (partially) seen and implemented.

The candidate's task is to simultaneously present a hypothetical alternative plan: a tax rate and a division proposal. This hypothetical plan is (partially) seen but not implemented.

Every third period, there is an election decided by majority vote. The newly elected politician comes into office and the losing one becomes the candidate. In the periods without election there is an approval survey on the job performance of the incumbent. Results are always publicly announced. There are sixteen periods, with the exact number of periods not announced, in order to avoid end-game effects.

The different levels of economic information that could influence voting behavior are the individual, the community and the national levels. Understanding which information voters look for in order to support their voting and approval decision is the main goal of this chapter. In order to directly observe which levels are relevant for a given subject, information is provided in a costly way. This choice is motivated by the following

Table 4.1: Impact of Tax Rates Across Treatments

| Tax Rate   | Tax Burden  | Tax Revenue | Difference  |
|------------|-------------|-------------|-------------|
| 0%         | 0           | 0           | 0           |
| 10%        | 390         | 507         | 117         |
| <b>20%</b> | <b>780</b>  | <b>936</b>  | <b>156</b>  |
| 30%        | 1170        | 1287        | 117         |
| <b>40%</b> | <b>1560</b> | <b>1560</b> | <b>0</b>    |
| 50%        | 1950        | 1755        | -195        |
| 60%        | 2340        | 1872        | -468        |
| <b>70%</b> | <b>2730</b> | <b>1911</b> | <b>-819</b> |
| 80%        | 3120        | 1872        | -1248       |
| 90%        | 3510        | 1755        | -1755       |
| 100%       | 3900        | 1560        | -2340       |

(a) Treatments: *Baseline, Clustered, and Heterogeneous*

| Tax Rate   | Tax Burden  | Tax Revenue | Difference  |
|------------|-------------|-------------|-------------|
| 0%         | 0           | 0           | 0           |
| 10%        | 270         | 351         | 81          |
| <b>20%</b> | <b>540</b>  | <b>648</b>  | <b>108</b>  |
| 30%        | 810         | 891         | 81          |
| <b>40%</b> | <b>1080</b> | <b>1080</b> | <b>0</b>    |
| 50%        | 1350        | 1215        | -135        |
| 60%        | 1620        | 1296        | -324        |
| <b>70%</b> | <b>1890</b> | <b>1323</b> | <b>-567</b> |
| 80%        | 2160        | 1296        | -864        |
| 90%        | 2430        | 1215        | -1215       |
| 100%       | 2700        | 1080        | -1620       |

(b) Treatment: *Poor*

*Notes.* Tables show the tax rates and how they relate to values of Tax Burden and Revenue in the different treatments (cf. section 4.4.1). The fourth column shows the difference between burden and revenue, where positive values reflect a net benefit to society. Bold highlights the optimal level (20%), the break-even level (40%) and the maximum revenue level (70%).

factors. First, it provides a direct mechanism to experimentally observe the information requested by subjects. Second, the politicians policies are likely to be functions of the information provided to voters. By providing voters with the same available information across treatments, we avoid confounding effects of (free) information with different policies and (initial) economic conditions. Finally, since demand for information has been shown to have a discontinuity at zero (see, e.g., Schram & Sonnemans 2011), subjects face a small but positive cost, set to 2 ECUs per item. We believe this induces a more careful consideration of the pieces of information, allowing us to better understand their search patterns.

Voters are always informed about their endowment and final payoff. They are also informed about the initial economic conditions of each community and whole nation. They can, additionally purchase information about the tax rate and on the welfare change of their own community, other communities and the whole nation. Voters can see the same information (including purchased information) for both politicians. That means, if a voter purchases a piece of information, she will have access to that piece of information about both politicians. Politicians are also informed about initial economic conditions. Additionally, they are informed about average welfare change caused by their policy for the low and high endowed voters in each community separately and for the average voter in a given community and nation. They can also see the past policy decisions of the other politician.

A full copy of the instructions can be found in Appendix 4.A. After reading the instructions, understanding of the experimental environment, as described in the previous paragraphs, was ensured by requiring subjects to take a quiz. Incorrect answers were met by an automatic prompt, informing the subject of the error. After the experiment was over and before receiving their payment, subjects were asked to provide an answer to the question “Can you describe how you made your decisions and/or used the information provided?”.

All experimental sessions were run between November 2010 and February 2011 in the Experimental Social Sciences Cluster (xs/fs) laboratory at Florida State University<sup>2</sup>. For the sixteen sessions, a total of 272 subjects were recruited (17 per session) via the ORSEE (Greiner 2004) online recruiting system. All subjects who arrived on time, regardless of whether or not they were used, were paid a \$10 show up fee. Total per subject payments averaged \$18.07 and sessions typically lasted between 75 and 90 minutes. The experiment was programmed and conducted with the software z-Tree (Fischbacher 2007).

---

<sup>2</sup>Information about the laboratory and members of the cluster can be found at <http://www.xsfs.fsu.edu>

### 4.4.1 Treatments

Since the income distribution is expected to affect the demand for information (cf. section 4.3), the treatment variable is the income compositions of the three communities. Our baseline composition is the homogeneous income distribution in which each community contains 3 low endowed and 2 high endowed voters. We refer to this distribution as *baseline*: (3,2); (3,2); (3,2). This presents a total of 9 low endowed and 6 high endowed voters, and thus a total national endowment of 3900 ECUs.

In order to test the effect of the *intra*-community heterogeneity in the information decision while keeping the national distribution constant, we introduce the income distribution *clustered*: (1,4); (4,1); (4,1). This distribution differs from the baseline, however, also on the degree of *inter*-community heterogeneity. To disentangle these effects, we look additionally at the distribution *poor*: (4,1); (4,1); (4,1), which has the same degree of inter-community heterogeneity as the *baseline* (i.e., homogeneous) and the same degree of intra-community heterogeneity as *clustered*. This comes at the cost of changing the national endowment and national income distribution (now 12 low endowed and 3 high endowed voters, and thus a national endowment of 2700 ECUs).

In order to complete the picture a final income distribution is needed: *heterogeneous*: (2,3); (3,2); (4,1). This distribution has the same national endowment as *baseline*, with a higher degree of inter community heterogeneity.

Table 4.2 summarizes the design highlighting how the different distributions can be compared.

Table 4.2: Experimental Treatments

| Distribution           | National Distribution    | Intra-Community Heterogeneity | Inter-Community Heterogeneity |
|------------------------|--------------------------|-------------------------------|-------------------------------|
| <i>baseline</i> :      | {(3, 2), (3, 2), (3, 2)} | 9,6                           | base                          |
| <i>clustered</i> :     | {(1, 4), (4, 1), (4, 1)} | 9,6                           | increased                     |
| <i>poor</i> :          | {(4, 1), (4, 1), (4, 1)} | 12,3                          | base                          |
| <i>heterogeneous</i> : | {(2, 3), (3, 2), (4, 1)} | 9,6                           | (3,2): base; (4,1): increased |

## 4.5 Predictions

Based on the theories discussed in sections 4.2 and 4.3 and the experimental environment, it is possible to make predictions as to what will be observed in the laboratory. What we predict depends, however, on both the preferences of voters and on the beliefs of politicians regarding those preferences. Since the preferences of voters are what we seek to examine in this chapter, making clear predictions becomes difficult. So in an attempt

at clarity, we distinguish between two sets of predictions, one assuming that voters have selfish preferences, the other allowing for other-regarding preferences. The set assuming selfish preferences provides the null hypotheses while the alternatives are derived assuming other-regarding preferences.

#### 4.5.1 Case 1: Pure self interest

First, assume that voters are purely self interested. That is, they care only about their personal net benefits/losses from the policies set by the incumbent. If that is the case, information purchase will be close to 0 in all treatments and across all types because voters know their own income without having to purchase information. Moreover, under pure self interest there should be no treatment effects in information purchase or voting and approval strategies. Thus, changes in the income distribution within and between communities should have no effect on information search and voters will vote and approve whichever politician gives them the highest net income. Additionally, if politicians know that voters are self-interested they will target two communities and try simply to maximize vote share without any distributional concerns, since these cannot possibly be known by uninformed voters.

This leads to a set of predictions, that will serve as null hypotheses for the tests to be conducted when analyzing the results.

**P1:** Politicians will chose the maximum tax revenue tax rate (70%).

**P2:** Politicians will target two communities.

**P3:** Information purchase will be 0.

**P4:** There will be no treatment effects, i.e., the information purchase level will be indistinguishable across treatments.

**P5:** Voters' support will not be influenced by community, national nor distributional concerns.

#### 4.5.2 Case 2: Other-regarding preferences

To derive alternative predictions assume some degree of other-regarding preferences among voters. That is, voters care not only about their own personal welfare, but also about the welfare of neighbors and members of other communities. First of all, information purchase must be higher than in the case of purely self-interested voters because other-regarding voters need information about policies' welfare consequences for other voters. Therefore we predict significantly positive level of information purchase. How this increase takes place, however, depends on whether voters care about the whole nation and/or

about the community level. If voters have mainly national concerns we should expect no difference across treatments, with most of the information demand about national level indicators. If voters have specific community level concerns, more information is needed as income distribution heterogeneity increases. This follows from the fact that to better understand how the policies affect different communities, more information must be acquired. Finally, community and/or national concerns must also be reflected in voting and approval behavior, i.e., voters will support politicians that provide higher income for the nation and/or communities.

If politicians anticipate this voter behavior, they must also act differently than in the self-interested case. We assume here national and distributional concerns and predict behavior anticipating only own community level concerns to be somewhere in between these and behavior anticipating pure self interest. First of all tax rate will be set at or near the optimal tax rate of 20%, since this is where national welfare is maximized. Further, the tax revenue will be distributed in a relatively even manner across communities, with any particular community rarely bearing more than its fair share of the burden. That is, where communities begin as equal to one another, they will remain more or less equal after taxation and redistribution.

Following this reasoning, we present the following set of alternative predictions:

**P1<sub>A</sub>**: Politicians will choose the ‘optimal’ tax rate (20%).

**P2<sub>A</sub>**: Politicians will redistribute revenue proportionally in all treatments.

**P3<sub>A</sub>**: Information purchase will be significantly higher than 0.

**P4<sub>A</sub>**: Information purchase will increase as inequalities within and between communities increase. Specifically, information purchase will increase in the following order: *baseline, poor, clustered, heterogeneous*.

**P5<sub>A</sub>**: Voters’ support will be influenced by community, national and distributional concerns.

## 4.6 Results

Since the focus of this chapter is the behavior of voters, the central analysis will focus on their choices. We start this section, however, by providing a description of the politicians’ behavior.

### 4.6.1 Politicians’ Behavior

Table 4.3 shows the average tax rate chosen by politicians while incumbent or candidates, by treatment and in total. As it illustrates, both incumbent and candidate select, on

average, a tax rate close to the optimal (20%). As for redistributive policies, figure 4.1 shows triplots of the percentage of the after tax national endowment given to each community. This shows that politicians structure tax returns such that they do not heavily modify the initial distributions. This is revealed by the clustering of points near the center of the triangle. Combined, this suggests that differences between the incumbent and candidate are more about specific values than about the structure of the policies. If politicians are electorally motivated (Mayhew 1974, Fenno 1978), then this behavior would be consistent with expecting voters to behave in line with other-regarding preferences as presented in the previous section. The data thus reject predictions P1 and P2 in favor of P1<sub>A</sub> and P2<sub>A</sub>, respectively<sup>3</sup>.

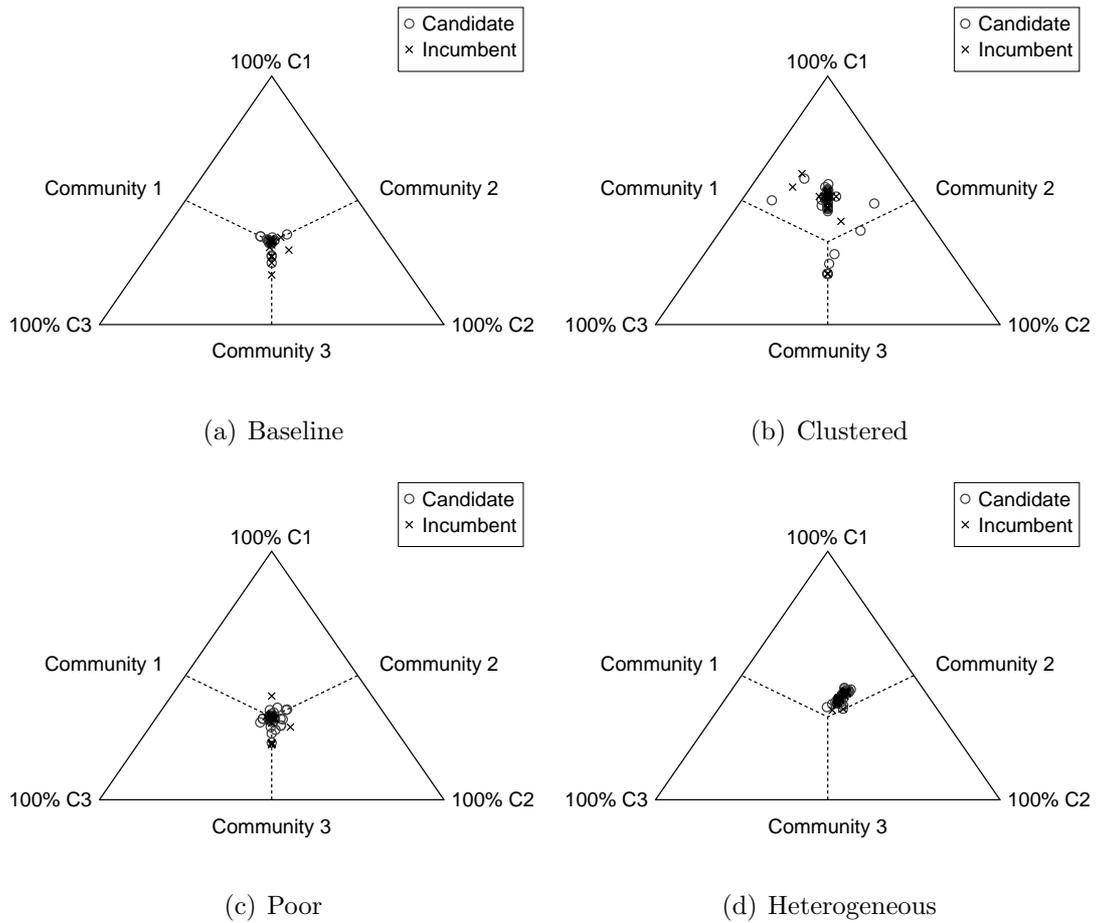
Table 4.3: Politicians' Average Choice

| <b>Treatment</b>     | <b>Tax Rate</b> |
|----------------------|-----------------|
| <b>Baseline</b>      |                 |
| Incumbent            | 23.75           |
| Candidate            | 21.72           |
| <b>Clustered</b>     |                 |
| Incumbent            | 27.19           |
| Candidate            | 30.31           |
| <b>Poor</b>          |                 |
| Incumbent            | 24.38           |
| Candidate            | 27.81           |
| <b>Heterogeneous</b> |                 |
| Incumbent            | 22.97           |
| Candidate            | 23.59           |
| <b>Total</b>         |                 |
| Incumbent            | 24.57           |
| Candidate            | 25.86           |

*Notes.* The second column shows the average tax rate chosen by the Incumbent and Candidate. The average is across all rounds and groups within each treatment.

<sup>3</sup>Using average behavior per electorate, t-tests reject the null hypothesis that the tax rate is 70% both for the incumbent and candidate ( $p \leq 0.01$ ,  $N = 16$ ). Likewise, they can only marginally reject that the hypothesized value is 20% ( $p = 0.0534$ ,  $N = 16$  for the incumbent and  $p = 0.0150$ ,  $N = 16$  for the candidate). Regarding redistributive policies, the average standard deviation of the fractions for each community is 0.0645 (with a 95% CI of [0.0318; .0971]) for the incumbent and 0.0638 (with a 95% CI of [0.0309; 0.0967]) for the candidate. Notice that a policy in line with targeting (on the limit, 50% for a community, 50% for another and 0% for the remaining one), would result in a standard deviation of 0.2886

Figure 4.1: Politicians' After Policy Dispersion



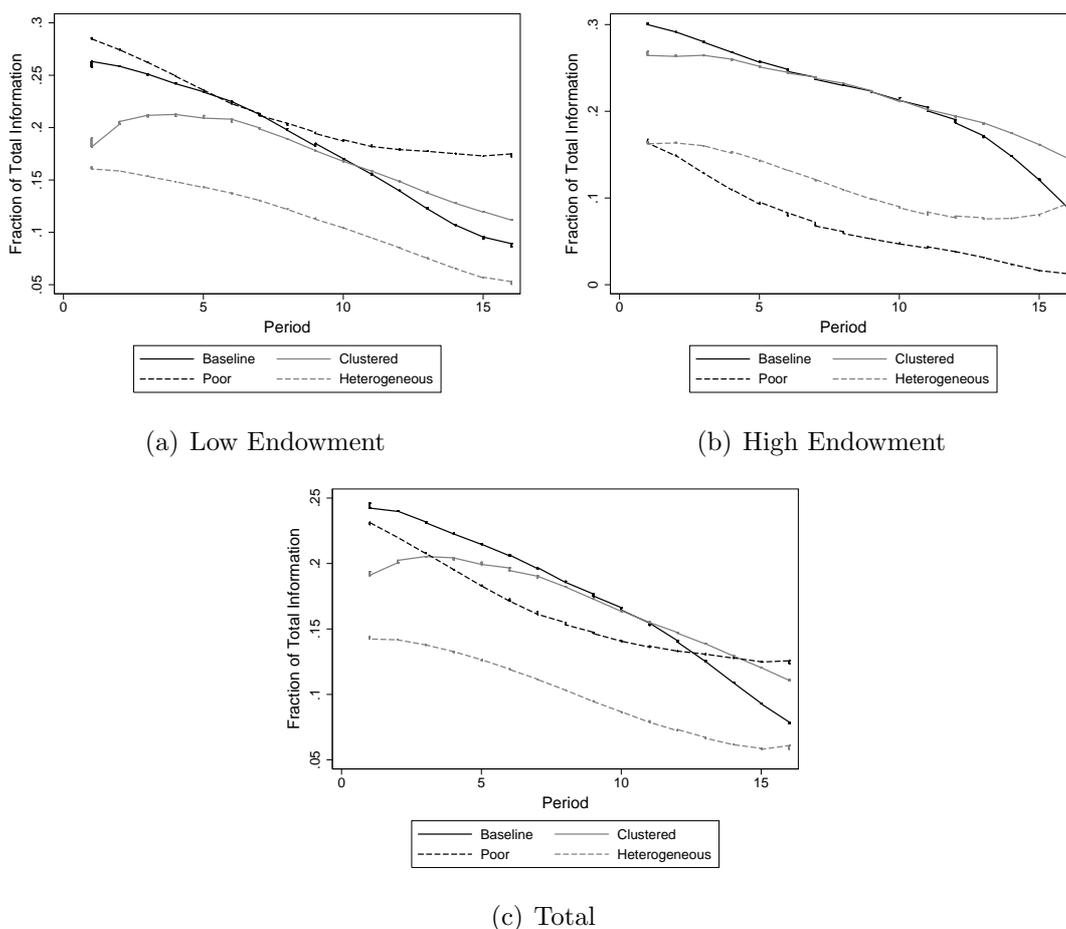
*Notes.* Triplots show the percentage of the after tax national endowment allocated by politicians (either incumbent or candidate) to each community. Each panel shows data from all rounds in a given treatment (cf. section 4.4.1). The triplot is an equilateral triangle in which the top, bottom right and bottom left corners indicate an allocation of 100% to communities 1, 2 and 3, respectively. The 'Y' in the center divides the triangle into regions in which two communities receive the same percentage, with the crossing of the 3 lines indicating an equal split (i.e., one-third to each community).

## 4.6.2 Voters' Behavior

In order to understand voters' behavior we consider two aspects of the experimental data. We start by looking at the information demand and then move into voting and approval behavior.

Figure 4.2 presents lowest curves of the proportion of information purchased over time for each treatment, in total and by endowment.

Figure 4.2: Total Information Demand



*Notes.* The figures show lowest curves of the proportion of information purchased over time. Panel (a) presents information purchase for low endowment voters, panel (b) presents the same for high endowment voters, and panel (c) shows information demand for all voters together.

Eyeballing figure 4.2 suggests that information demand is significantly positive, rejecting prediction P3 in favor of the alternative P3<sub>A</sub>. This suggestion is indeed confirmed by a one-sided truncated t-test ( $p \leq 0.001$ ,  $N = 16$ )<sup>4</sup>, for total (0.1718), low (0.1709) and high (0.1554) endowed voters, where the number in parentheses indicate the average proportion of information purchased in each group. This is in line with other-regarding

<sup>4</sup>This test uses average information purchase per electorate as independent observations.

preferences, and reveals some degree of sociotropic behavior. In order to test prediction P4 we compare across treatments. First, notice that among high endowment voters, average information purchase was lowest in the *poor* treatment, i.e., where there was only one high endowment voter in each community and in the *heterogeneous* treatment, where there was the greatest degree of complexity. Taken together, the high endowed voters demand for information in these two treatments is statistically lower than in joint *baseline* and *clustered* treatments ( $p = 0.0457$ , Rank-Sum Mann-Whitney test,  $N = 16$ ). Moreover, information purchase was at the lowest in the *heterogeneous* treatment, for low endowed voters alone ( $p = 0.0522$ , Rank-Sum Mann-Whitney test,  $N = 16$ ) and when low and high endowment voters are combined ( $p = 0.0391$ , Rank-Sum Mann-Whitney test,  $N = 16$ )<sup>5</sup>. Therefore, evidence is against P4, which predicts no differences across treatments. However it does not support P4<sub>A</sub> either because this alternative predicts the highest level of information purchase for the *heterogeneous* treatment. What the evidence suggests is that the more complex environment induces a more simple strategy for all voters, with less information demand. A possible explanation is that in a most complex environment, obtaining and processing all information might be more difficult, leading to a point in which voters revert to a strategy that exploits mostly the most convenient and available information.

At a more disaggregate level, table 4.4 shows similar data per type of information, averaged across all periods and further broken down by high and low endowment voters. This shows that most of the information purchased is about the National level<sup>6</sup>, followed by Own Community. Overall, table 4.4 reinforces the patterns observed in Figure 4.2, with particular attention to be paid to the *poor* and *heterogeneous* treatments. In the *poor* treatment, high endowment voters almost never purchased information about other communities. The average demand for this piece of information is not only lower than for any other type of information, but it is also not statistically significantly greater than zero (one sided truncated t-test,  $N = 4$ ,  $p = 0.2125$ ). The *heterogeneous* treatment again follows the previously described pattern, however with the average purchase of information about other communities significantly greater than zero (one sided truncated t-test,  $N = 4$ ,  $p = 0.002$ ). With all voters combined, purchase of each type of information is lowest in the *heterogeneous* treatment.

---

<sup>5</sup>In these tests we use each electorate as an independent observation and test whether a sub-group of sessions/treatments were different from the remaining ones.

<sup>6</sup>The piece of information purchased most often is ‘Tax Rate’. If combined with information about the average voter on the nation (column 4 of table 4.4), it reaches an average of 0.31.

Table 4.4: Proportion of Information Purchased

|                      | <b>Own<br/>Community</b> | <b>Other<br/>Communities</b> | <b>Aggregate</b> | <b>Tax Rate</b> |
|----------------------|--------------------------|------------------------------|------------------|-----------------|
| <b>Baseline</b>      | 0.24                     | 0.15                         | 0.18             | 0.27            |
| Low Endowment        | 0.22                     | 0.14                         | 0.17             | 0.25            |
| High Endowment       | 0.26                     | 0.17                         | 0.19             | 0.32            |
| <b>Clustered</b>     | 0.21                     | 0.15                         | 0.17             | 0.30            |
| Low Endowment        | 0.18                     | 0.14                         | 0.15             | 0.27            |
| High Endowment       | 0.25                     | 0.16                         | 0.19             | 0.35            |
| <b>Poor</b>          | 0.25                     | 0.12                         | 0.13             | 0.30            |
| Low Endowment        | 0.29                     | 0.14                         | 0.15             | 0.32            |
| High Endowment       | 0.05                     | 0.02                         | 0.04             | 0.21            |
| <b>Heterogeneous</b> | 0.13                     | 0.06                         | 0.11             | 0.20            |
| Low Endowment        | 0.13                     | 0.06                         | 0.10             | 0.21            |
| High Endowment       | 0.13                     | 0.06                         | 0.12             | 0.20            |
| <b>Total</b>         | 0.21                     | 0.12                         | 0.14             | 0.27            |
| Low Endowment        | 0.21                     | 0.12                         | 0.14             | 0.27            |
| High Endowment       | 0.19                     | 0.11                         | 0.15             | 0.28            |

*Notes.* Cells show, for each type of information, the proportion of the available information purchased. For ‘Other Communities’ we aggregate the two communities to which the voter does not belong. ‘Aggregate’ refers to information about the average voter in the nation.

Moving next to voting and approval behavior, we can examine the effect of economic conditions at the various levels on vote choice. To start with an intuitive approach, we examine conflicting situations, those where personal conditions are bad but national conditions are good (figure 4.3(a)), or where personal conditions are good but national conditions are bad (figure 4.3(b)).

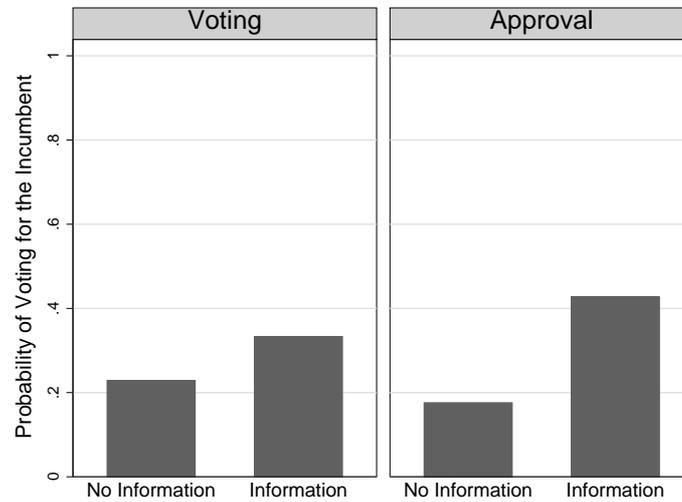
Here voters are split into two groups: those who purchased national level information (tax rate and/or average voter in the nation) and those who did not (see figure 4.3). First, in both the voting and approval rounds, we see the same patterns. The informed are more likely to vote against their personal interests. For instance, figure 4.3(a) depicts voters in the situation where, compared to the candidate, the incumbent had made the voter worse off but had improved the economy as a whole. Those who were aware of a positive change in national economic conditions were more supportive of the incumbent than those who were only aware of the personal negative conditions. While it is tempting to say that the informed are more sociotropic (which they are), there is perhaps a selection effect. There may simply be types of voters that a simple informed versus uninformed comparison cannot reveal while uninformed voters can obviously not behave more sociotropically than informed voters. What can be said is that this supports the assumption in our design that sociotropic behavior is correlated with higher information demand. An attempt to measure how *more* sociotropic these voters are is presented further below.

Next, we compare voting rounds to approval rounds. While the graph suggests little difference between voting and approval rounds for uninformed voters, it does suggest differences for informed voters. Specifically, informed voters appear more likely to approve sociotropically (i.e., report approving of an incumbent who is good for the nation at the expense of individuals and disapprove of an incumbent who is good for individuals at the expense of the nation) than they are to vote sociotropically. In this sense, informed voters may be using cheap talk, voicing a preference for improved national conditions, when they really prefer better personal conditions. Or more simply, the informed may aspire to vote sociotropically, but given a potentially costly decision (vote choice) they revert to egotropic reasoning.

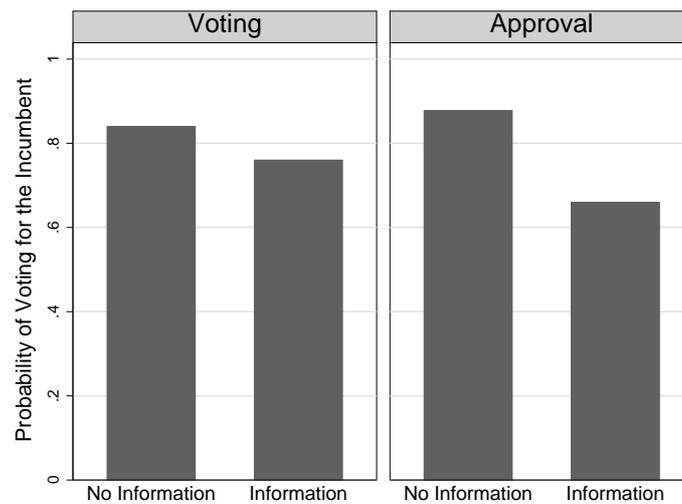
To generalize the previous analysis, tables 4.5 and 4.6 show marginal effects after random effects probit estimations. The dependent variable is the probability of voting for (table 4.5) or approving of (table 4.6) the incumbent. The models present results of aggregate behavior, further decomposed into low and high endowment voters.

In the regressions on tables 4.5 and 4.6 the first variable ('Self Indicator') is an indicator with value 1 if the Incumbent offers the highest net after policy welfare to a voter,  $-1$  if the Candidate does and 0 in case of a tie. The next three variables present interaction effects of this indicator with whether or not the voter purchased information concerning her own community, at least one of the other communities and national level indicators (average voter in the nation or tax rate), respectively. All voters are expected to react

Figure 4.3: Voting and Approval Behavior Conditional on Conflicting Situation



(a) Negative Personal Welfare vs. Positive National Welfare



(b) Positive Personal Welfare vs. Negative National Welfare

*Notes.* Shown are the probabilities of voting for or approving of the incumbent under conflicting situations. Panel (a) shows situations in which the incumbent offers less personal net after policy welfare but more national net after policy welfare than the candidate, while panel (b) shows the opposite case, i.e., situations in which the incumbent offers more personal net after policy welfare but less national net after policy welfare than the candidate. ‘No information’ refer to voters that, in that particular round, did not purchase national information. ‘Information’ indicates that the voter purchased tax rate information and/or information about the average voter in the nation.

Table 4.5: Voting Behavior, Marginal Effects

|                                      | Total<br>b(se)     | Low Endowment<br>b(se) | High Endowment<br>b(se) |
|--------------------------------------|--------------------|------------------------|-------------------------|
| Prediction at zero                   | 0.550              | 0.663                  | 0.410                   |
| Self indicator                       | 0.407**<br>(0.025) | 0.443**<br>(0.055)     | 0.318**<br>(0.042)      |
| Self x own community information     | -0.148*<br>(0.061) | -0.152*<br>(0.077)     | -0.193+<br>(0.099)      |
| Self x other communities information | -0.018<br>(0.064)  | -0.007<br>(0.077)      | -0.089<br>(0.110)       |
| Self x national information          | -0.060<br>(0.046)  | -0.096+<br>(0.057)     | 0.033<br>(0.077)        |
| (known) own community indicator      | 0.167**<br>(0.043) | 0.184**<br>(0.055)     | 0.146+<br>(0.075)       |
| (known) fairness indicator           | 0.203**<br>(0.048) | 0.224**<br>(0.062)     | 0.131<br>(0.083)        |
| (known) national indicator           | 0.028<br>(0.042)   | -0.024<br>(0.053)      | 0.148*<br>(0.071)       |
| N                                    | 1200               | 780                    | 420                     |

*Notes.* Cells show marginal effects and standard errors of a probit panel regression with random effects at the individual level and session fixed effects (not reported). The dependent variable is a dummy indicating whether or not a voter voted for the incumbent. ‘Self Indicator’ is an indicator variable if value 1 if the Incumbent provides a voter with more net after policy income than the Candidate, -1 on the opposite case and 0 on an tie. The next three variables are interaction effects with a dummy variable indicating whether or not a voter purchased information about her own community, any of the other communities or national indicators (tax rate or average voter in the nation). The final three variables are indicator variables defined similarly to ‘Self Indicator’ interacting with the dummies presented before, respectively. They, thus, compare the known differences in net after policy income for a voter’s own community, (negative of the) dispersion across communities and national welfare.

(+), (\*) and (\*\*) denotes statistical significance at the 10%-, 5%- and 1%-level.

Table 4.6: Approval Behavior, Marginal Effects

|                                      | Total<br>b(se)      | Low Endowment<br>b(se) | High Endowment<br>b(se) |
|--------------------------------------|---------------------|------------------------|-------------------------|
| Prediction at zero                   | 0.621               | 0.596                  | 0.684                   |
| Self indicator                       | 0.429**<br>(0.028)  | 0.451**<br>(0.031)     | 0.385**<br>(0.060)      |
| Self x own community information     | -0.122**<br>(0.043) | -0.105+<br>(0.054)     | -0.171*<br>(0.073)      |
| Self x other communities information | -0.056<br>(0.044)   | -0.114*<br>(0.053)     | 0.078<br>(0.079)        |
| Self x national information          | -0.128**<br>(0.031) | -0.150**<br>(0.040)    | -0.094+<br>(0.050)      |
| (known) own community indicator      | 0.122**<br>(0.030)  | 0.108**<br>(0.039)     | 0.171**<br>(0.053)      |
| (known) fairness indicator           | 0.059+<br>(0.031)   | 0.055<br>(0.038)       | 0.109+<br>(0.060)       |
| (known) national indicator           | 0.080**<br>(0.027)  | 0.014<br>(0.034)       | 0.168**<br>(0.049)      |
| N                                    | 2640.000            | 1716.000               | 924.000                 |

*Notes.* Cells show the marginal effects and standard errors of a probit panel regression with random effects at the individual level and session fixed effects (not reported). The dependent variable is a dummy indicating whether or not a voter approved of the incumbent. Remarks concerning the dependent variables are as in table 4.5.

(+), (\*) and (\*\*) denotes statistical significance at the 10%-, 5%- and 1%-level.

somewhat positively to gains on own income, but sociotropic preferences, signaled by the purchase of information, should reduce this effect if voters have some form of other-regarding preferences. The next three variables are also indicators comparing incumbent's and candidate's policies with respect to their effects in, respectively, net after policy welfare for the voter's own community; differences across communities and national welfare. These variables enter the regression only when known, i.e., only when the voter purchased information on the level concerned. The coefficients for these three variables are expected to be positive if voters have other-regarding preferences.

Several interesting observations can be made. We start at the aggregate level ('Total'). First, as expected, improvement of the own conditions positively increases the voting and approval probabilities. Other things equal, receiving a higher income from one of the politicians increases the probability of voting for (by 40.7 percentage points) and approving of (by 42.9 percentage points) this politician compared to the case where both offer the same. Rejecting P5 in favor of P5<sub>A</sub>, informed voters are less sensitive to personal gains, however. This can be seen by the negative interaction effects on 'Self Indicator', which in both regressions is significant in at least one of the three cases. The last three indicators show that knowledge of positive (negative) community, distributional and national conditions also favor the incumbent (candidate). This also sheds light on the meaningful difference between uninformed voting and informed egotropic voting, introduced in section 4.3. Informed egotropic voting would be revealed if the interaction terms on 'Self Indicator' would be zero, which would indicate that acquisition of information leads to no change in behavior. If information is used to make a social comparisons that serves as a benchmark for one's own personal economic welfare, negative estimates for the last three variables would indicate acquisition of information and a voting/approval behavior against others' best interest. Neither are observed, which supports the argument that the purchase of information reveals communitropic and/or sociotropic behavior.

As indicated previously by figure 4.3, voters seem to be more 'extreme' in approval rounds than in voting rounds (the combined effects are larger and statistically stronger in approval rounds). Specifically, national conditions seem to matter more in approval rounds. Distributional concerns seem to be very relevant in voting rounds, however.

When comparing endowment types, the general patterns are in line with the aggregate analysis. For example, both react positively to higher own income and are more 'extreme' in approval rounds than in voting rounds. Important differences emerge, however. In particular, while low endowed voters react mostly to community level information, high endowed voters are primarily concerned with national conditions. Moreover, low endowed voters seem to react quite strongly to distributional concerns in voting rounds when, in contrast, high endowed voters are only mildly affected by this indicator in approval rounds.

All analyses presented here considered average behavior, only accounting for differences

across endowments. It may well be, however, that voters are heterogeneous in their preferences and that individual differences in behavior might explain (better) the observed patterns. While an in-depth heterogeneity analysis is beyond the scope of this chapter, some observations can be made. For example, we do observe that 58 voters (24.2% of the sample) never buy a single piece of information, while 3 voters (1.25%) buy all information available. Likewise, while 66 voters (27.5%) never purchase national level indicators, 16 (6.67%) do so in every single round. Reading the post-experiment questionnaire, we can classify 177 (74%) voters' explanation of their decision making process as presenting selfish motives<sup>7</sup> and 55 (23%) with sociotropic motives<sup>8</sup>.

### 4.6.3 Summary of Results

All in all, data supports most of the alternative hypotheses, indicating presence of other-regarding preferences instead of pure egotropic voting. As presented in section 4.6.1, the first two null hypotheses are rejected in favor of the alternatives. Specifically, politicians choose tax levels close to the 'optimal' tax rate of 20% and do not heavily alter the initial income distributions. Section 4.6.2 provided strong evidence that information purchase is significantly positive, thus rejecting the third null hypothesis in favor of the alternative. The fourth null hypothesis is also rejected, as this predicted no treatment effects in information purchase. However, as the alternative predicted the highest information purchase at the *heterogeneous* treatment, this is not supported either. Finally, the fifth null hypothesis is rejected. It predicted that voter behavior would not be influenced by community, national nor distributional concerns. The evidence suggests that informed voters are less sensitive to own income changes and that once aware of improved community or national conditions tend to favor these politicians, even if it comes at their own income costs.

The data also suggests that voters are more 'extreme' in approval rounds, specially regarding national indicators. Across endowment types, differences are also observed. More specifically, high endowed voters react mostly to national conditions while low endowed voters seem more concerned with the community level and distributional indicators. We now discuss these results.

## 4.7 Discussion

We highlight some of our main findings. First, there is evidence of sociotropic (or other-regarding) voting, even though there was no direct financial incentive to do so. While there is no monetary incentive to engage in anything much more sophisticated than unin-

---

<sup>7</sup>Statements such as "I voted for the candidate that best helped me".

<sup>8</sup>Statements such as "I chose whichever candidate was offering the fairest tax rates and incomes".

formed egotropic voting, information purchase remains non-trivial and sociotropic voting occurs at significant levels.

Second, voters are responsive to economic conditions at the various levels, when they are aware of incumbent performance. That is, voters respond to changes in both tax and redistribution policies in a systematic manner. Specifically, high endowment voters demonstrate more sensitivity to national conditions while low endowment voter react more to community level indicators.

Third, politicians rarely engage in targeting specific communities. While it would always have been feasible for politicians to set taxes and redistribution in a manner that would have maximized profit to two communities at the expense of the third, this is not observed. This structure of redistribution combined with the choice of the ‘optimal’ tax rate possibly reflects a belief that voters may have preferred more egalitarian and socially maximizing outcomes.

Finally, there is evidence that some informed voters are engaging in cheap talk, signaling that they will vote sociotropically but then voting (more) egotropically. This may suggest that the considerations involved in the approval choice are not necessarily the same as those that induce vote choice.

In sum, this chapter has presented a novel experimental investigation of information search and economic voting. While there is significant potential for further innovation, with modification of this design, this chapter has contributed insight into the mechanisms underlying egotropic and sociotropic behavior. So, what information is relevant in economic voting? The answer depends not only on who the individual is, but also on where she lives and on her endowment.

## Appendix 4.A Experimental Instructions

In this appendix we provide a transcript of the experimental instructions. Brackets indicate parts of the instruction that varied across treatments. The “Experimental Instructions” were given to all subjects (upon arrival) while the “Specific Instructions” were sealed in an envelope and given to the specified roles only. Instructions were also provided on screen. In addition to the instructions, subjects also received a version of table 4.1(a) or 4.1(b), according to treatment, without the last column and highlights.

### Experimental Instructions

Welcome to today’s experiment. Over the next two hours, you will be engaged in an activity for which you will be paid by check upon completion. Just for arriving on time and agreeing to participate, you will be paid a show up fee of \$10. Additional money will be earned through the course of the experiment, depending on your choices and the choices made by other participants. During the experiment, all the money you earn will be listed in experimental currency units (ECUs). When the experiment is complete, these will be converted to dollars at a rate of one dollar for every 500 ECUs.

From this point on, you may not speak or attempt to communicate with any of the other participants. Turn OFF, not just to silent, any phones or electronic devices and keep them off for the duration of the experiment. Violation of these policies will result in first a warning and then dismissal from the experiment without payment (but with no further penalty). If you have a question, please raise your hand and an experimenter will come to you to answer your question.

### Roles

At the beginning of the experiment, all participants are assigned to be either a Politician or a Voter. Each participant has the same chance of being assigned to one of the two roles. You will remain in the same role for the entire duration of the experiment.

**Politicians (2):** Two participants will be randomly chosen to be politicians. Of these two, one will be randomly chosen to start as the Incumbent, while the other will be the Candidate seeking to replace the Incumbent. The Incumbent will receive a salary of 500 ECUs per period, while the Candidate will receive a salary of 100 ECUs per period.

**Voters (15):** The remaining fifteen participants will comprise a nation of voters, randomly split into three communities of five. Once assigned to a community, a voter will remain in that community for the rest of the experiment.

Each voter will also be randomly assigned to receive either a high endowment of 500 ECUs

or a low endowment of 100 ECUs per period. This too will remain constant throughout the experiment. [*baseline*: There will be 3 low endowment and 2 high endowment voters in each community.][*clustered*: There will be 2 communities of 4 low endowment voters and 1 high endowment voter and 1 community of 1 low endowment and 4 high endowment voters. ][*poor*: There will be 4 low endowment and 1 high endowment voter in each community.][*heterogeneous*: There will be a community of 4 low endowment and 1 high endowment voters, a community of 3 low endowment and 2 high endowment voters and a community of 2 low endowment and 3 high endowment voters.]

### Structure of the experiment

#### Stage 1: Politicians choose a tax rate and the tax returns

In the first stage, politicians make the following choices: the tax rate and the tax returns. The tax rate is the percentage of endowment collected from each voter. It can be a number between 0% and 100% in increments of 10%. The same tax rate  $t$  will apply to ALL communities and, thus, all voters. Each tax rate is associated with collected taxes and a tax revenue. These relationships can be seen in two ways. First, it is given by mathematical equations. [*baseline, clustered and heterogeneous*: Collected taxes are given by  $(3900 * t)$ , where 3900 is the total national endowment (everyone's endowment added up). Tax revenue is then given by  $(3900 * t) * (1.40 - t)$ .][*poor*: Collected taxes are given by  $(2700 * t)$ , where 2700 is the total national endowment (everyone's endowment added up). Tax revenue is then given by  $(2700 * t) * (1.40 - t)$ .] If you find this too hard to understand, there is no need to worry. In the accompanying table, we list for every possible  $t$ , the collected taxes and tax revenue that it generates.

Once the tax revenue has been determined, the politician has to decide on the tax returns. That is, how much of the tax revenue to return to each community. The total amount returned must be equal to the tax revenue. Within each community the tax return is equally divided among its voters. (Notice a politician can return different amounts to different communities but cannot affect how the tax return is distributed within a community).

The tax rate and tax returns chosen by the Incumbent will be implemented. The choices made by the Candidate are hypothetical proposals that can also be seen by the voters.

#### Stage 2: Voters observe information

Voters will be informed about their own endowment, their own income after taxes and tax returns, and how their own income has changed as a result of these choices.

Voters will have the opportunity to purchase additional information for 2 ECUs per piece. Voters can buy up to 5 pieces of information. The information relates to the tax rate and the Average

Income Change, that is, how much better or worse an average voter is compared to her initial endowment. The five pieces of information available are: tax rate, Average Income Change in the voter's own community, in each of the other two communities, and at the national level.

Voters can see the same information (including purchased information) for both politicians. That means, if a voter purchases a piece of information, s/he will have access to that piece of information about both politicians.

### **Stage 3:** *Approval Poll / Election*

Voters will have the chance to say whether or not they are happy with the current Incumbent's policies. A question of the form "Do you approve of the job Politician X is doing as leader?" will be posed. Voters must select either yes or no. The results will be announced at the end of the period.

Every third period, instead of an approval question, there will be an election. Voters will have the choice to vote for either Politician 1 or Politician 2 to be the leader for the next three periods. The politician who receives the most votes wins. Results are announced at the end of the period.

### **Stage 4:** *Summary*

At the end of each period, a screen will appear showing results of the *Approval Poll / Election*, income from that period, and cumulative earnings.

### **Ending Conditions**

This procedure will be repeated a pre-determined number of times. When the experiment has been completed, you will be asked to fill out a short questionnaire. When everyone is finished, you will each be called individually to the back of the room to be paid privately.

Please press "Continue" on your screen once you finish reading this part. You will learn about your role (Politician or Voter) and receive further instructions about your screen.

**Specific Instructions for Politicians:**

As mentioned before, politicians make the following choices: the tax rate and the tax returns. The tax rate is set by moving the slider at the top of your screen from left to right. As you move the slider, you will see directly underneath, how the tax rate affects the tax revenue. The next choice to be made is the tax returns to each community. This has to be entered to each community individually on the left hand side of your screen.

To assist you in your decisions, below the tax revenue, there is an indication of the amount not yet distributed. There is also a calculator button on the rightmost side of the screen. You can click on this button to call a calculator in case you believe it may help you with the computations.

On the right side of your screen, you will see a column labeled “Total Income Change”. This refers to the amount your policies have given to or taken from certain voters. For example, total income change of 70.00 for Community 1 means that you have made that community 70 ECUs better off than it was before.

This view is called the “Aggregate Distribution View”. At the bottom of the screen, you will see a button labeled “Income Distribution View”. If you click this button, you will be shown how many low and high endowment voters are in each community and how your policy has affected the average voter in each group. Click “Aggregate Distribution View” to return to the previous view.

At anytime you can click the “Preview” button to see the effects of your current policy and to update the amount not yet distributed. Note: to preview a policy, the total amount returned to the communities must be no more than the tax revenue.

You will also see a button at the bottom of your screen labeled “History”. Click this button to see the policies chosen by you and by the other politician in previous periods. The buttons “Own History” and “Other Politician’s History” allow you to alternate views accordingly. The following information is provided on the history screen: Period, Status (Incumbent or Candidate), Tax Rate and Tax Returns for each community. (Note this will be empty in the first period). Click “Current Period” to return to current period’s view.

Once you are satisfied with a policy that completely distributes the tax revenue you can click “OK”. In the next period, this will be shown as the starting policy. You will, of course, be free to change it.

When both politicians have pressed “OK”, voters will be able to see the information and fill the Approval/ Election ballot. During this time, you will be shown a screen similar to your decision screen, which you can use to try different policies and test their effects. No values entered during

this stage will be implemented or recorded into the “History” screen.

Please press “Continue” on your screen once you finish reading this part. This concludes the instructions.

**Specific Instructions for Voters:**

Once both politicians have decided on their policies, you will see how their choices have translated into payoffs.

In the middle of the screen, you will see your endowment. Directly underneath, a table starts. This table presents a column associated with each Politician's policy. The first two rows indicate your income after taxes and tax returns, and how your income has changed. You have the opportunity to purchase up to 5 additional pieces of information for 2 ECUs per piece. The row below your income change holds the tax rate. Click on the button "Purchase Information" to reveal the tax rate. Next, there is a sub-table. The first columns indicate the number of low and high endowment voters, followed by the average income. The final columns refer to the Avg. Income Change. For this column, the first three options are Own Community, Other Community 1, and Other Community 2. If you click on one of the "Purchase Information" buttons, you will be told how much better or worse off the average member of that community is, compared to the initial endowment, due to the policy choices. The final row provides information about the whole nation, that is, the number of low and high endowment voters and the average endowment, and the possibility to "Purchase Information" about the Avg. Income Change in the nation as a whole.

At the bottom of the screen there are also two buttons labeled "History Politician 1" and "History Politician 2" which will show you information about previous periods. You will be shown the following information: Period, Status (Incumbent or Candidate), Own Income Change and, if purchased, Tax Rate, Average Income Change in your Own Community, Other Community 1, Other Community 2 and Nation. Notice it is not possible to purchase information regarding previous periods. Click "Current Period" to return to current period's view.

The ballot for approval or election will appear on the top of your screen. You must indicate if you approve or not of the job the current incumbent is doing as the leader, and in election periods (every third period), indicate instead, for whom you wish to vote.

Once you are done reviewing information and casting your vote, please click "OK" to continue, in the bottom right corner of the screen. The experiment cannot continue until all voters have done this, so please remember to click the button.

While the politicians are making their choices you will be shown the "History" screens. (Note this will be empty on the first period).

Please press "Continue" on your screen once you finish reading this part. This concludes the instructions.

## Appendix 4.B Experimental Screen Shots

In this appendix we provide screen shots of the politicians (4.4(a)) and voters (4.4(b)) decision screens, in order to illustrate the interface used by subjects and the information possibility contained in their screens.

Figure 4.4: Experimental Screen Shots

|             | Tax Return | Total Endowment | Total Income Change |
|-------------|------------|-----------------|---------------------|
| Community 1 | 0.00       | 1300            | 0.00                |
| Community 2 | 0.00       | 1300            | 0.00                |
| Community 3 | 0.00       | 1300            | 0.00                |
| Nation      | 0.00       | 3900            | 0.00                |

(a) Politicians

|                   | Low Endowment | High Endowment | Avg. Endowment | Avg. Income Change |
|-------------------|---------------|----------------|----------------|--------------------|
| Own Community     | 3             | 2              | 260.00         |                    |
| Other Community 1 | 3             | 2              | 260.00         |                    |
| Other Community 2 | 3             | 2              | 260.00         |                    |
| Nation            | 9             | 6              | 260.00         |                    |

(b) Voters

Notes. The figure presents screen shots for the politicians (panel (a)) and voters ((b)). These are illustrative examples and not a taken from an actual session.



# Chapter 5

## Preference for Efficiency or Confusion?<sup>1</sup>

### 5.1 Introduction

Subjects contribute to public goods even in situations in which it is individually optimal to free-ride. Amongst the experimental paradigms, over-contribution in linear public good experiments represents one of the best documented and most studied regularities. In order to explain this evidence, social scientists have elaborated a large number of behavioral explanations that are based on refinements of the hypothesis of “other-regarding preferences”: reciprocity (Falk & Fischbacher 2006, Fischbacher, Gaechter & Fehr 2001, Holländer 1990, Sugden 1984), altruism and spitefulness (Andreoni 1989, Andreoni 1990, Levine 1998), commitment and Kantianism (Bordignon 1990, Laffont 1975), norm compliance (Bernasconi, Corazzini & Marenzi 2010), and team-thinking (Bacharach 2006, Cookson 2000, Sugden 2003).

Recently, the hypothesis of preference for (group) efficiency has been invoked as an additional psychological explanation for agents’ attitude to freely engage in pro-social behaviors. Indeed, there is evidence showing that experimental subjects often make choices that increase group efficiency, even at the cost of sacrificing their own payoff (Charness & Rabin 2002, Engelmann & Strobel 2004). Corazzini, Faravelli & Stanca (2010) use this behavioral hypothesis to explain evidence from linear public good experiments based on prizes (a lottery, a first price all pay auction and a voluntary contribution mechanism used as a benchmark) and characterized by endowment heterogeneity and incomplete information on the distribution of incomes. In particular, they present a simple model in which subjects bear psychological costs from contributing less than what is efficient for the group. The main theoretical prediction of their model when applied to linear public good experiments is that the equilibrium contribution of a subject is increasing in both

---

<sup>1</sup>This chapter is based on Corazzini & Tyszler (2010).

her endowment and the weight attached to the psychological costs of (group-)inefficient contributions in the utility function. The authors show that this model is capable of accounting for over-contribution as observed in their experiment as well as evidence reported by related studies.

However, as argued by several scholars, rather than being related to subjects' kindness, over-contribution may reflect their natural propensity to make errors. There are several experimental studies (Andreoni 1995, Brandts & Schram 2001, Goeree, Holt & Laury 2002, Houser & Kurzban 2002, Palfrey & Prisbrey 1996, Palfrey & Prisbrey 1997) that seek to disentangle other-regarding preferences from noisy behaviors by running *ad hoc* variants of the linear public good game. A general finding in these papers is that "warm-glow effects and random error played both important and significant roles" (Palfrey & Prisbrey 1997, p. 842) in explaining over-contribution.

In a similar vein, one may wonder about the relative importance of noise and preference for efficiency in explaining the experimental evidence. In order to tackle this question, we build and estimate a quantal response equilibrium (henceforth QRE, McKelvey & Palfrey 1995) extension of the model presented by Corazzini, Faravelli & Stanca (2010). This boundedly rational model formally incorporates both preference for efficiency and the noise arguments. Moreover, in contrast to previous studies that aim to find the relative importance of error and other-regarding preferences, the QRE approach explicitly applies an equilibrium analysis.

There are several alternative theoretical frameworks that can be used to model noisy behaviors (bounded rationality) and explain experimental evidence in strategic games. Two examples are the level- $k$  model (e.g. Stahl & Wilson 1995, Ho, Camerer & Weigelt 1998, Stahl & Haruvy 2008) and (reinforcement) learning models (e.g. Erev & Roth 1998). In the level- $k$  model of iterated dominance, level-0 subjects choose an action randomly and with equal probability over the set of possible pure strategies while level- $k$  subjects choose the action that represents the best response against level- $(k - 1)$  subjects. Level- $k$  models have been used to explain experimental results in games in which other-regarding preferences do not play any role, such as  $p$ -Beauty contests and other constant sum game. Since in public good games there is a strictly dominant strategy of no contribution, unless other-regarding preferences are explicitly assumed, level- $k$  models do not apply. Similar arguments apply to learning models. In the basic setting, each subject takes her initial choice randomly and with equal probability over the set of possible strategies. As repetition takes place, strategies that turn out to be more profitable are chosen with higher probability. Thus, unless other-regarding preferences are explicitly incorporated into the utility function, repetition leads to the Nash Equilibrium of no contribution.

The QRE approach has the advantage that even in the absence of other-regarding preferences it can account for over-contribution in equilibrium. Moreover, we can use the model to assess the relative importance of noise and efficiency concerns.

For our QRE approach, we start from a benchmark model in which the population is homogeneous in both concerns for (group) efficiency and the noise parameter. Then, we allow for heterogeneity across subjects by assuming the population to be partitioned into subgroups with the same noise parameters but distinct in the preference for (group) efficiency.

In line with our theoretical setting, we use data from the VCM sessions of Corazzini, Faravelli & Stanca (2010) to compare estimates from the model not accounting for noise in subjects' behaviors with those from the QRE extension. For the QRE model with a homogeneous population, we find that subjects' over-contribution is entirely explained by noise in behaviors, with the estimated parameter of concerns for (group) efficiency being zero. A formal likelihood ratio test strongly rejects the specification not allowing for randomness in contributions in favor of the more general QRE model. A different picture emerges in the QRE model with heterogeneous subjects. In the model with two sub-groups, the probability of a subject being associated with a strictly positive degree of preference for (group) efficiency is approximately one third. This probability increases to 59% when we add a third subgroup characterized by an even higher efficiency concern. A formal likelihood ratio test confirms the supremacy of the QRE model with three subgroups over the other specifications. These results are robust to learning processes over repetitions. Indeed, estimates remain qualitatively unchanged when we replicate our analysis on the last 25% of the experimental rounds. The rest of this chapter is structured as follows. In section 5.2, we describe the experimental setting of Corazzini, Faravelli & Stanca (2010). In section 5.3, we present the QRE extension of the model based on the preference for (group) efficiency hypothesis. Section 5.4 reports results from our statistical analysis. Section 5.5 concludes.

## 5.2 The Experiment

Our statistical analysis is based on the experimental results reported by Corazzini, Faravelli & Stanca (2010). More specifically, we use data from three sessions of a voluntary contribution mechanism with endowment heterogeneity and incomplete information. Each session consisted of 20 rounds and involved 16 subjects. At the beginning of each session, each subject was randomly and anonymously assigned an endowment of either 120, 160, 200, or 240 tokens. The endowment assigned at the beginning was kept constant throughout the 20 rounds of the experiment and this was common knowledge. The experiment was run in a strangers condition (Andreoni 1988) such that, at the beginning of each round, subjects were randomly and anonymously rematched in groups of four players. Thus, in each round subjects made their choices under incomplete information on the distribution of the endowments in their group. In each round, every subject had to allocate her endowment between an individual and a group account. While subjects

allocated tokens to the accounts, payoff were expressed in points. The individual account implied a private benefit such that for each token a subject allocated to the individual account, she received two points. On the other hand, tokens in the group account generated monetary returns to each of the group members. In particular, each subject received one point for each token allocated by her, or by any other member of her group to the group account. Thus, the marginal per capita return used in the experiment was 0.5. At the beginning of each round, the experimenter exogenously allocated 120 tokens to the group account, independently of subjects' choices, thus implying 120 extra points for each group member. At the end of each round, subjects received information about their payoffs. Points were converted to euros using an exchange rate of 1000 points per euro. Subjects, mainly undergraduate students of economics, earned 12.25 euros on average for sessions lasting about 50 minutes. The experiment took place in May 2006 in the Experimental Economics Laboratory of the University of Milan Bicocca and was computerized using the z-Tree software (Fischbacher 2007).

The main features of anonymity and random rematching introduced by Corazzini, Faravelli & Stanca (2010) in their experimental setting, narrow the relevance of some 'traditional' behavioral hypotheses used to explain subjects' over-contribution. For instance, they preclude subjects' possibility to reciprocate (un)kind contributions of group members (Rabin 1993). Moreover, under these conditions, subjects with preferences for equality cannot make compensating contributions to reduce (dis)advantageous inequality (Fehr & Schmidt 1999, Bolton & Ockenfels 2000). Rather, the hypothesis of preference for (group) efficiency as a particular form of warm-glow (Andreoni 1989, 1990) appears a more plausible justification.

### 5.3 Theoretical Predictions and Estimation Procedure

Consider a finite set of subjects  $P = \{1, 2, \dots, p\}$ . In a generic round, subject  $i \in P$ , with endowment  $w_i \in N^+$  contributes  $g_i$  to the group account, with  $g_i \in N^+$  and  $0 \leq g_i \leq w_i$ . The monetary payoff of subject  $i$  who contributes  $g_i$  in a round is given by

$$\pi_i(w_i, g_i) = 2(w_i - g_i) + 120 + g_i + G_{-i}, \quad (5.1)$$

where  $G_{-i}$  is the sum of the contributions of group members other than  $i$  in that round. Given equation (5.1), if subjects' utility only depends on the monetary payoff, zero contribution is the unique Nash equilibrium of each round. In order to explain the positive contributions observed in their experiment, Corazzini, Faravelli & Stanca (2010) assume that subjects suffer psychological costs if they contribute less than what is optimal for the group. In particular, psychological costs are introduced as a convex quadratic func-

tion of the difference between a subject's endowment (i.e., the social optimum) and her contribution. In the VCM, player  $i$ 's (psychological) utility function is given by

$$u_i(w_i, g_i, \alpha_i) = \pi_i(w_i, g_i) - \alpha_i \frac{(w_i - g_i)^2}{w_i} \quad (5.2)$$

where  $\alpha_i$  is a non-negative and finite parameter measuring the weight attached to the psychological costs,  $\frac{(w_i - g_i)^2}{w_i}$ , in the utility function. Notice that psychological costs are increasing in the difference between a subject's endowment and her contribution. Under these assumptions, in each round, there is a unique Nash equilibrium in which individual  $i$  contributes

$$g_i^{NE} = \frac{2\alpha_i - 1}{2\alpha_i} w_i \quad (5.3)$$

The higher the value of  $\alpha_i$ , the higher the equilibrium contribution of subject  $i$  is. The average relative contribution,  $g_i/w_i$ , observed by Corazzini, Faravelli & Stanca (2010) in their VCM sessions is 22%. By calibrating equation (5.3) accordingly the authors find an average  $\alpha = 0.64$ .

Following (McKelvey & Palfrey 1995), we introduce noisy decision-making and consider a Logit Quantal Response extension of (5.2). In particular, we assume subjects to choose their contributions randomly according to a logistic quantal response function. Namely, for a given endowment,  $w_i$ , and contributions of the other group members,  $G_{-i}$ , the probability that subject  $i$  contributes  $g_i$  is given by

$$q_i(w_i, g_i, \alpha_i, \mu) = \frac{\exp \left\{ \frac{u_i(w_i, g_i, \alpha_i)}{\mu} \right\}}{\sum_{g_j=0}^{w_i} \exp \left\{ \frac{u_i(w_i, g_j, \alpha_i)}{\mu} \right\}} \quad (5.4)$$

where  $\mu \in \mathfrak{R}_+$  is a noise parameter reflecting a subject's capacity of noticing differences in expected payoffs.

Therefore each subject  $i$  is associated with a  $(w_i + 1)$ -dimensional vector  $\underline{\mathbf{q}}_i(w_i, \underline{\mathbf{g}}_i, \alpha_i, \mu)$  containing a value of  $q_i(w_i, g_i, \alpha_i, \mu)$  for each possible contribution level  $g_i \in \underline{\mathbf{g}}_i \equiv \{0, \dots, w_i\}$ . Let  $\left\{ \underline{\mathbf{q}}_i(w_i, \underline{\mathbf{g}}_i, \alpha_i, \mu) \right\}_{i \in P}$  be the system including  $\underline{\mathbf{q}}_i(w_i, \underline{\mathbf{g}}_i, \alpha_i, \mu)$ ,  $\forall i \in P$ . Notice that since others' contribution,  $G_{-i}$ , enters the r.h.s of the system, others'  $q_i$  will also enter the r.h.s. A fixed point of  $\left\{ \underline{\mathbf{q}}_i(w_i, \underline{\mathbf{g}}_i, \alpha_i, \mu) \right\}_{i \in P}$  is, hence, a Quantal Response Equilibrium (QRE),  $\left\{ \underline{\mathbf{q}}_i^{QRE}(w_i, \underline{\mathbf{g}}_i, \alpha_i, \mu) \right\}_{i \in P}$ .

In equilibrium, the noise parameter  $\mu$  reflects the dispersion of subjects' contributions around the Nash prediction expressed by equation (5.3). The higher  $\mu$ , the higher the dispersion of contributions. As  $\mu$  tends to infinity, contributions are randomly drawn from a uniform distribution defined over  $[0, w_i]$ . On the other hand, if  $\mu$  is equal to 0, the

equilibrium contribution collapses to the Nash equilibrium.<sup>2</sup>

In this framework, we use data from Corazzini, Faravelli & Stanca (2010) to jointly estimate  $\alpha$  and  $\mu$ . We proceed as follows. Our initial analysis is conducted by using all rounds ( $n = 20$ ) and assuming the population to be homogeneous in both  $\alpha$  and  $\mu$ . This gives us a benchmark that can be directly compared to the results reported by Corazzini, Faravelli & Stanca (2010). In our estimation procedure, we use a likelihood function that assumes each subject's contributions to be drawn from a multinomial distribution. That is:

$$L_i(w_i, \underline{\mathbf{g}}_i, \alpha, \mu) = \frac{n!}{\prod_{g_j=0}^{w_i} n(g_j)!} \prod_{g_k=0}^{w_i} q_i^{QRE}(w_i, g_k, \alpha, \mu)^{n(g_k)} \quad (5.5)$$

where  $n(g_j)$  is the number of times subject  $i$  contributed  $g_j$  over the  $n$  rounds of the experiment, and similarly for  $n(g_k)$ . The contribution of each person to the log-likelihood is the log of expression (5.5). The Maximum Likelihood procedure consists of finding the non-negative values of  $\mu$  and  $\alpha$  (and corresponding QRE) that maximize the summation of the log-likelihood function evaluated at the experimental data. In other words, we calculate the multinomial probability of the observed data by restricting the theoretical probabilities to QRE probabilities only.

We then extend our analysis to allow for cross-subject heterogeneity. In particular, we generalize the QRE model above by assuming the population to be partitioned into  $S$  subgroups that are characterized by the same  $\mu$  but different  $\alpha$ . In this case, the likelihood function becomes:

$$L_i(w_i, \underline{\mathbf{g}}_i, \alpha_1, \alpha_2, \dots, \alpha_S, \gamma_1, \gamma_2, \dots, \gamma_S, \mu) = \sum_{s=1}^S \gamma_s \frac{n!}{\prod_{g_j=0}^{w_i} n(g_j)!} \prod_{g_k=0}^{w_i} q_i^{QRE}(w_i, g_k, \alpha_s, \mu)^{n(g_k)} \quad (5.6)$$

where  $\gamma_1, \gamma_2, \dots, \gamma_S$ , with  $\sum_{s=1}^S \gamma_s = 1$ , are the probabilities for agent  $i$  belonging to the sub-group associated with  $\alpha_1, \alpha_2, \dots, \alpha_S$ , respectively. This allows us to estimate the value of  $\mu$  for the whole population, the value of  $\alpha_1, \alpha_2, \dots, \alpha_S$  for the  $S$  sub-groups and the corresponding probabilities,  $\gamma_1, \gamma_2, \dots, \gamma_S$ . For identification purposes we impose that  $\alpha_s \leq \alpha_{s+1}$ . The introduction of one group at a time accompanied by a corresponding likelihood-ratio test allows us to determine the number of  $\alpha$ -groups that can be statistically identified from the original data. In the following statistical analysis, estimates account for potential dependency of subject's contributions across rounds. Confidence intervals at the 0.01 level are provided using the inversion of the likelihood-ratio statistic,

<sup>2</sup>More specifically, for each subject  $i$  equilibrium contributions converge to  $q_i(w_i, g_i^{NE}, \alpha_i, 0) = 1$  and  $q_i(w_i, g_i, \alpha_i, 0) = 0, \forall g_i \neq g_i^{NE}$ .

subject to parameter constraints, in line with Cook & Weisberg (1990), Cox & Hinkley (1979) and Murphy (1995).

## 5.4 Results

Using data from the 20 rounds of the experiment, table 5.1 reports average contributions (both by endowment type and overall) observed in the experiment, average contributions as predicted by the model not accounting for noise in subjects' contributions and estimates as well as average contributions from different parameterizations of the Logit Quantal Response extension of the model. In particular, specification (1) refers to a version of the model in which both  $\alpha$  and  $\mu$  are constrained to be equal to benchmark values based on Corazzini, Faravelli & Stanca (2010). Under this parameterization,  $\alpha$  is fixed to the value computed by calibrating equation (5.3) on the original experimental data, 0.64, while  $\mu$  is constrained to 1<sup>3</sup>.

Table 5.1: Homogeneous population (all rounds)

|                                | <i>Data</i> | <i>CFS</i> | (1) $\bar{\mu}, \bar{\alpha}$ | (2) $\mu, \bar{\alpha}$ | (3) $\mu, \alpha$       |
|--------------------------------|-------------|------------|-------------------------------|-------------------------|-------------------------|
| $\mu$                          | –           | –          | 1                             | 21.83<br>[19.69; 24.34] | 41.59<br>[39.11; 44.34] |
| $\alpha$                       | –           | 0.64       | 0.64                          | 0.64                    | 0<br>[0; 0.01]          |
| (Predicted) Avg. Contributions |             |            |                               |                         |                         |
| Overall endowments             | 37.91       | 39.38      | 39.41                         | 60.24                   | 37.91                   |
| $w_i = 120$                    | 34.02       | 26.25      | 26.34                         | 44.84                   | 34.12                   |
| $w_i = 160$                    | 24.53       | 35.00      | 35.03                         | 55.68                   | 37.67                   |
| $w_i = 200$                    | 47.50       | 43.75      | 43.76                         | 65.57                   | 39.48                   |
| $w_i = 240$                    | 45.57       | 52.50      | 52.50                         | 74.86                   | 40.36                   |
| $\log ll$                      |             |            | –8713.95                      | –3483.79                | –3170.69                |
| <i>Obs.</i>                    | 960         | 960        | 960                           | 960                     | 960                     |

*Notes.* This table reports average contributions as well as estimates and predictions from various specifications of the model based on the efficiency concerns assumption using all 20 rounds of the experiment. CFS refers to the specification not accounting for noise in subjects' contributions while (1), (2) and (3) are Logit Quantal Response extensions of the model. In (1)  $\alpha$  and  $\mu$  are constrained to 0.64 and 1, respectively. In (2), the value on  $\alpha$  is set to 0.64, while  $\mu$  is estimated through equation (5.5). Finally, (3) refers to the unconstrained model in which both  $\alpha$  and  $\mu$  are estimated through equation (5.5). The table also reports, for each specification, the corresponding log-likelihood. Confidence Intervals are computed using a inversion of the likelihood-ratio statistic, at the 0.01 level, subject to parameter constraints.

<sup>3</sup>Appendix 5.A shows the Maximum Likelihood estimation value of  $\alpha$  when we vary  $\mu$ . It is possible to see that for a large range of values of  $\mu$  this value is close to 0.64. We choose  $\mu = 1$  as a sufficiently low value in which the estimated  $\alpha$  is close to 0.64 and thus provide a noisy version of the base model which can be used for statistical tests.

As shown by table 5.1, specification (1) closely replicates predictions of the original model presented by Corazzini, Faravelli & Stanca (2010) not accounting for noise in subjects' contributions. In specification (2),  $\alpha$  is fixed to 0.64, while  $\mu$  is estimated by using equation (5.4). The value of  $\mu$  increases substantially with respect to the benchmark value used in specification (1). A likelihood-ratio test strongly rejects specification (1) that imposes restrictions on the values of both  $\alpha$  and  $\mu$  in favor of specification (2) in which  $\mu$  can freely vary on  $\mathfrak{R}_+$  ( $LR = 10460.33; \Pr\{\chi^2(1) > LR\} < 0.01$ ). However, if we compare the predicted average contributions of the two specifications, we find that specification (1) better approximates the original experimental data. This is because a higher value of the noise parameter spreads the distributions of contributions around the mean. Therefore even with mean contributions further from the data (induced by the fixed value of  $\alpha$ ) the spread induced by the noise parameter in specification (2) produces a better fit. This highlights the importance of taking into account not only the average (point) predictions, but also the spread around it. It also suggests that allowing  $\alpha$  to vary can improve fit.

In specification (3),  $\alpha$  and  $\mu$  are jointly estimated using equation (5.5), subject to  $\alpha \geq 0$ . If both parameters can freely vary over  $\mathfrak{R}_+$ ,  $\alpha$  reduces to zero and  $\mu$  reaches a value that is higher than what was obtained in specification (2). As confirmed by a likelihood-ratio test, specification (3) fits the experimental data better than both specification (1) ( $LR = 11086.54; \Pr\{\chi^2(2) > LR\} < 0.01$ ) and specification (2) ( $LR = 626.21; \Pr\{\chi^2(1) > LR\} < 0.01$ ). Thus, under the maintained assumption of homogeneity our estimates suggest that contributions are better explained by randomness in subjects' behavior rather than by concerns for efficiency.

In order to control for learning effects, we replicate our analysis using the last five rounds only. Results are shown in table 5.2.

Consistent with a learning argument, in both specifications (2) and (3) of table 5.2, the values of  $\mu$  are substantially lower than the corresponding estimates in table 5.1. Thus, repetition reduces randomness in subjects' contributions. The main results presented above, however, are confirmed by our analysis on the last five periods. Looking at specification (3) of table 5.2, in the model with no constraints on the parameters, the estimated value of  $\alpha$  again drops to zero. A likelihood-ratio test again shows that specification (3) explains the data better than both specifications (1) ( $LR = 1578.83; \Pr\{\chi^2(2) > LR\} < 0.01$ ) and (2) ( $LR = 203.85; \Pr\{\chi^2(1) > LR\} < 0.01$ ).

These results seem to reject the preference for (group) efficiency hypothesis in favor of pure randomness in subjects' contributions. A different picture emerges when we allow for cross-subject heterogeneity, however. In table 5.3 we drop the assumed homogeneity. In particular, we consider two models with heterogeneous subjects: the first assumes the population to be partitioned into two sub-groups ( $S = 2$ ) and the second into three

Table 5.2: Homogeneous population (last 5 rounds)

|                                | <i>Data</i> | <i>CFS</i> | (1) $\bar{\mu}, \bar{\alpha}$ | (2) $\mu, \bar{\alpha}$ | (3) $\mu, \alpha$       |
|--------------------------------|-------------|------------|-------------------------------|-------------------------|-------------------------|
| $\mu$                          |             | –          | 1                             | 11.63<br>[9.80; 13.95]  | 26.91<br>[24.14; 30.17] |
| $\alpha$                       |             | 0.59       | 0.59                          | 0.59                    | 0<br>[0; 0.03]          |
| (Predicted) Avg. Contributions |             |            |                               |                         |                         |
| Overall endowments             | 25.94       | 26.39      | 26.91                         | 44.78                   | 25.94                   |
| $w_i = 120$                    | 21.13       | 17.59      | 18.44                         | 34.55                   | 25.05                   |
| $w_i = 160$                    | 17.63       | 23.46      | 24.04                         | 41.68                   | 26.01                   |
| $w_i = 200$                    | 35.28       | 29.32      | 29.71                         | 48.30                   | 26.30                   |
| $w_i = 240$                    | 29.70       | 35.19      | 35.45                         | 54.60                   | 26.39                   |
| $\log ll$                      |             |            | –1675.03                      | –987.54                 | –885.62                 |
| <i>Obs.</i>                    | 240         | 240        | 240                           | 240                     | 240                     |

*Notes.* This table reports average contributions as well as estimates and predictions from various specifications of the model based on the efficiency concerns assumption using the last 5 rounds of the experiment only. The same remarks as in table 5.1 apply.

subgroups ( $S = 3$ ).<sup>4</sup> As before, we conduct our analysis both by including all rounds of the experiment and by focusing on the last five repetitions only.

We find strong evidence of heterogeneity. Focusing on the analysis across all rounds, according to the model with two sub-groups, a subject is associated with  $\alpha_1 = 0$  with probability 0.66 and with  $\alpha_2 = 0.53$  with probability 0.34. Results are even sharper in the model with three subgroups: in this case  $\alpha_1 = 0$  and the two other  $\alpha$ -parameters are strictly positive:  $\alpha_2 = 0.43$  and  $\alpha_3 = 1.04$ . Subjects are associated with these values with probabilities 0.41, 0.50 and 0.09, respectively. Thus, in the more parsimonious model, the majority of subjects contribute in a way that is compatible with the preference for (group) efficiency hypothesis. These proportions are in line with findings of previous studies (Andreoni 1995, Brandts & Schram 2001, Houser & Kurzban 2002) in which, allowing for confusion, social preferences explain the behavior of about half of the experimental population.

Heterogeneity across subjects reduces the estimated randomness in subjects' contributions: the value of  $\mu$  reduces from 41.59 in specification (3) of the model with homogeneous population (table 5.1), to 28.50 and 22.14 in the model with two and three subgroups, respectively. According to a likelihood-ratio test, both the models with  $S = 2$  and  $S = 3$  fit the data better than the (unconstrained) specification of the model with homogeneous subjects (for the model with  $S = 2$ ,  $LR = 117.25$ ;  $\Pr\{\chi^2(2) > LR\} < 0.01$ ; whereas for the model with  $S = 3$ ,  $LR = 174.66$ ;  $\Pr\{\chi^2(4) > LR\} < 0.01$ ). Moreover, adding an

<sup>4</sup>We have also estimated a model with  $S = 4$ . However, adding a fourth sub-group does not significantly improve the goodness of fit of the model compared to the specification with  $S = 3$ . In particular, with  $S = 4$ , the point estimates for the model with all periods are:  $\mu = 21.81$ ,  $\alpha_1 = 0$ ,  $\alpha_2 = 0.38$ ,  $\alpha_3 = 0.61$ ,  $\alpha_4 = 1.04$ ,  $\gamma_1 = 0.39$ ,  $\gamma_2 = 0.42$ ,  $\gamma_3 = 0.09$ .

Table 5.3: Heterogeneous Subjects (all and last 5 rounds)

|                                | $\mu, \alpha_1, \alpha_2(n = 20)$ | $\mu, \alpha_1, \alpha_2(n = 5)$ | $\mu, \alpha_1, \alpha_2, \alpha_3(n = 20)$ | $\mu, \alpha_1, \alpha_2, \alpha_3(n = 5)$ |
|--------------------------------|-----------------------------------|----------------------------------|---|--|
| $\mu$                          | 28.50<br>[25.88; 31.26]           | 15.07<br>[12.90; 17.64]          | 22.14<br>[20.56; 23.95]                     | 14.25<br>[12.04; 16.85]                    |
| $\alpha_1$                     | 0<br>[0; 0.01]                    | 0<br>[0; 0.02]                   | 0<br>[0; 0.01]                              | 0<br>[0; 0.02]                             |
| $\alpha_2$                     | 0.53<br>[0.46; 0.60]              | 0.54<br>[0.47; 0.61]             | 0.43<br>[0.39; 0.46]                        | 0.48<br>[0.40; 0.56]                       |
| $\alpha_3$                     |                                   |                                  | 1.04<br>[0.92; 1.16]                        | 0.76<br>[0.53; 1.01]                       |
| $\gamma_1$                     | 0.66<br>[0.53; 0.78]              | 0.63<br>[0.50; 0.75]             | 0.41<br>[0.33; 0.46]                        | 0.59<br>[0.49; 0.64]                       |
| $\gamma_2$                     |                                   |                                  | 0.50<br>[0.43; 0.55]                        | 0.34<br>[0.23; 0.40]                       |
| (Predicted) Avg. Contributions |                                   |                                  |   |  |
| Overall endowments             | 37.15                             | 25.57                            | 38.51                                       | 25.72                                      |
| $w_i = 120$                    | 32.06                             | 22.17                            | 31.97                                       | 22.07                                      |
| $w_i = 160$                    | 36.04                             | 24.63                            | 36.78                                       | 24.68                                      |
| $w_i = 200$                    | 39.01                             | 26.77                            | 40.83                                       | 26.99                                      |
| $w_i = 240$                    | 41.48                             | 28.73                            | 44.45                                       | 29.13                                      |
| $\log ll$                      | -3112.06                          | -865.75                          | -3083.35                                    | -865.16                                    |
| <i>Obs.</i>                    | 960                               | 240                              | 960   | 240  |

*Notes.* This table reports estimates and predictions from two specifications of the model with efficiency concerns accounting for cross-subject heterogeneity in the value of  $\alpha$ . The analysis is conducted both by including all experimental rounds and by focusing on the last five repetitions only. Parameters are estimated through equation (5.6). Given the linear restriction  $\sum_{s=1}^S \gamma_s = 1$ , we only report estimates of  $\gamma_1, \gamma_2, \dots, \gamma_{S-1}$ . Confidence Intervals are computed using an inversion of the likelihood-ratio statistic, at the 0.01 level, subject to parameter constraints.

additional subgroup to the model with  $S = 2$ , significantly increases the goodness of fit of the specification ( $LR = 57.42$ ;  $\Pr\{\chi^2(2) > LR\} < 0.01$ ). As before, all these results remain qualitatively unchanged when we control for learning processes and focus on the last 5 experimental rounds.

In order to check for the robustness of our results in table 5.3, we have also estimated additional specifications accounting for heterogeneity in both concerns for (group) efficiency and noise in subjects' behaviors. Although the log-likelihood of the model with both sources of heterogeneity significantly improves in statistical terms, the estimated values of the  $\alpha$ -parameters remain qualitatively the same of those reported in table 5.3.

## 5.5 Conclusions

Is over-contribution in linear public good experiments explained by subjects' preference for (group) efficiency or does it rather simply reflect their natural attitude to make errors? In order to answer this fundamental question, we have built and estimated a quantal response equilibrium model in which, in choosing their contributions, subjects are influenced by both a genuine concern for (group) efficiency and a random noise in their behavior.

In line with other studies, we find that both concerns for (group) efficiency and noise in behaviors play an important role in determining subjects' contributions. However, assessing which of these two behavioral hypotheses is more relevant in explaining contributions strongly depends on the degree of cross-subject heterogeneity admitted by the model. Indeed, by estimating a model with homogeneous subjects, the parameter capturing concerns for (group) efficiency vanishes while noise in behavior entirely accounts for over-contribution. A different picture emerges when we allow the subjects to be heterogeneous in their concerns for efficiency. By estimating a model in which the population is partitioned into three subgroups that differ in the degree of concerns for efficiency, we find that the most of the subjects contribute in a way that is compatible with the preference for (group) efficiency hypothesis. A formal likelihood-ratio test confirms the supremacy of the QRE model with three subgroups over the other specifications.

Previous studies (Andreoni 1995, Brandts & Schram 2001, Goeree, Holt & Laury 2002, Houser & Kurzban 2002, Palfrey & Prisbrey 1996, Palfrey & Prisbrey 1997) tried to disentangle the effects of noise from other-regarding preferences mainly by manipulating the experimental design. Our approach adds a theoretical foundation in the form of an equilibrium analysis. In contrast to studies which focus mostly on (direct) altruism, we follow Corazzini, Faravelli & Stanca (2010) and allow for preference for efficiency. Our results are in line with the literature in the sense that we also conclude that a combination of noise and social concerns play a role. Our results, however, are directly supported by a sound theoretical framework proven valid in similar settings (e.g. Goeree & Holt 2005).

Recent studies (Erlei 2008, Fischbacher & Gaechter 2006) have emphasized the im-

portance of admitting heterogeneity in social preferences in order to better explain experimental evidence. In this chapter we show that neglecting heterogeneity in subjects' social preferences may lead to erroneous conclusions on the relative importance of the love for (group) efficiency hypothesis with respect to the confusion argument. Indeed, as revealed by our analysis, the coupling of cross-subject heterogeneity in concerns for (group) efficiency with noise in the decision process seems to be the relevant connection to better explain subjects' contributions.

## Appendix 5.A Maximum Likelihood of $\alpha$ for varying $\mu$ -values

Table 5.4 shows the Maximum Likelihood value of  $\alpha$  and the log-likelihood according to equation (5.5) as  $\mu$  decreases from 1000 to 0.4. As shown by the table, for high values of  $\mu$  the estimated value of  $\alpha$  is 0. When  $\mu$  is equal to 10, the estimated value of alpha is 0.50. Moreover, for  $\mu$  lower than 2.00, the estimated value of  $\alpha$  is 0.61. For the specification tests presented in section 5.4, we set  $\mu = 1$ . This is a sufficiently low value of  $\mu$  in order to generate a noisy version of the base model. Two arguments indicates why this choice is valid. First, for a range of values including  $\mu = 1$ , the estimated  $\alpha$  is stable. Moreover, since the log-likelihood of a model with  $\alpha = 0.61$  and  $\mu = 1$  is higher than that corresponding to a model with  $\mu=0.4$  (and similarly for  $\alpha = 0.64$ ), the choice of any  $\mu$  lower than 1 for the benchmark value would only reinforce the results of section 5.4. More specifically, both likelihood-ratio statistics comparing specifications (1) with specifications (2) and (3) of tables 5.1 and 5.2 would increase.

Table 5.4: Maximum Likelihood of  $\alpha$  for varying  $\mu$ -values

| $\mu$   | $\alpha$ | log-likelihood |
|---------|----------|----------------|
| 1000.00 | 0        | -3637.64       |
| 500.00  | 0        | -3591.79       |
| 333.33  | 0        | -3548.7        |
| 250.00  | 0        | -3508.34       |
| 200.00  | 0        | -3470.67       |
| 166.67  | 0        | -3435.64       |
| 142.86  | 0        | -3403.19       |
| 125.00  | 0        | -3373.25       |
| 111.11  | 0        | -3345.76       |
| 100.00  | 0        | -3320.64       |
| 90.91   | 0        | -3297.8        |
| 83.33   | 0        | -3277.17       |
| 76.92   | 0        | -3258.65       |
| 71.43   | 0        | -3242.16       |
| 66.67   | 0        | -3227.61       |
| 62.50   | 0        | -3214.93       |
| 58.82   | 0        | -3204.01       |
| 55.56   | 0        | -3194.79       |
| 52.63   | 0        | -3187.18       |
| 50.00   | 0        | -3181.1        |
| 40.00   | 0        | -3171.22       |
| 30.30   | 0.14     | -3192.52       |
| 20.00   | 0.33     | -3247.22       |
| 10.00   | 0.50     | -3444.42       |
| 9.09    | 0.52     | -3488.26       |
| 8.00    | 0.53     | -3555.57       |
| 7.04    | 0.55     | -3634.45       |
| 5.99    | 0.56     | -3753.67       |
| 5.00    | 0.57     | -3916.89       |
| 4.00    | 0.58     | -4173.35       |
| 3.00    | 0.59     | -4615.92       |
| 2.00    | 0.60     | -5547.35       |
| 1.00    | 0.61     | -8506.13       |
| 0.90    | 0.61     | -9181.67       |
| 0.80    | 0.61     | -10032.07      |
| 0.70    | 0.61     | -11133.38      |
| 0.60    | 0.61     | -12612.63      |
| 0.50    | 0.61     | -14699.13      |
| 0.40    | 0.61     | -17852.64      |

*Notes.* This table reports Maximum Likelihood estimates of  $\alpha$  for selected values of  $\mu$  (see equation (5.5)). The last column reports the corresponding log-likelihood value.

# Bibliography

- Andersen, Steffen, Glenn W. Harrison, Morten Igel Lau & E. Elisabet Rutström. 2010. "Preference heterogeneity in experiments: Comparing the field and laboratory." *Journal of Economic Behavior and Organization* 73(2):209–224.
- Andreoni, James. 1988. "Why free ride? : Strategies and learning in public goods experiments." *Journal of Public Economics* 37(3):291–304.
- Andreoni, James. 1989. "Giving with Impure Altruism: Applications to Charity and Ricardian Equivalence." *The Journal of Political Economy* 97(6):1447–1458.
- Andreoni, James. 1990. "Impure Altruism and Donations to Public Goods: A Theory of Warm-Glow Giving." *The Economic Journal* 100(401):464–477.
- Andreoni, James. 1995. "Cooperation in Public-Goods Experiments: Kindness or Confusion?" *The American Economic Review* 85(4):891–904.
- Arcelus, Francisco & Allen Meltzer. 1975. "The effect of aggregate economic variables on congressional elections." *American Political Science Review* 69(4):1232–1239.
- Austen-Smith, David & Jeffrey S. Banks. 1996. "Information Aggregation, Rationality, and the Condorcet Jury Theorem." *The American Political Science Review* 90(1):34–45.
- Bacharach, Michael. 2006. *Beyond Individual Choice: Teams and Frames in Game Theory*. New Jersey: Princeton University Press. Edited by Natalie Gold and Robert Sugden.
- Bendor, Jonathan, Daniel Diermeier & Michael Ting. 2003. "A Behavioral Model of Turnout." *The American Political Science Review* 97(2):261–280.
- Bernasconi, Michele, Luca Corazzini & Anna Marenzi. 2010. "'Expressive' Obligations in Public Good Games: Crowding-in and Crowding-out Effects." Working Paper 2010(04), University of Venice "Ca' Foscari", Department of Economics.
- Blais, André & Richard Nadeau. 1996. "Measuring strategic voting: A two-step procedure." *Electoral Studies* 15(1):39–52.

- Blais, André, Richard Nadeau, Elisabeth Gidengil & Neil Neviite. 2001. "Measuring strategic voting in multiparty plurality elections." *Electoral Studies* 20(3):343–352.
- Bloom, Harold & H. Douglas Price. 1975. "Voter response to short-run economic conditions: The asymmetric effect of prosperity and recession." *American Political Science Review* 69(4):1240–1254.
- Bolton, Gary E & Axel Ockenfels. 2000. "ERC: A Theory of Equity, Reciprocity, and Competition." *The American Economic Review* 90(1):166–193.
- Bordignon, Massimo. 1990. "Was Kant Right? Voluntary Provision of Public Goods under the Principle of Unconditional Commitment." *Economic Notes* 3:342–372.
- Brandts, Jordi & Arthur Schram. 2001. "Cooperation and noise in public goods experiments: applying the contribution function approach." *Journal of Public Economics* 79(2):399–427.
- Brown, Lloyd B. & Henry W. Chappell. 1999. "Forecasting presidential elections using history and polls." *International Journal of Forecasting* 15(2):127–135.
- Cain, Bruce E. 1978. "Strategic Voting in Britain." *American Journal of Political Science* 22(3):639–655.
- Chamlee-Wright, Emily. 2010. "Expectations of Government's Response to Disaster." *Public Choice* 144(1):253–274.
- Charness, Gary & Matthew Rabin. 2002. "Understanding Social Preferences with Simple Tests." *Quarterly Journal of Economics* 117(3):817–869.
- Clinton, Joshua D. & Adam Meirowitz. 2004. "Testing Explanations of Strategic Voting in Legislatures: A Reexamination of the Compromise of 1790." *American Journal of Political Science* 48(4):675–689.
- Conlisk, John. 1996. "Why Bounded Rationality?" *Journal of Economic Literature* 34(2):669–700.
- Cook, R. Dennis & Sanford Weisberg. 1990. "Confidence Curves in Nonlinear Regression." *Journal of the American Statistical Association* 85(410):544–551.
- Cookson, R. 2000. "Framing Effects in Public Goods Experiments." *Experimental Economics* 3:55–79.
- Corazzini, Luca & Marcelo Tyszler. 2010. "Love for Efficiency or Confusion? A QRE Analysis of Individual Contributions in a Public Good Game." ISLA Working Papers 37, ISLA, Centre for research on Latin American Studies and Transition Economies, Universita' Bocconi, Milano, Italy.

- Corazzini, Luca, Marco Faravelli & Luca Stanca. 2010. "A Prize To Give For: An Experiment on Public Good Funding Mechanisms." *The Economic Journal* 120(547):944–967.
- Cox, David R. & David V. Hinkley. 1979. *Theoretical Statistics*. London: Chapman and Hall.
- Downs, Anthony. 1957. "An Economic Theory of Political Action in a Democracy." *The Journal of Political Economy* 65(2):135–150.
- Duch, Raymond M., Harvey D. Palmer & Christopher J. Anderson. 2000. "Heterogeneity in Perceptions of National Economic Conditions." *American Journal of Political Science* 44(4):635–652.
- Duch, Raymond & Randolph Stevenson. 2011. "Context and Economic Expectations: When do Voters Get it Right?" *British Journal of Political Science* 41(1):1–31.
- Engelmann, Dirk & Martin Strobel. 2004. "Inequality Aversion, Efficiency, and Maximin Preferences in Simple Distribution Experiments." *The American Economic Review* 94(4):857–869.
- Erev, Ido & Alvin E. Roth. 1998. "Predicting How People Play Games: Reinforcement Learning in Experimental Games with Unique, Mixed Strategy Equilibria." *The American Economic Review* 88(4):848–881.
- Erikson, Robert S. & Christopher Wlezien. 1999. "Presidential Polls as a Time Series: The Case of 1996." *The Public Opinion Quarterly* 63(2):163–177.
- Erlei, Mathias. 2008. "Heterogeneous social preferences." *Journal of Economic Behavior and Organization* 65(3-4):436–457.
- Falk, Armin & Urs Fischbacher. 2006. "A theory of reciprocity." *Games and Economic Behavior* 54(2):293–315.
- Farquharson, Robin. 1969. *Theory of Voting*. New Haven, Conn: Yale University Press.
- Feddersen, Timothy & Alvaro Sandroni. 2006. "A Theory of Participation in Elections." *The American Economic Review* 96(4):1271–1282.
- Fehr, Ernst & Klaus M. Schmidt. 1999. "A Theory Of Fairness, Competition, and Cooperation." *Quarterly Journal of Economics* 114(3):817–868.
- Fenno, Richard. 1978. *Homestyle: House Members and Their Districts*. Boston, MA: Little, Brown.

- Fey, Mark. 1997. "Stability and Coordination in Duverger's Law: A Formal Model of Preelection Polls and Strategic Voting." *The American Political Science Review* 91(1):135–147.
- Fiorina, Morris. 1978. "Economic Retrospective Voting in American National Elections: A Micro-Analysis." *American Journal of Political Science* 22(2):426–443.
- Fischbacher, Urs. 2007. "z-Tree: Zurich Toolbox for Ready-made Economic Experiments." *Experimental Economics* 10(2):171–178.
- Fischbacher, Urs & Simon Gaechter. 2006. "Heterogeneous Social Preferences and the Dynamics of Free Riding in Public Goods." *IZA Discussion Paper* No. 2011.
- Fischbacher, Urs, Simon Gaechter & Ernst Fehr. 2001. "Are people conditionally cooperative? Evidence from a public goods experiment." *Economics Letters* 71(3):397–404.
- Forsythe, Robert, Roger B. Myerson, Thomas A. Rietz & Robert J. Weber. 1993. "An experiment on coordination in multi-candidate elections: The importance of polls and election histories." *Social Choice and Welfare* 10:223–247.
- Forsythe, Robert, Thomas A. Rietz, Roger B. Myerson & Robert J. Weber. 1996. "An experimental study of voting rules and polls in three-candidate elections." *International Journal of Game Theory* 25:355–383.
- Galbraith, John W. & Nicol C. Rae. 1989. "A Test of the Importance of Tactical Voting: Great Britain, 1987." *British Journal of Political Science* 19(1):126–136.
- Gelman, Andrew & Gary King. 1993. "Why are American presidential election campaign polls so Variable when votes are so Predictable?" *British Journal of Political Science* 23:409–451.
- Gerber, Elisabeth R., Rebecca B. Morton & Thomas A. Rietz. 1998. "Minority Representation in Multimember Districts." *The American Political Science Review* 92(1):127–144.
- Goeree, Jacob K. & Charles A. Holt. 2005. "An Explanation of Anomalous Behavior in Models of Political Participation." *The American Political Science Review* 99(2):201–213.
- Goeree, Jacob K., Charles A. Holt & Susan K. Laury. 2002. "Private costs and public benefits: unraveling the effects of altruism and noisy behavior." *Journal of Public Economics* 83(2):255–276.
- Goldfinger, Johnny. 2004. The Normative Implications of Cyclical Majorities in Theory and Practice. In *Workshop on Political Theory and Public Policy*.

- Gomez, Brad T. & J. Matthew Wilson. 2001. "Political Sophistication and Economic Voting in the American Electorate: A Theory of Heterogeneous Attribution." *American Journal of Political Science* 45(4):899–914.
- Gomez, Brad T. & J. Matthew Wilson. 2007. "Economic Voting and Political Sophistication: Defending Heterogeneous Attribution." *Political Research Quarterly* 60(3):555–558.
- Grafstein, Robert. 2005. "The Impact of Employment Status on Voting Behavior." *Journal of Politics* 67(3):804–824.
- Gratschew, Maria. 2001. "Compulsory Voting." IDEA - International Institute for Democracy and Electoral Assistance: <http://www.idea.int/vt/compulsoryvoting.cmf>.
- Greiner, Ben. 2004. An Online Recruitment System for Economic Experiments. In *Forschung und wissenschaftliches Rechnen 2003. GWDG Bericht 63*, ed. Kurt Kremer & Volker Macho. Göttingen: Ges. für Wiss. Datenverarbeitung pp. 79–93.
- Großer, Jens & Arthur Schram. 2010. "Public Opinion Polls, Voter Turnout, and Welfare: An Experimental Study." *American Journal of Political Science* 54(3):700–717.
- Gross, Donald A. 1979. "Conference Committees, Sophisticated Voting, and Cyclical Majorities." *Legislative Studies Quarterly* 4(1):79–94.
- Hetherington, Marc. 1996. "The Media's Role in Forming Voters' National Economic Evaluations in 1992." *American Journal of Political Science* 40(2):372–395.
- Ho, Teck-Hua, Colin Camerer & Keith Weigelt. 1998. "Iterated Dominance and Iterated Best Response in Experimental "p-Beauty Contests"." *The American Economic Review* 88(4):947–969.
- Holländer, Heinz. 1990. "A Social Exchange Approach to Voluntary Cooperation." *The American Economic Review* 80(5):1157–1167.
- Houser, Daniel & Robert Kurzban. 2002. "Revisiting Kindness and Confusion in Public Goods Experiments." *The American Economic Review* 92(4):1062–1069.
- Kinder, Donald R. & D. Roderick Kiewiet. 1979. "Economic Discontent and Political Behavior: The Role of Personal Grievances and Collective Economic Judgments in Congressional Voting." *American Journal of Political Science* 23(3):495–527.
- Kurrild-Klitgaard, Peter. 2001. "An Empirical Example of the Condorcet Paradox of Voting in a Large Electorate." *Public Choice* 107(1/2):135–145.

- Laffont, Jean-Jacques. 1975. "Macroeconomic Constraints, Economic Efficiency and Ethics: An Introduction to Kantian Economics." *Economica* 42(168):430–437.
- Lau, Richard & David Redlawsk. 2006. *How Voters Decide*. New York: Cambridge University Press.
- Lehtinen, Aki. 2007. The Welfare Consequences of Strategic Voting. PhD thesis Erasmus Universty Rotterdam.
- Lepper, Susan. 1974. "Voting behavior and aggregate policy targets." *Public Choice* 25(2):67–82.
- Levine, David K. 1998. "Modeling Altruism and Spitefulness in Experiments." *Review of Economic Dynamics* 1(3):593–622.
- Levine, David K. & Thomas R. Palfrey. 2007. "The Paradox of Voter Participation? A Laboratory Study." *The American Political Science Review* 101(1):143–158.
- Lewis-Beck, Michael S. & Charles Tien. 1996. "The Future in Forecasting: Prospective Presidential Models." *American Politics Quarterly* 24(4):468–491.
- Lewis-Beck, Michael S. & Martin Paldam. 2000. "Economic Voting: An Introduction." *Electoral Studies* 19:113–121.
- Lewis-Beck, Michael S. & Tom W. Rice. 1984. "Forecasting U.S. House Elections." *Legislative Studies Quarterly* 9(3):475–486.
- Lijphart, Arend. 1997. "Unequal Participation: Democracy's Unresolved Dilemma." *The American Political Science Review* 91(1):1–14.
- Lowi, Theodore. 1964. "American Business and Public Policy, Case Studies, and Political Theory." *World Politics* 16:677–715.
- MacKuen, Michael B., Robert S. Erikson & James A. Stimson. 1992. "Peasants or Bankers? The American Electorate and the U.S. Economy." *American Political Science Review* 86(3):597–611.
- Mayhew, David. 1974. *Congress: The Electoral Connection*. New Haven, CT: Yale University Press.
- McKelvey, Richard D. & Peter C. Ordeshook. 1986. "Information, Electoral Equilibria and the Democratic Ideal." *The Journal of Politics* 48(4):909–937.
- McKelvey, Richard D. & Thomas R. Palfrey. 1995. "Quantal Response Equilibria for Normal Form Games." *Games and Economic Behavior* 10(1):6–38.

- Morton, Rebecca B. & Kenneth C. Williams. 1999. "Information Asymmetries and Simultaneous versus Sequential Voting." *The American Political Science Review* 93(1):51–67.
- Morton, Rebecca B. & Kenneth C. Williams. 2001. *Learning by Voting*. Ann Arbor, MI: University of Michigan Press.
- Murphy, S. A. 1995. "Likelihood Ratio-Based Confidence Intervals in Survival Analysis." *Journal of the American Statistical Association* 90(432):1399–1405.
- Myatt, David P. & Stephen D. Fisher. 2002. "Tactical Coordination in Plurality Electoral Systems." *Oxford Review of Economic Policy* 18(4):504–522.
- Myerson, Roger B. & Robert J. Weber. 1993. "A Theory of Voting Equilibria." *The American Political Science Review* 87(1):102–114.
- Nannestad, Peter & Martin Paldam. 1994. "The VP-function: A survey of the literature on vote and popularity functions after 25 years." *Public Choice* 79:213–245.
- Neufeld, John L., William J. Hausman & Ronald B. Rapoport. 1994. "A Paradox of Voting: Cyclical Majorities and the Case of Muscle Shoals." *Political Research Quarterly* 47(2):423–438.
- Nitzan, Shmuel & Uriel Procaccia. 1986. "Optimal Voting Procedures for Profit Maximizing Firms." *Public Choice* 51(2):191–208.
- Norpoth, Helmut. 1996. "Of Time and Candidates: A Forecast for 1996." *American Politics Quarterly* 24(4):443–467.
- Palfrey, Thomas R. 1989. A mathematical proof of Duverger's Law. In *Models of Strategic Choice in Politics*, ed. Peter Ordeshook. The University of Michigan Press pp. 69–91.
- Palfrey, Thomas R. 2006. Laboratory Experiments in Political Economy. In *Handbook of Political Economy*, ed. B. Weingast & D. Wittman. Oxford University Press.
- Palfrey, Thomas R. & Howard Rosenthal. 1983. "A Strategic Calculus of Voting." *Public Choice* 41(1):7–53.
- Palfrey, Thomas R. & Howard Rosenthal. 1985. "Voter Participation and Strategic Uncertainty." *The American Political Science Review* 79(1):62–78.
- Palfrey, Thomas R. & Jeffrey E. Prisbrey. 1996. "Altruism, reputation and noise in linear public goods experiments." *Journal of Public Economics* 61(3):409–427.

- Palfrey, Thomas R. & Jeffrey E. Prisbrey. 1997. "Anomalous Behavior in Public Goods Experiments: How Much and Why?" *The American Economic Review* 87(5):829–846.
- Rabin, Matthew. 1993. "Incorporating Fairness into Game Theory and Economics." *The American Economic Review* 83(5):1281–1302.
- Riker, William H. 1982a. *Liberalism against populism: A confrontation between the theory of democracy and the theory of social choice*. San Francisco: W. H. Freeman.
- Riker, William H. 1982b. "The Two-Party System and Duverger's Law: An Essay on the History of Political Science." *The American Political Science Review* 76(4):753–766.
- Rivers, Douglas. 1988. "Heterogeneity in Models of Electoral Choice." *American Journal of Political Science* 32(3):737–757.
- Schram, Arthur & Joep Sonnemans. 1996a. "Voter turnout as a participation game: An experimental investigation." *International Journal of Game Theory* 25:385–406.
- Schram, Arthur & Joep Sonnemans. 1996b. "Why people vote: Experimental evidence." *Journal of Economic Psychology* 17(4):417–442.
- Schram, Arthur & Joep Sonnemans. 2011. "How individuals choose health insurance: An experimental analysis." *European Economic Review* 55(6):799–819.
- Schwenk, Charles R. 1984. "Cognitive Simplification Processes in Strategic Decision-Making." *Strategic Management Journal* 5(2):111–128.
- Stahl, Dale O. & Ernan Haruvy. 2008. "Level-n bounded rationality in two-player two-stage games." *Journal of Economic Behavior and Organization* 65(1):41–61.
- Stahl, Dale O. & Paul W. Wilson. 1995. "On Players' Models of Other Players: Theory and Experimental Evidence." *Games and Economic Behavior* 10(1):218–254.
- Sugden, Robert. 1984. "Reciprocity: The Supply of Public Goods Through Voluntary Contributions." *The Economic Journal* 94(376):772–787.
- Sugden, Robert. 2003. "The Logic of Team Reasoning." *Philosophical Explorations* 6(3):165–181.
- Swank, Otto. 1990. "Presidential Popularity and Reputation." *De Economist* 138(2):168–180.
- Turocy, Theodore L. 2005. "A dynamic homotopy interpretation of the logistic quantal response equilibrium correspondence." *Games and Economic Behavior* 51(2):243–263. Special Issue in Honor of Richard D. McKelvey.

- Turocy, Theodore L. 2010. "Computing sequential equilibria using agent quantal response equilibria." *Economic Theory* 42:255–269.
- Tyszler, Marcelo. 2008. Information and Strategic Voting. Master's thesis Tinbergen Institute.
- Tyszler, Marcelo & Arthur Schram. 2011. "Information and Strategic Voting." Tinbergen Institute Discussion Papers TI 2011-025/1, Tinbergen Institute.
- Wartko, Karen J. 2007. "Voting system for making family decisions and method employing such system." Patent. US 7252229.
- Wlezien, Christopher & Robert S. Erikson. 1996. "Temporal Horizons and Presidential Election Forecasts." *American Politics Quarterly* 24(4):492–505.



# Samenvatting (summary in Dutch)<sup>1</sup>

Stemmen is waarschijnlijk het instrument dat het meest geassocieerd wordt met het idee van democratische besluitvorming. Er wordt gestemd bij nationale en lokale verkiezingen, om besluiten te nemen in een parlement, door commissies, jury's en ook in raden van bestuur. Een goed begrip van het gedrag van kiezers is daarom van groot belang voor verschillende vakgebieden. In dit proefschrift benaderen we kiezersgedrag vanuit het perspectief van de politieke economie. Daarnaast onderzoeken we andere aspecten van individueel gedrag in de publieke arena.

In hoofdstuk 2 onderzoeken we kiezersgedrag, zowel theoretisch als experimenteel, in een omgeving gekenmerkt door drie kandidaten, een pluraliteitsregel en stemplicht. We kijken of strategisch stemgedrag optreedt in een omgeving waarin Condorcet cycli kunnen voorkomen. In het bijzonder richten we ons op de vraag hoe informatie over de verdeling van voorkeuren invloed heeft op strategisch gedrag. Hierbij variëren we ook de relatieve waardering van de op een na favoriete kandidaat. 'Quantal response' evenwichtsanalyse wordt gebruikt om het spel te analyseren en blijkt een goede voorspeller voor de experimentele data. Uit onze resultaten blijkt dat mensen inderdaad strategisch stemmen. De mate waarin men strategisch stemt is afhankelijk van (i) de beschikbaarheid van informatie, (ii) de relatieve waardering van de op een na favoriete kandidaat, (iii) de populariteit binnen het electoraat van de favoriete kandidaat van een kiezer, en (iv) de relatieve waardering van de kiezer voor de meest populaire kandidaat in het electoraat. Onze resultaten laten zien dat informatie als een coördinatiemechanisme dient waarbij strategisch stemmen niet schadelijk blijkt te zijn voor de kansen van de kandidaat die de grootste steun geniet.

In hoofdstuk 3 onderzoeken we kiezersgedrag in een vergelijkbare setting. In tegenstelling tot hoofdstuk 2, kunnen kiezers binnen hetzelfde electoraat nu verschillen in hun relatieve waardering van de drie kandidaten. Dit introduceert heterogeniteit in de voorkeuren van het electoraat. We onderzoeken drie verschillende situaties met betrekking tot informatie: *geen informatie*, waarbij kiezers alleen hun eigen voorkeur kennen; *geaggregeerde informatie*, waarbij ze daarnaast de gerealiseerde verdeling van de preferenties weten en *volledige informatie*, waarbij ze ook weten hoe de relatieve waardering van de

---

<sup>1</sup>Deze samenvatting is tot stand gekomen met behulp van Rosalie de Vries, Arthur Schram en Roel van Veldhuizen.

opties is verdeeld binnen het electoraat. Een algemeen resultaat is dat heterogeniteit leidt tot minder strategisch stemmen in ons experiment. We constateren echter, zowel theoretisch als experimenteel, dat de belangrijkste resultaten uit hoofdstuk 2 robuust blijken tegen de introductie van voorkeurheterogeniteit. Daarnaast lijken verschillen in informatie over de totale verdeling van voorkeuren de beste verklaring te geven voor waargenomen verschillen in stemgedrag.

Ondanks een uitgebreide literatuur over ‘economisch stemmen’ heeft zich nog geen echte consensus ontwikkeld over de invloed van economische overwegingen op de stemkeuze. Een mogelijke reden hiervoor is de inherente complexiteit van het politieke klimaat. Om de effecten van economische overwegingen te isoleren, ontwikkelen en presenteren we in hoofdstuk 4 een laboratoriumexperiment dat het mogelijk maakt deze overwegingen te variëren op drie niveaus: het individu, de gemeenschap en de nationale economie. Keuzes door een beleidsmaker hebben direct invloed op de resultaten op elk van deze niveaus, zodat we kunnen testen op ‘egotropic’, ‘communitropic’, en ‘sociotropic’ stemmen. Ons ontwerp stelt ons in staat om specifiek te observeren welke informatie door kiezers als relevant wordt beschouwd en in welke mate ‘de economie’ van belang wordt geacht. Hoofdstuk 4 presenteert onzes inziens de eerste experimentele studie die expliciet onderzoekt hoe verschillende niveaus van economische overwegingen de stemkeuze beïnvloeden. We observeren een vraag naar informatie, in een omgeving waar traditionele economische argumenten voorspellen dat er geen vraag zou moeten zijn en dat het stemmen gebaseerd zou zijn op pure ‘egotropic’ (egoïstische) gronden. Wij zien dat de vraag naar informatie afneemt naarmate de complexiteit van de omgeving toeneemt en dat geïnformeerde kiezers meer ‘sociotropic’ stemmen. Bovendien lijken kiezers meer ‘extreem’ te kiezen in enquêtes waarin hun oordeel wordt gevraagd dan in werkelijke verkiezingen.

In hoofdstuk 5 stellen we de vraag in welke mate bijdragen aan publieke goederen in een ‘public good game’ zijn toe te schrijven aan het bewust nastreven van een gemeenschappelijk goed (efficiëntie), dan wel kunnen worden afgedaan aan ruis in het individueel gedrag. Met behulp van een evenwichtsbenadering gebaseerd op ‘bounded rationality’ schatten we het relatieve belang van efficiëntie en ruis. Met data uit een ‘public good game’ experiment met heterogene ‘endowment’ en asymmetrische informatie, schatten we een ‘quantal response’ evenwicht voor een model waarbij proefpersonen een voorkeur kunnen hebben voor efficiëntie. Onder de aanname van een homogene bevolking, lijkt het grootste deel van de bijdragen te kunnen worden verklaard door ruis. Het resultaat wordt anders wanneer we heterogeniteit tussen individuen introduceren. In dit geval levert een meerderheid van de proefpersonen een bijdrage die verenigbaar is met de hypothese dat mensen een voorkeur hebben voor efficiëntie. Een formele ‘likelihood-ratio’ test verworpt sterk de modellen die geen ruis toestaan en een homogene populatie aannemen en ondersteunt de meer algemene QRE uitbreiding met heterogene voorkeuren en ruis.

The Tinbergen Institute is the Institute for Economic Research, which was founded in 1987 by the Faculties of Economics and Econometrics of the Erasmus University Rotterdam, University of Amsterdam and VU University Amsterdam. The Institute is named after the late Professor Jan Tinbergen, Dutch Nobel Prize laureate in economics in 1969. The Tinbergen Institute is located in Amsterdam and Rotterdam. The following books recently appeared in the Tinbergen Institute Research Series:

- 467 T. FARENHORST-YUAN, *Efficient Simulation Algorithms for Optimization of Discrete Event Based on Measure Valued Differentiation*.
- 468 M.I. OCHEA, *Essays on Nonlinear Evolutionary Game Dynamics*.
- 469 J.L.W. KIPPERSLUIS, *Understanding Socioeconomic Differences in Health An Economic Approach*.
- 470 A. AL-IBRAHIM, *Dynamic Delay Management at Railways: A Semi-Markovian Decision Approach*.
- 471 R.P. FABER, *Prices and Price Setting*.
- 472 J. HUANG, *Education and Social Capital: Empirical Evidences from Microeconomic Analyses*.
- 473 J.W. VAN DER STRAATEN, *Essays on Urban Amenities and Location Choice*.
- 474 K.M. LEE, *Filtering Non Linear State Space Models: Methods and Economic Applications*.
- 475 M.J. REINDERS, *Managing Consumer Resistance to Innovations*.
- 476 A. PARAKHONYAK, *Essays on Consumer Search, Dynamic Competition and Regulation*.
- 477 S. GUPTA, *The Study of Impact of Early Life Conditions on Later Life Events: A Look Across the Individual's Life Course*.
- 478 J. LIU, *Breaking the Ice between Government and Business: From IT Enabled Control Procedure Redesign to Trusted Relationship Building*.
- 479 D. RUSINOVA, *Economic Development and Growth in Transition Countries*.
- 480 H. WU, *Essays on Top Management and corporate behavior*.
- 481 X. LIU, *Three Essays on Real Estate Finance*
- 482 E.L.W. JONGEN, *Modelling the Impact of Labour Market Policies in the Netherlands*
- 483 M.J. SMIT, *Agglomeration and Innovations: Evidence from Dutch Microdata*
- 484 S.VAN BEKKUM, *What is Wrong With Pricing Errors? Essays on Value Price Divergence*
- 485 X. HU, *Essays on Auctions*
- 486 A.A. DUBOVNIK, *Economic Dances for Two (and Three)*
- 487 A.M. LIZYAYEV, *Stochastic Dominance in Portfolio Analysis and Asset Pricing*
- 488 B. SCHWAAB, *Credit Risk and State Space Methods*
- 489 N. BASTÜRK, *Essays on parameter heterogeneity and model uncertainty*

- 490 E.GUTIÉRREZ PUIGARNAU, *Labour markets, commuting and company cars*
- 491 M.W. VORAGE, *The Politics of Entry*
- 492 A.N. HALSEMA, *Essays on Resource Management: Ownership, Market Structures and Exhaustibility*
- 493 R.E. VLAHU, *Three Essays on Banking*
- 494 N.E. VIKANDER, *Essays on Teams and the Social Side of Consumption*
- 495 E. DEMIREL, *Economic Models for Inland Navigation in the Context of Climate Change*
- 496 V.A.C. VAN DEN BERG, *Congestion pricing with Heterogeneous travellers*
- 497 E.R. DE WIT, *Liquidity and Price Discovery in Real Estate Assets*
- 498 C. LEE, *Psychological Aspects of the Disposition Effect: An Experimental Investigation*
- 499 MHA. RIDHWAN, *Regional Dimensions of Monetary Policy in Indonesia*
- 500 J. GARCÍA, *The moral herd: Groups and the Evolution of Altruism and Cooperation*
- 501 F.H. LAMP, *Essays in Corporate Finance and Accounting*
- 502 J. SOL, *Incentives and Social Relations in the Workplace*
- 503 A.I.W. HINDRAYANTO, *Periodic Seasonal Time Series Models with applications to U.S. macroeconomic data*
- 504 J.J. DE HOOP, *Keeping Kids in School: Cash Transfers and Selective Education in Malawi*
- 505 O. SOKOLINSKIY, *Essays on Financial Risk: Forecasts and Investor Perceptions*
- 506 T. KISELEVA, *Structural Analysis of Complex Ecological Economic Optimal Management Problems*
- 507 U. KILINC, *Essays on Firm Dynamics, Competition and Productivity*
- 508 M.J.L. DE HEIDE, *R&D, Innovation and the Policy Mix*
- 509 F. DE VOR, *The Impact and Performance of Industrial Sites: Evidence from the Netherlands*
- 510 J.A. NON, *Do ut Des: Incentives, Reciprocity, and Organizational Performance*
- 511 S.J.J. KONIJN, *Empirical Studies on Credit Risk*
- 512 H. VRIJBURG, *Enhanced Cooperation in Corporate Taxation*
- 513 P.ZEPPINI, *Behavioural Models of Technological Change*
- 514 P.H.STEFFENS, *It's Communication, Stupid! Essays on Communication, Reputation and (Committee) Decision-Making*
- 515 K.C. YU, *Essays on Executive Compensation - Managerial Incentives and Disincentives*
- 516 P. EXTERKATE, *Of Needles and Haystacks: Novel Techniques for Data-Rich Economic Forecasting*