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Coalition Dynamics, Voting Strategies, and Redistributive Policies:

Theoretical and Experimental Perspectives

Thesis Advisors
Prof. Giuseppe Attanasi
Prof. Luca Panaccione

Candidate
Maria Luigia Signore
1999615

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General Introduction

In contemporary economic-political systems, all economic agents, from policymakers to citizens, are called to make decisions that systematically impact institutional equilibria and policy outcomes. Political decision-makers must first be able to design effective policies that address the needs and preferences of citizens. In turn, citizens, recognizing the value of these proposals, elect representatives who can implement them effectively. Among these decisions are those related to redistributive policies, which regulate the trade-off between equity and efficiency. However, both policymakers and citizens often make their decisions under conditions of uncertainty. Limited information, shifting political landscapes, and unpredictable economic fluctuations contribute to the complexity of decision-making processes. In this context, strategic dynamics play a crucial role in shaping political competition, democratic representation, and the allocation of resources. Understanding these interactions is essential for analyzing the formation and stability of political coalitions, voter behavior under uncertain conditions, and the balance between equity and economic efficiency in policy design.

Coalition formation is a critical area of study, since it examines how different parties align with one another to influence policy decisions, often in the pursuit of shared objectives. Coalitions can generally be classified into pre-electoral and post-electoral alliances. Although post-electoral coalitions are relatively stable and effective in governance, pre-electoral coalitions represent a particularly compelling case. By influencing electoral outcomes, they play a pivotal role in shaping strategic behavior and determining future political representation, ultimately setting the stage for policymaking and the power distribution within governing institutions. These pre-electoral coalitions profoundly affect voters' behavior, creating tensions between ideological loyalty and the desire for effective government representation, often leading to strategic voting. *Voting strategies* are equally important, as they describe the decision-making processes by which individuals or groups choose to support specific policies, candidates, or coalitions. These strategies often reflect voters' preferences given the available information and play a pivotal role in determining candidates' eligibility. Finally, *redistributive policies* are a central concern of economic and political systems, aiming to reduce inequality and distribute resources more equitably among society's members. However, such policies often come with a tradeoff: while they promote equity, they may reduce economic efficiency and alter individuals' incentives to work, save, and invest.

Therefore, this thesis consists of three distinct chapters that sequentially explore the complex dynamics of pre-electoral coalition formation (Chapter 1), voting strategies (Chapter 1 and Chapter 2), and redistributive choices (Chapter 3). This exploration is carried out through a combination of theoretical and experimental approaches, providing a comprehensive analysis of the behavioral conduct and the strategic interactions that shape political and economic outcomes. Specifically, the first chapter is a purely theoretical study that investigates the bargaining dynamics of pre-electoral coalitions and their influence on voting strategies. Differently, the second and third chapters present two theory-driven experiments that empirically examine strategic decision-making under different types of electoral ambiguity (the second) and redistributive choices under different types of taxation (the third). Below, I briefly outline the contents of these three chapters.

Chapter 1 – ***"The dynamics of Pre-Electoral Coalitions on Voting Strategies"***, co-authored with Michela Chessa (University of Côte d'Azur) – examines from a theoretical perspective the decision-making process of candidates in forming pre-electoral coalitions, and its impact on the subsequent voters' choices under the plurality system. It is a generalization of the model proposed by Shin (2019), with the introduction of a centrist candidate, next to two left-wing candidates and one right-wing candidate. In this model, pre-electoral opinion polls and ideological distances matter and play a fundamental role in defining the best strategies for both candidates and voters. Using a sequential game framework, it is found that only when opinion polls are disclosed: (i.) strategic voting arises, as voters maximize expected utility by supporting the most viable candidate while considering ideological proximity, benefiting the centrist the most; (ii.) candidates enter in a pre-electoral coalition bargaining only if (ii.a) forming a coalition provides higher expected utility than running individually, and (ii.b) the comparative advantage of being in that coalition holds across all potential coalitions.

Chapter 2 – ***"More ambiguity, more sincere voting? Evidence on the neglected role of primary elections"***, co-authored with Giuseppe Attanasi (Sapienza University of Rome), Etienne Farvaque (University of Lille, CNRS), Yoichi Hizen (Kochi University of Technology), and Yoshio Kamijo (Waseda University) – investigates how two different types of ambiguity, preference and outcome, influence voters' behavior during primary elections. Building on the model proposed by Bouton et al. (2017), which is assumed to be the preliminary stage of a primary election with ambiguity about the preference distribution, the framework is extended to include a second stage simulating general elections. This addition introduces outcome ambiguity, providing a more comprehensive representation of real-world electoral dynamics. Through a theory-driven experiment, which includes a cross-country comparison between Italy and Japan, it is analyzed how voters adapt their voting strategies under varying configurations of ambiguity. It is shown that increasing levels of ambiguity foster convergence toward a sincere voting equilibrium, wherein voters prioritize ideological alignment over strategic considerations, and are only marginally influenced by cultural and institutional factors.

Chapter 3 – ***"Equity or Efficiency: An Experimental Investigation"***, co-authored with Daniela Di Cagno (LUISS University of Rome) and Luca Panaccione (Sapienza University of Rome) – contributes to the broader debate on the equity-efficiency tradeoff by examining how individuals perceive and respond to it through a theory-driven experiment. Participants, engaged in a dyadic proposer-responder interaction, are tasked with redistributing an income between themselves and an anonymous counterpart while we manipulate levels of efficiency loss and the responder's veto power. Our findings reveal that: (i.) efficiency-seeking behavior increases as the equity-efficiency tradeoff worsens, with the extent of this shift varying across game types; (ii.) equity-seeking behavior increases with the responder's veto power; (iii.) despite efficiency loss and veto power, individuals' equity preferences remain stable.

These three chapters, while addressing different issues, share a common approach to investigating strategic choices and their implications for political and economic outcomes. The joint analysis of these phenomena allows us to better understand the dynamics of political representation in democratic systems and their management in resource redistribution.

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Chapter 1

The dynamics of Pre-Electoral Coalitions on Voting Strategies

Keywords: Opinion poll, Pre-electoral coalitions, Plurality system, Strategic voting

JEL codes: C70, D72, P16

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1.1 Introduction

Elections are a pivotal mechanism for citizen representation, with candidates and voters being the main actors in the democratic process. Candidates strive to secure many votes to govern, while electors base their voting decisions on their preferences. To enhance their chances of being elected, candidates often form Pre-Electoral Coalitions – henceforth, PECs (Powell, 2000; Golder, 2005; Golder, 2006a; Borges et al., 2021). Such coalitions are commonly seen in single-office elections, such as presidential or gubernatorial elections (Golder, 2006b; Bandyopadhyay et al., 2011), but also in multi-seat elections like parliamentary elections (Kellam, 2017; Hortala-Vallve et al., 2024). A notable example of PECs formation occurred during the 2024 European elections for the renewal of the European Parliament, where multiple coalitions were formed across EU member states to unite ideologically aligned parties and enhance their chances of securing parliamentary seats. In Italy, the right-wing PEC composed of *Fratelli d'Italia (FdI)*, *Lega*, and *Forza Italia (FI)* achieved significant success, gaining a substantial number of seats. In Spain, although the main parties *Partido Popular (PP)* and *Vox* competed separately for the right-wing vote,[1] other parties such as *Bildu*, *Esquerra Republicana*, and *BNG*[2] formed a joint list, illustrating how PECs can consolidate electoral support and achieve favorable electoral outcomes. In France, the right-wing victory in the European Parliament election prompted President Macron to dissolve the Assemblée Nationale and call for early legislative elections. During these elections, strategic bargaining among candidates to define coalitions emerged from both political sides, intending to counter the advance of the opposing political alignment. In light of these recent political developments, this chapter examines the bargaining dynamics underlying PECs' formation and explores how these coalitions influence voter strategies.

Golder (2005; 2006a; 2006b) provides a comprehensive analysis of PECs worldwide, highlighting their significance in both presidential and parliamentary contexts, and demonstrating their effects on different electoral systems. He identifies that out of 364 elections in 23 advanced parliamentary democracies from 1946 to 2002, there were 240 instances of pre-electoral agreements. Kellam (2017), studying the effect of PECs in 77 presidential elections across eleven Latin American countries, finds that 44% of the presidents were elected with the support of PECs. Moreover, Carroll and Cox (2007) and Debus (2009) provide empirical evidence that PECs significantly impact election outcomes and government formation. These coalitions typically form around the strongest contender, who, if elected, is more likely to implement policies aligned with the coalition partners' interests, reflecting a policy-seeking approach. Additionally, Goodin et al. (2008) illustrate how the timing of coalition formation reveals strategic behavior among candidates and influences voters' strategy on election day.

All of the studies mentioned have shown that PECs serve as a strategic means to coordinate political forces toward common goals and improve the benefits derived from electoral outcomes. Consequently, PECs typically form among candidates with ideological proximity (Golder, 2006a; Allern and Aylott, 2009; Debus, 2009; Glasgow et al., 2012; Ibenskas, 2016). If candidates tend to favor joint platforms according to a policy-seeking approach (see, e.g., Axelrod, 1970; De Swaan, 1973; Aleskerov et al., 2008), voters tend to perceive coalitions between ideologically similar candidates as more rational and acceptable. This happens because voters find it easier to understand and support coalitions that share common policy goals and values, which align with their own preferences. When candidates with similar ideologies join forces, it signals a coherent and unified vision, reducing ambiguity about the coalition's policy direction. This perceived ideological alignment increases voters' trust in the future coalition's ability to govern effectively and pursue consistent, predictable policies that reflect their own beliefs and interests. However, signals about coalition formation affect voters' perception of candidates' positions and the future government orientation (Jang et al., 2022), enabling voters to punish coalitions with heterogeneous ideologies by voting strategically (Hortala-Vallve et al., 2024).

Therefore, it is undeniable that candidates must consider the reaction of voters during the bargaining process to form PECs. Faced with a PEC, voters experience an internal conflict between the need to uphold their political ideology by voting sincerely for their preferred candidate regardless of contingent situations and the necessity for adequate government representation. Consequently, they may opt for strategic voting to avoid wasting their vote and to prevent the rise of the least desirable candidate to power (Duverger, 1951; Cox and Shugart, 1996; Cox, 1997; Alvarez and Nagler, 2000;

[1]While PP and VOX govern together in various autonomous communities (primarily through post-election agreements), they did not form a coalition at the national level. In the 2024 European elections, the two parties also ran separately, with PP joining the European People's Party (EPP) and VOX aligning with Patriots for Europe (PfE).

[2]BNG represents Basque, Catalan, and Galician independence movements, respectively

Bouton, 2013). In this way, the knowledge of pre-electoral coalitions and the outcomes of opinion polls provides valuable information to guide voters' choices. Voters may be inclined to vote for their second-best if their favorite candidate is unlikely to win according to the opinion poll or is part of what is perceived as a good coalition, and they may wish to avoid the victory of the less preferred candidate. This allows us to assume that PECs increase the strategic behavior of voters (Goodin et al., 2008; Hortala-Vallve et al., 2024).

However, the impact of PECs on electoral outcomes and the extent to which they affect voters' behavior vary significantly depending on the inherent voting rules of the electoral system. Bandyopadhyay et al. (2011) conducted a comparative analysis of coalition outcomes in parliamentary systems under plurality and proportional representation elections, considering various bargaining protocols and highlighting a diverse range of motivations behind the formation of coalitions. They assumed a continuum of voters, implying that individual voters are not strategic since no single voter can sway election outcomes. In contrast, Shin (2019) provides a theoretical framework to analyze the incentives behind PEC formation in single-office elections, considering three key factors: election rules, ideological distance, and pre-election opinion polls. His model considers three candidates – two leftists and one rightist – competing for a single office, where the two leftist candidates can strategically form a coalition before the election. Since candidates are both policy- and office-motivated, one candidate may withdraw in favor of the other by negotiating a joint policy platform. Comparing the effects under Plurality with the Runoff electoral system, Shin (2019) finds that: (i) PECs are more likely to form in plurality elections than in runoff systems; (ii) in runoff elections, coalition incentives increase as the first-round victory threshold decreases; (iii) greater ideological distance between potential coalition partners can encourage PEC formation, provided that their support base is divided; (iv) and the likelihood of coalition formation rises as the share of office benefits that can be transferred between candidates increases.

This chapter extends the original model of Shin (2019) by introducing a fourth centrist candidate, adding complexity to both coalition formation and voter behavior. The addition of this centrist candidate differentiates our model from Shin (2019) under three different perspectives. First, unlike the other candidates, the centrist can align with either the left or the right, shifting the model from a single coalition possibility – between the two left-wing candidates – to multiple potential PECs. This expanded framework reflects real-world electoral competition, where candidates span a broad ideological spectrum, from extreme right to extreme left, including moderate positions.

Second, by including a centrist candidate, our framework explicitly links coalition incentives to voters' strategic considerations. In Shin (2019)'s setting, voters' choices hinge on the likelihood of a leftist coalition versus a rightist candidate. In our model, however, the presence of a centrist introduces an additional coordination problem: voters must consider not only their ideological affinities but also the electoral viability of different PECs. This interplay between candidate bargaining and voters' strategic responses is novel and allows us to capture how opinion polls and ideological proximity jointly affect both coalition formation and electoral outcomes.

Third, our contribution emphasizes empirical plausibility. Multi-party systems in Europe and Latin America often feature centrist actors capable of tilting the balance between left- and right-wing blocs. By formally incorporating this additional strategic actor into the bargaining and voting framework, our model explores how shifts in ideological proximity influence coalition incentives, voter coordination, and overall electoral dynamics, aligning more closely with observed patterns of PEC formation, such as those in the 2024 European elections..[3]

Despite these extensions, due to the added complexity introduced by the centrist candidate, we begin by analyzing its impact specifically within the plurality system – henceforth, PL.

Taken together, these three extensions provide a more general and realistic framework for analyzing pre-electoral coalition bargaining. They enable us to address questions that remain unexplored in existing models: under what conditions does a centrist candidate prefer to ally with one bloc over another? How do opinion polls affect the bargaining leverage of a centrist actor? And how do these dynamics shape the strategic behavior of voters in systems with plurality elections?

Given the sequential structure of four periods – voters' types assignment, opinion poll revelation, bargaining for PEC formation, and election day – from the voters' perspective, we find through backward induction that strategic voting arises only when opinion polls are disclosed. In this case, voters seek to maximize their expected utility by supporting the candidate with the highest winning probability in pivotal scenarios. However, their choices remain influenced by ideological proximity. The centrist voter benefits the most, as they can gain utility from any candidate's victory. Meanwhile, the two left-wing candidates and the right-wing candidate never have the incentive to vote strategically for their direct opponent, but may prefer the centrist when polls indicate a pivotal scenario favoring the victory of their ideological opponent.

From the candidates' viewpoint, after observing the opinion poll results, they enter the bargaining phase to decide whether to form PECs and, if so, with which candidates. We model these decisions using a generalized Nash bargaining framework. Candidates evaluate their status quo utility to compete individually with the utility they would receive from forming a PEC with another candidate. A PEC is formed if the utility of joining the coalition exceeds the utility of running individually, satisfying the individual rationality condition. However, since candidates can form multiple PECs, they will choose the coalition that provides the highest utility, ensuring the comparative advantage condition is met.

Before going in-depth with this chapter lecture, I would like to note that this is a work in progress, presenting preliminary findings that are still subject to further development, especially in the second part of the discussion.

The remainder of the chapter is organized as follows. In Section 1.2 we describe the sequential structure and equilibrium conditions of the model. In Section 1.3 we analyze the dynamics of the plurality system by defining the possible voting strategies and the bargaining process for the formation of PECs. In Section 1.4, we conclude.

[3] With this study, we offer a bridge between the literature on strategic voting in multi-candidate elections (see e.g., Cox, 1997; Myatt, 2007; Goodin et al., 2008; Bouton, 2013; Hummel, 2014) with researches on the formation of PECs (see, e.g., Golder, 2006b; Debus, 2009; Bandyopadhyay et al., 2011; Borges et al., 2021).

1.2 Theoretical model

We set up our model using Shin (2019) sequential voting game as our benchmark model.

1.2.1 The model

Consider an economy with a finite set of voters $N = \{1, 2, ..., n\}$, who are only political ideology-oriented, and four ideology and office-motivated candidates $\Psi = \{L1, L2, C, R\}$, who are competing for one office. L1 and L2 are left-wing candidates with similar ideologies, while R is the sole right-wing candidate. C represents a centrist candidate, whose ideology is intermediate between the left and right candidates. Following well-established literature that models political ideologies along a left-right axis (Chessa and Fragnelli, 2011; Fragnelli et al., 2009), we define the political landscape as a continuum ranging from 0 to 1, with candidates positioned according to their respective ideologies. At position 0, there are the two left-wing candidates; at position 1, there is the right-wing candidate; and at position 1/2, there is the centrist candidate.

The voting game is modeled as a four-period sequence, as reported in Table 1.1.

Table 1.1: Sequence of game

Period 1	Random assignment of voters' type
Period 2	Communication of opinion poll results
Period 3	Bargaining among candidates for PEC formation
Period 4	Election day, where the election rule decides the winner

In **Period 1** the four candidates are declared and each voter is assigned to a specific type. Let T=$\{t_{L1}$, t_{L2}, t_C, $t_R\}$ be the set of four mutually exclusive voters' types. A voter is said to be of type t_j if her most preferred candidate is j$\in\Psi$. Given a type, a voter's preference over the candidates then depends on the ideological distance candidates have from her preferred candidate on the 0-1 axis:

$$
\begin{aligned}
&t_{L1} : L1 \succ L2 \succ C \succ R \\
&t_{L2} : L2 \succ L1 \succ C \succ R \\
&t_C : C \succ L1 \sim L2 \sim R \\
&t_R : R \succ C \succ L1 \sim L2
\end{aligned}
\tag{1.1}
$$

Candidates' preferences on herself and on other candidate are still given as in (1.1), where each candidate lists herself as preferred candidate, and the other candidates according to the ideological distance from herself.

The random variables N_{L1}, N_{L2}, N_C, N_R denote the number of times a voter of type t_{L1}, t_{L2}, t_C and t_R, respectively, is observed. The vector $\mathcal{N} = (N_{L1}, N_{L2}, N_C, N_R)$ follows a multinomial distribution with parameters n, the total number of voters, and p, where $p = (p_{L1}, p_{L2}, p_C, p_R)$, and where p_j is the probability for a voter of being of type t_j, with $0 \leq p_j \leq 1$ and $\sum_{j\in\Psi} p_j = 1$. The trials (each voter's type assignment) are independent, but the outcomes are dependent because the counts must sum to the total number of voters, i.e., $N_{L1}+N_{L2}+N_C+N_R=n$. The probability mass function of the multinomial distribution is :

$$f\left(x_{L1},x_{L2},x_C,x_R;n,p_{L1},p_{L2},p_C,p_R\right)=\begin{cases}\frac{n!}{x_{L1}!x_{L2}!x_C!x_R!}p_{L1}^{x_{L1}}p_{L2}^{x_{L2}}p_C^{x_C}p_R^{x_R} & \text{if } \sum_{j\in\psi}x_j=n,\\ \\ 0 & \text{otherwise.}\end{cases} \tag{1.2}$$

Here, (x_{L1},x_{L2},x_C,x_R) denotes a specific realization of the random vector $\mathcal{N}$. That is, x_{L1}, x_{L2}, x_C, and x_R represent the observed number of voters of type t_{L1}, t_{L2}, t_C, and t_R, respectively.

Each voter only knows her type, but not the type of others, then the number of voters of each type is unknown. Voters and candidates know that $\mathcal{N}$ follows a multinomial distribution, but they do not know the vector p.

In **Period 2**, candidates and voters receive information from one pre-electoral opinion poll. The opinion poll is defined as the number of i.i.d. public signals randomly drawn from p. Define an opinion poll result as $\sigma=(\frac{\sigma_{L1}}{m},\frac{\sigma_{L2}}{m},\frac{\sigma_C}{m},\frac{\sigma_R}{m})$, where σ_j refers to the number of signals for j, and $m\geq 1$ is the total number of signals. As m goes to infinity, the knowledge about electoral preferences becomes clear. In practice, $m\ll n$, i.e., m is much smaller than n. The set of all possible opinion poll results is:

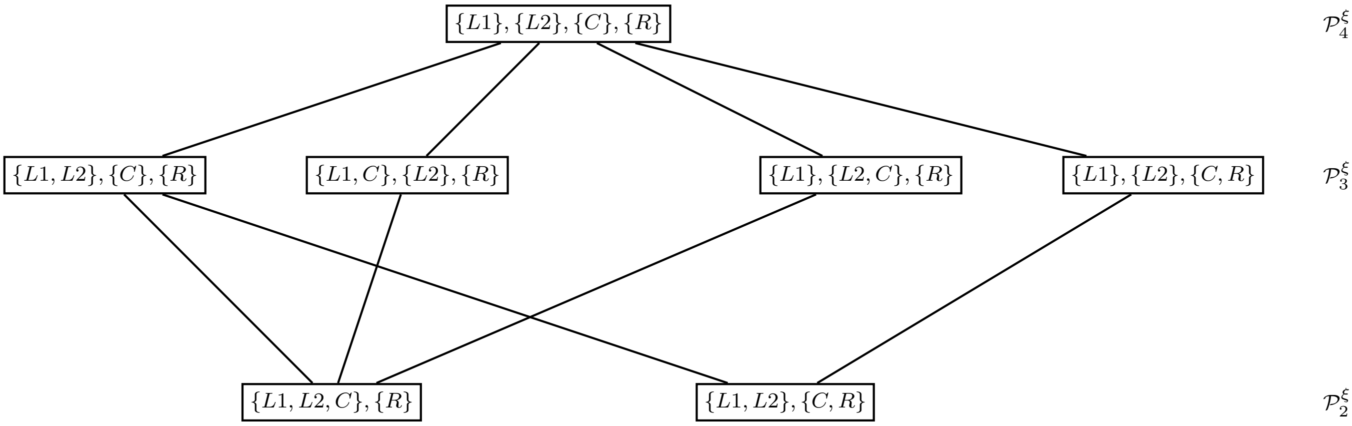
$$\Sigma=\left\{\left(\frac{\sigma_{L1}}{m},\frac{\sigma_{L2}}{m},\frac{\sigma_C}{m},\frac{\sigma_R}{m}\right)\in\Delta^4\mid 0\leq\frac{\sigma_{L1}}{m},\frac{\sigma_{L2}}{m},\frac{\sigma_C}{m},\frac{\sigma_R}{m}\leq 1\text{ and }\sum_{j\in\Psi}\frac{\sigma_j}{m}=m\right\}.$$

Given a poll result, each voter and each candidate forms her belief about the distribution of voters' types, and hence the belief on the possible winner of the election. It is worth noting that in this simplified model, there is no update of personal beliefs, and therefore all participants (candidates and voters) form the same beliefs. From a candidate's viewpoint, the observation of a pre-electoral opinion poll is essential to deciding whether it is convenient to form a coalition or it is preferable to compete individually. From a voter's perspective, examining a pre-election poll is crucial in deciding whether to vote truthfully or strategically. Candidates and voters approximate probabilities p_j with the observed distribution $\frac{\sigma_j}{m}$.

In **Period 3** candidates decide how they want to compete in the election: individually or in a coalition. Therefore, a bargaining process among candidates takes place for the PECs formation. During this bargaining process, they have to make two decisions: a) the members of the coalition, b) the nominated candidate. We denote a PEC as $\xi(x,y;\theta)$ (or $\xi(x,y,k;\theta)$ for coalitions of three candidates, respectively), where $x,y,k\in\{L1,L2,C,R\}$ represent the candidates in the coalition, and $\theta\in\{x,y,k\}$ is the candidate nominated to represent the coalition. The nominated candidate must be one of the members of the coalition.

We preserve and strengthen the assumption of a *policy-seeking approach* (see, e.g., Axelrod, 1970; De Swaan, 1973; Aleskerov et al., 2008), according to which coalition formation is restricted to candidates with contiguous political ideologies. According to this assumption, we claim that PECs are possible between the two left-wing candidates, between the two left-wing candidates and the centrist candidate, or between one of the left-wing candidates (either L1 or L2) and the centrist candidate, and between the centrist candidate, and the right-wing candidate. Due to the ideological distance, we exclude the possibility of a coalition between left and right-wing candidates and the unique grand coalition of the four candidates. Given this, we reproduce in Figure 1.1 the space of possible coalition structures as modeled by Sandholm et al. (1999).

Figure 1.1: Coalition structure graph



Note: Figure 1.1 depicts the coalition structure graph of our four candidates' interaction. Each node represents a possible coalition structure, while each arc indicates a merger of two coalitions when followed downward or a split of a coalition into two when followed upward. To the right of each line of nodes is the identification of the level partition. This progression starts from $\mathcal{P}_4^{\xi}$, where each candidate competes alone in a coalition of one (consisting of themselves only), and moves to the penultimate level $\mathcal{P}_2^{\xi}$. We do not include the final level $\mathcal{P}_1^{\xi}$ since we are excluding the possibility of forming the grand coalition.

Given this policy-seeking approach, we derive five different types of coalitions, according to the bargaining process for the membership and the political orientation of the candidates. The five possible coalitions are: L1 and L2, L1 and C, L2 and C, C and R, and the triple coalition L1, L2 and C. Two disjoint coalitions may coexist. Each of these coalitions and each singleton coalition, together with the nominated candidate, when winning the election returns a certain utility for candidates and voters.

Specifically, suppose the winner of the election θ has competed individually, thus she coincides with the nominated candidate. Voter t_j utility depends on the candidate's j distance from the nominated candidate's position. Therefore, a voter t_j utility is given by:

$$U_{t_j}(\theta) = \frac{1}{2} - |\frac{d_j - d_\theta}{2}| \tag{1.3}$$

where: d_j is the ideological position of the candidate j on the segment 0-1, and d_θ is the position of the nominated candidate θ on the segment 0-1. Candidate j utility is as in (1.3), but with two additional values assigned to the winning candidate. One value is assigned for holding office, denoted by V, and another is assigned for choosing her ideal policy, denoted by $\phi = 1/2$. Thus, the total utility is $V + 1$.[4] Therefore, if L1 (resp., L2) wins, L2 (resp., L1) obtains a utility of $1/2$, C a utility of $1/4$ and R a utility of 0. Conversely, if the winner is R, L1 and L2 obtain a utility of 0 while C has a utility of $1/4$. When C wins, being the centrist candidate, all other parties obtain a utility of $1/4$. Thus, given $t_j \in T$ the voter's type, in absence of a coalition, a type t_{L1} (resp., t_{L2}) voter obtains a utility of 1 if L1 (resp., L2) wins, $1/2$ if L2 (resp., L1) wins, $1/4$ if C wins and 0 if R wins; a type

[4] Utilities are normalized to align with those in our benchmark model (Shin, 2019).

t_R obtain a utility of $\frac{3}{2}$ if R wins[5] and 1/4 if C wins but 0 if one of the two left-wing party wins; a type t_C voter obtains a utility of 1 if C wins, 1/4 if one of the other three parties wins. These utilities translate the preferences in (1.1).

Suppose the winning candidate has competed within a coalition. Then, a voter t_j or a candidate j utility still depends on her distance from the nominated candidate's position, as in (1.3). For any coalition's type ξ, the value of holding office V is assigned to the nominated candidate while the premium price $\phi = \frac{1}{2}$ for the combination of ideal policy is allocated for $\frac{2}{3}$ to the nominated candidate and for the remaining $\frac{1}{3}$ to the other candidates in the coalition (with equally share between them if they are more than one). Therefore, the candidate's utility can be expressed as follows:

$$U_j(\theta, \xi) = V \cdot \mathbf{1}_{\{\text{winner}\}} + \phi + \frac{1}{2} - \left| \frac{d_j - d_\theta}{2} \right| \tag{1.4}$$

We summarize these several utilities for voters and for candidates in Table 1.2.

Table 1.2: The utility structure

Winners	**Candidates**				**Voter types**			
	L1	L2	C	R	t_{L1}	t_{L2}	t_C	t_R
L1	$V+1$	$\frac{1}{2}$	$\frac{1}{4}$	0	1	$\frac{1}{2}$	$\frac{1}{4}$	0
L2	$\frac{1}{2}$	$V+1$	$\frac{1}{4}$	0	$\frac{1}{2}$	1	$\frac{1}{4}$	0
C	$\frac{1}{4}$	$\frac{1}{4}$	$V+1$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$	1	$\frac{1}{4}$
R	0	0	$\frac{1}{4}$	$V+1$	0	0	$\frac{1}{4}$	$\frac{3}{2}$
$\xi(L1, L2; L1)$	$V+\frac{5}{6}$	$\frac{2}{3}$	$\frac{1}{4}$	0	$\frac{5}{6}$	$\frac{2}{3}$	$\frac{1}{4}$	0
$\xi(L1, L2; L2)$	$\frac{2}{3}$	$V+\frac{5}{6}$	$\frac{1}{4}$	0	$\frac{2}{3}$	$\frac{5}{6}$	$\frac{1}{4}$	0
$\xi(L1, C; L1)$	$V+\frac{5}{6}$	$\frac{1}{2}$	$\frac{5}{12}$	0	$\frac{5}{6}$	$\frac{1}{2}$	$\frac{5}{12}$	0
$\xi(L1, C; C)$	$\frac{5}{12}$	$\frac{1}{4}$	$V+\frac{5}{6}$	$\frac{1}{4}$	$\frac{5}{12}$	$\frac{1}{4}$	$\frac{5}{6}$	$\frac{1}{4}$
$\xi(L2, C; L2)$	$\frac{1}{2}$	$V+\frac{5}{6}$	$\frac{5}{12}$	0	$\frac{1}{2}$	$\frac{5}{6}$	$\frac{5}{12}$	0
$\xi(L2, C; C)$	$\frac{1}{4}$	$\frac{5}{12}$	$V+\frac{5}{6}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{5}{12}$	$\frac{5}{6}$	$\frac{1}{4}$
$\xi(C, R; C)$	$\frac{1}{4}$	$\frac{1}{4}$	$V+\frac{5}{6}$	$\frac{5}{12}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{5}{6}$	$\frac{5}{12}$
$\xi(C, R; R)$	0	0	$\frac{5}{12}$	$V+\frac{5}{6}$	0	0	$\frac{2}{3}$	$\frac{13}{12}$
$\xi(L1, L2, C; L1)$	$V+\frac{5}{6}$	$\frac{7}{12}$	$\frac{1}{3}$	0	$\frac{5}{6}$	$\frac{7}{12}$	$\frac{1}{3}$	0
$\xi(L1, L2, C; L2)$	$\frac{7}{12}$	$V+\frac{5}{6}$	$\frac{1}{3}$	0	$\frac{7}{12}$	$\frac{5}{6}$	$\frac{1}{3}$	0
$\xi(L1, L2, C; C)$	$\frac{1}{3}$	$\frac{1}{3}$	$\mathrm{V}+\frac{5}{6}$	$\frac{1}{4}$	$\frac{1}{3}$	$\frac{1}{3}$	$\frac{5}{6}$	$\frac{1}{4}$

In **Period 4**, voters participate in the election by casting a ballot for one of the four candidates. The winner is determined according to the electoral rule PL, with PL represents the plurality system. Under this electoral system, the candidate or coalition securing the relative majority of the votes wins the election.

[5]Following Shin (2019), we assume a utility of $\frac{3}{2}$ for a type t_R voter remember in order to normalize the sum of preferences corresponding to all four types.

1.2.2 Voting strategy

We preserve the first general assumption of Shin (2019) model: voters of the same type behave in the same way (this simplifies the analysis considering only symmetric pure strategies).

Given the plurality system (PL), we define the function $s : T \times \Sigma \to \Psi$ as a voting strategy. A voting strategy selects for each subject's type and for each opinion poll result a candidate to vote. Therefore, we denote with S the set of all possible strategies. For each voter, the voting choice in an election is related to her type, the results of the opinion poll and the set of all possible strategies among which she can choose, i.e., $BR : T \times \Sigma \times S_{-i} \to \Psi$.

Voters assume a strategy and cast a ballot for a candidate under an aggregate uncertainty condition since they only know their type but not the type of others. However, they know the probability distribution of other types and observe the opinion poll results, through which they form a belief that guides their choice.

We define the strategy in which a voter t_j votes for her favorite candidate as $\overline{s}_j \in$ S: $\overline{s}_j(t_j, \sigma) =$ j $\forall \sigma \in \Sigma$, and we call it *uninformative voting strategy*.

We define the strategy in which a voter t_j, given $\sigma \in \Sigma$, votes for her expected utility maximizing voting strategy as $s_j^*(\sigma) \in$ S and we call it *expected utility maximizing voting strategy*.

1.3 Plurality elections

In this section, we analyze the game under a plurality voting rule using backward induction. We begin by examining voters' optimal strategies in Period 4, based on expected utility maximization. In this final stage, strategic behavior is limited to the possible decision not to vote for one's most preferred candidate. However, we do not consider voting strategies in the sense of a full best response analysis. It can be argued, in fact, that a full best response analysis is excessively cognitively demanding for voters when faced with such a large number of individuals, as in the case of major elections. In this context, maximizing expected utility appears to be a more realistic approach. Next, we introduce a generalized Nash bargaining framework to formalize and study the pre-electoral coalition formation process in Period 3, focusing on the influence of a centrist candidate C.

An important simplification in our model is that, in Period 4, we assume that voters maximize their expected utility without taking into account any coalition structures that may have formed previously, namely in Period 3.

1.3.1 Expected utility maximizing voting strategy

Given a total number of votes n, in a plurality system, the winning candidate is the one among others who receives the highest number of votes.

To state how each voter type – t_{L1}, t_{L2}, t_C and t_R – votes in Period 4, we operate as follows. Considering a type t_j voter, given the other $n-1$ voters' decision her choice is pivotal under the following different scenarios: L1 and L2 obtain the same vote shares; L1 and C obtain the same vote shares, L1 and R obtain the same vote shares, L2 and C obtain the same vote shares, L2 and R obtain the same vote shares; C and R obtain the same vote shares. Observe that there may be also special cases, that are sub-cases of the previous ones, in which 3 or 4 candidates obtain the same vote shares simultaneously (L1, L2 and C; L1, L2 and R; L1, C and R; L2, C and R and L1, L2, C and R).

Therefore, we have a total of 11 pivotal scenarios under this electoral system. We denote by $VS \subseteq \Phi$ simply defined as $VS = \{T \subseteq \Psi \mid |T| \geq 2\}$ the set of all pivotal scenarios. For simplicity, given the probability mass function in (1.2), we denote as $P(T|p)$, the probability, given vector p, of scenario $T \in VS$ to occur.

In absence of strategic thinking/behavior, each voter t_j type will cast a ballot for her favorite candidate j. Instead, according to the expected utility maximizing principle, a voter t_j type may cast a vote for a candidate $k \in \Psi, k \neq j$ that maximizes her expected utility in the presence of an opinion poll σ (for example, a left-wing candidate who considers a pivotal situation between the centrist candidate and the right-wing candidate very likely might strategically choose to vote for the centrist candidate).

The expected utility of a voter t_j when observing σ and when voting for a candidate k may be written as in (1.5):

$$EU_{t_j}(k,\sigma) = \sum_{T \in VS,\ k \in T} [P(T|\sigma) \cdot U_{t_j}(\theta = k)] + \sum_{T \in VS,\ k \notin T} [P(T|\sigma) \cdot \sum_{h \in T} \frac{1}{|T|} U_{t_j}(\theta = h)] + A(\sigma). \quad (1.5)$$

The first term is the sum of the utilities obtained by voter t_j when candidate k wins thanks to her pivotal vote, weighted by the probability that a given scenario in which k is pivotal occurs. The second term is the sum of all scenarios in which candidate k is not pivotal, but other candidates are, again weighted by the probability that each voting scenario occurs. In such scenarios, voting for k does not have any effect. Here, the expected utility is given by assuming that the pivotal candidates will win with equal probability. The last term $A(\sigma)$ is a fixed term which depends solely on σ. It provides the expected utility of a voter t_j among all scenarios in which no candidate is pivotal, i.e., when her vote is irrelevant.[6]

Without any prior information on the probability distribution, i.e., without observing σ, voters are assumed to be uniformly distributed among the four candidates, which is equivalent to assuming that in Period 1, each voter is assigned to a specific type with probability $\frac{1}{4}$.

Consequently, the probability of each pivotal event – whether it involves two, three, or four candidates – is verified with equal likelihood among events of the same type. Specifically, we define these probabilities as follows:

a. Probability of a pivotal event involving any two candidates:

$$P(\{j,i\}) = a, \qquad \forall \{j,i\} \subseteq \Psi \text{ with } j \neq i.$$

b. Probability of a pivotal event involving any three candidates:

$$P(\{j,i,k\}) = b, \qquad \forall \{j,i,k\} \subseteq \Psi \text{ with } j \neq i,\ j \neq k,\ i \neq k.$$

c. Probability of a pivotal event involving any four candidates:

$$P(\{j,i,k,h\}) = c, \qquad \forall \{j,i,k,h\} \subseteq \Psi \text{ with } j \neq i,\ j \neq k,\ j \neq h,\ i \neq k,\ i \neq h,\ k \neq h.$$

[6] In Appendix 1.A.1, we provide the formalization of the expected utility for every candidate $j \in \Psi$, when voting for candidate $k \in \Psi$.

.

Here, $a, b, c \in (0, 1)$ are constant values such that $a > b > c$. In the absence of an opinion poll σ, and when voters are assumed to be uniformly distributed among the four candidates, we denote the expected utility in (1.5) simply as $EU_{t_j}(k)$. Therefore, the voting strategy depends only on the utility assigned to each candidate by each voter type. According to Table 1.2, each voter t_j derives the highest utility from the victory of her preferred candidate, i.e., $U_{t_j}(j) > U_{t_j}(k), \ \forall k \neq j$. This means that the choice that maximizes a voter's t_j type expected utility is always in casting a ballot for the preferred candidate j. This results in Lemma 1.1.

Lemma 1.1 *In the absence of an opinion poll σ, and when voters are assumed to be uniformly distributed among the four candidates, $EU_{t_j}(j) - EU_{t_j}(k) > 0 \quad \forall k \neq j \in \Psi$, thus $s_j^* = \overline{s}_j = j$.*

Proof of Lemma 1.1. See Appendix 1.A.2.

When the result of a pre-electoral opinion poll σ is revealed, it conveys valuable information about the expected performance of each candidate. This, in turn, influences the likelihood of pivotal scenarios and shapes voter expectations of the election outcome, leading to strategic thinking/behavior.

Given $\sigma \in \Sigma$, each voter approximates p_j with the observed distribution of signals $\frac{\sigma_j}{m}$, indicating the possible electoral outcome for each candidate j. Consequently, we can redefine equation (1.2) as follows:

$$f\left(x_{L1}, x_{L2}, x_C, x_R; n, \frac{\sigma_{L1}}{m}, \frac{\sigma_{L2}}{m}, \frac{\sigma_C}{m}, \frac{\sigma_R}{m}\right) = \begin{cases} \frac{n!}{x_{L1}!x_{L2}!x_C!x_R!}\left(\frac{\sigma_{L1}}{m}\right)^{x_{L1}}\left(\frac{\sigma_{L2}}{m}\right)^{x_{L2}}\left(\frac{\sigma_C}{m}\right)^{x_C}\left(\frac{\sigma_R}{m}\right)^{x_R}, & \text{if } \sum_{j \in \{L1, L2, C, R\}} x_j = n, \\ 0, & \text{otherwise.} \end{cases} \tag{1.6}$$

In this context, the optimal choice that maximizes a voter's t_j expected utility is not necessarily her first-best candidate j. Instead, she may strategically vote for a different candidate k if she perceives this candidate to have a higher likelihood of winning, guaranteeing a positive impact on her expected utility. The closer candidate k is to candidate j's ideology, the greater the expected utility gain from this strategic vote. This leads to the following Proposition 1.1.

Proposition 1.1 *Given an opinion poll $\sigma \in \Sigma$ and $t_j \in \{t_{L1}, t_{L2}, t_R\}$, then there may exists $k \neq j$, with $t_k \in \{t_{L1}, t_{L2}, t_R\}$, such that $s_j^*(\sigma) = k$.*

Proof of Proposition 1.1. See Appendix 1.A.3.

Proposition 1.1 states that a voter t_j type will find the best response in a candidate k over the first-best candidate j only when k can outperform j in terms of expected utility.

In particular, from Proposition 1.1 we demonstrate that a type t_j voter engages in strategic voting based on the ideological proximity of the candidate k to her preferred candidate j. Then, given σ, a voter will never strategically support a candidate who is ideologically opposed to their preferences. Even in an extreme scenario where the probability of the ideologically opposing candidate winning is equal to 1, a left-wing voter (t_{L1} or t_{L2}) will always derive a higher expected utility from supporting any other candidate rather than the right-wing candidate R. Similarly, a right-wing voter (t_R) will never strategically vote for a left-wing candidate ($L1$ or $L2$), even if her vote will be a wasted vote.

Corollary 1.1 completes the statement of the Proposition 1.1 by specifying that strategic voting of t_j can only occur in favor of a candidate that received, in the pre-electoral opinion poll, more votes than her preferred candidate.

Corollary 1.1 *Given an opinion poll $\sigma \in \Sigma$ and $t_j \in \{t_{L1}, t_{L2}, t_R\}$, then there may exists $k \neq j$, with $t_k \in \{t_{L1}, t_{L2}, t_R\}$, such that $s_j^*(\sigma) = k$, only if $\sigma_K > \sigma_j$.*

Proof of Corollary 1.1. See Appendix 1.A.4.

Observe that Proposition 1.1 and Corollary 1.1 exclude C, i.e., the centrist voters. This because her preference structure makes her indifferent among all other k candidates, each of whom provides the same utility in case of victory. For any revealed opinion poll σ, a type t_C voter will always cast a ballot for her first-best candidate C, since any other outcome is equally (un)desirable. This is formalized in Proposition 1.2.

Proposition 1.2 *For any $\sigma \in \Sigma$, then $s_C^*(\sigma) = \bar{s}_C = C$.*

Proof of Proposition 1.2. See Appendix 1.A.5.

With Proposition 1.2 we establish that a type t_C voter will never participate in strategic voting because, regardless of the provided signal, there is no scenario in which the expected utility of voting for any other candidate k exceeds that of voting for C, that is, $EU_{t_C}(C, \sigma) - EU_{t_C}(k, \sigma) < 0$ for every $k \in \{L1, L2, C\}$ never holds.

Given Lemma 1.1 as well as Propositions 1.1 and 1.2, the equilibrium voting strategy follows a specific pattern: in the absence of opinion polls, voters cast their ballots sincerely for their preferred candidate. However, when opinion polls are disclosed, voters may engage in conditional strategic voting, meaning they switch only if an alternative candidate offers higher expected utility (Corollary 1.1). As a result, not all voters engage in strategic voting to the same extent – some continue voting sincerely if their best response aligns with their first-best choice (Proposition 1.2), while others may deviate strategically depending on ideological distances. Consider the case of the 2015 UK general election, where polling data led Labour's more extremist supporters to vote sincerely for their preferred candidates, while moderate supporters shifted strategically to the Liberal Democrats to block Conservative victories. Similarly, in the 2019 Canadian federal election, opinion polls signaling a tight race between the Liberals and Conservatives prompted some progressive voters to abandon smaller parties (e.g., the NDP and Greens) and vote strategically for the Liberals to prevent a Conservative-led government. In both cases, polling information triggered conditional strategic voting, with voter behavior varying according to ideological proximity.

1.3.2 Pre-electoral coalition bargaining mechanism

After observing the opinion poll results σ in Period 2, the bargaining process among candidates to form PECs starts. In Period 3, each candidate has to make two key decisions: a) to evaluate whether it is convenient or not to form a PEC with at least one other candidate; b) and if yes, which candidate to coalesce with. To solve these questions, we adopt a generalized Nash bargaining problem.

In order to define the bargaining environment, we start by calculating the status quo utilities of each candidate j, with $j = \{L1, L2, C, R\}$, denoted as $\overline{U}_j^{PL}(\sigma)$, and representing her disagreement utilities. It defines her expected utility if she decides to compete individually, and is determined by considering three possible scenarios: (i) if candidate j wins, (ii) if another individual candidate i wins, or (iii) if a PEC (not including j) wins. We formalize this in equation (1.7).

$$\overline{U}_j^{PL}(\sigma) = p_j^{PL}(\sigma) \cdot U_j(\theta = j) + \sum_{i \neq j} p_i^{PL}(\sigma) \cdot U_j(\theta = i) + \sum_{i,k \neq j} p_{\xi_{ik}}^{PL}(\sigma) \cdot U_j(\theta = \xi_{i,k}) \tag{1.7}$$

$U_j(\theta)$ is the utility candidate j received given the election outcome θ; $p_j^{PL}(\sigma)$, $p_i^{PL}(\sigma)$ and $p_{\xi_{i,k}}^{PL}(\sigma)$ represent the probabilities that a candidate j, a candidate i or a PEC $\xi_{i,k}$ wins in a plurality election, respectively. For simplicity, we consider only PECs composed of two candidates, which we denote $\xi_{i,k}$ instead of $\xi(i,k)$.[7]

Now, a candidate j can evaluate the convenience of competing by forming a PEC if the utility she obtains from staying in it is higher compared to her status quo condition. Hence, we formalize the PEC formation problem as follows:

$$\begin{aligned} \max_{U_j^{\xi_{ji}}, U_i^{\xi_{ji}}} \quad & (U_j^{\xi_{ji}} - \overline{U}_j^{PL}(\sigma)) \cdot (U_i^{\xi_{ji}} - \overline{U}_i^{PL}(\sigma)) \\ \text{st:} \quad & \\ & (1) \quad U_j^{\xi_{ji}} + U_i^{\xi_{ji}} \leq \sum_{j,i \in \xi_{ji}} U_{j,i}^{\xi_{ji}}(\theta, \sigma) \cdot P_\theta(\sigma) \\ & (2) \quad U_j^{\xi_{ji}} \geq \overline{U}_j^{PL}(\sigma) \\ & (3) \quad U_i^{\xi_{ji}} \geq \overline{U}_i^{PL}(\sigma) \end{aligned} \tag{1.8}$$

The variables $U_j^{\xi_{ji}}$ and $U_i^{\xi_{ji}}$ represent the utilities that candidates j and i will receive if they form a PEC together. The total utility constraint (1) ensures that the combined utility of both candidates in the coalition does not exceed the total utility they would receive if any candidate or coalition (including themselves) wins, which is weighted by the probability of each possible outcome in the electoral environment. Essentially, this constraint defines the upper limit on the total utility that the coalition can achieve based on the electoral situation. The status quo constraints (2) and (3) require that the utilities of both candidates be at least as large as their respective status quo utilities. This condition is necessary because candidates will only agree to form the coalition if the utility they expect from it is greater than or at least equal to the utility they would receive by not joining. These constraints ensure that joining the coalition benefits both candidates relative to their current status.[8]

For each candidate j, the solution to the bargaining problem determines the set of utility pairs (or utility triplets in the case of a three-candidate PEC) that make coalition formation beneficial for all its members.[9] Intuitively, a candidate will only agree to form a pre-electoral coalition if doing so is at least as rewarding as remaining outside it. Otherwise, her best response is to reject the coalition offer and run independently. This occurs according to the *individual rationality condition* in Lemma 1.2.

[7] In Appendix 1.A.6, we provide a detailed breakdown of each candidate's status quo utilities.

[8] The same problem can also be generalized to our case of a three-candidate pre-electoral coalition $L1$, $L2$, C.

[9] In Appendix 1.A.7, we provide a detailed breakdown of the utilities that each candidate j would receive for every possible PEC.

Lemma 1.2 *A candidate $j = \{L1, L2, C, R\}$ satisfies the individual rationality condition if and only if* $U_j^{\xi_{ji}} \geq \overline{U}_j^{PL}(\sigma), \quad \forall i \in \{L1, L2, C, R\},\ i \neq j.$

Lemma 1.2 captures the idea that joining a PEC must be at least weakly preferable to staying out of it. Thus, each coalition must be composed only of candidates who find it individually rational to join. Building on this, we can characterize the one-sided PEC stability in Proposition 1.3.

Proposition 1.3 *For any $\sigma \in \Sigma$, a candidate j forms a PEC with a candidate i, and it is stable if and only if the individual rationality condition for j is satisfied.*

Proof of Proposition 1.3. See Appendix 1.A.8.

However, since candidate $j = \{L1, L2, C\}$ may have the opportunity to form multiple PECs, the individual rationality condition is <u>necessary but not sufficient</u> for the formation of PECs. In such cases, each candidate must compare all feasible coalitions and select the one that provides the highest payoff. This leads to satisfying the *comparative advantage condition* in Lemma 1.3.[10]

Lemma 1.3 *A candidate j satisfies the* comparative advantage condition *if and only if*

$$U_j^{\xi_{ji}} \geq \max_{k \neq i} U_j^{\xi_{jk}},$$

and, whenever feasible,

$$U_j^{\xi_{ji}} \geq U_j^{\xi_{jik}},$$

for every $j = \{L1, L2, C\}$, and $j \neq i \neq k$.

Lemma 1.3 ensures that a candidate satisfies the comparative advantage condition if she chooses, among all individually rational PECs, the one that maximizes her expected utility. Thus, in Proposition 1.4 we formalize the strategically optimal coalition.

Proposition 1.4 *For any $\sigma \in \Sigma$, a candidate $j \in \{L1, L2, C\}$ who decides to form a PEC will strategically coalesce with candidate i if and only if the comparative advantage condition is satisfied.*

Proof of Proposition 1.4. See Appendix 1.A.9.

Together, Proposition 1.3 and Proposition 1.4 address the two key decisions that candidates must make in Period 3, ensuring that each candidate (i) forms a coalition only if it is individually rational, and (ii) selects the coalition that provides the greatest comparative advantage. In this way, coalition choices are simultaneously stable and strategically optimal for the single candidate within the PEC framework.

However, although *individual rationality* (Lemma 1.2) and *comparative advantage* (Lemma 1.3) ensure that candidates form PECs that are stable and strategically optimal for themselves, these conditions are <u>necessary but not sufficient</u> to guarantee overall coalition stability when there are multiple feasible coalitions. For instance, while candidate j may find a PEC with candidate i stable and strategically

[10] We exclude R candidate as their only possible PEC is with candidate C. Consequently, their decision-making is solely governed by Proposition 1.3, with the individual rationality condition serving as a necessary and sufficient condition.

optimal, candidate i might prefer to deviate and form an alternative coalition with candidate k that maximizes their expected utility.

To prevent this possibility, we extend the PEC framework by incorporating the *pairwise stability* (or *three-sided stability* in case of three candidates' PEC) condition in Lemma 1.4.

Lemma 1.4 *Let $\mathcal{X}$ denote the set of all feasible coalitions of candidates. A PEC is pairwise (or three-sided) stable if and only if:*

1. *Every PEC satisfies the individual rationality condition for each candidate inside it;*
2. *There exists no alternative coalition $\xi_{ij} \in \mathcal{X}$ (or $\xi_{ijk} \in \mathcal{X}$) such that all involved candidates weakly prefer joining it and at least one of them strictly prefers it.*

Proof of Lemma 1.4. See Appendix 1.A.10.

If the three conditions of individual rationality (Lemma 1.2), comparative advantage (Lemma 1.3), and pairwise stability (Lemma 1.4) hold simultaneously, then no candidate within a PEC has an incentive to deviate. Hence, Proposition 1.5 formally defines the stability and optimality of PEC.

Proposition 1.5 *A PEC is stable and strategically optimal for all candidates in the PEC if and only if the following conditions are satisfied:*

1. *Every candidate in a PEC satisfies the individual rationality condition (Lemma 1.2);*
2. *Every candidate selects the PEC that maximizes her utility among all individually rational options, satisfying the comparative advantage condition (Lemma 1.3);*
3. *There exists no alternative coalition $\xi \in \mathcal{X}$ such that all involved candidates can strictly improve their utilities relative to their current PEC assignment (Lemma 1.4).*

1.4 Concluding remarks

This chapter investigates the bargaining dynamics underlying the PECs' formation and their subsequent influence on voter strategies, focusing on the plurality electoral system. By extending the theoretical framework of Shin (2019), we introduce a fourth centrist candidate, adding complexity to both the pre-electoral coalition formation and the voter decision-making process. This expanded model better captures real-world electoral competition by allowing multiple PEC possibilities. The two key factors influencing candidates' and voters' decisions are the ideological political proximity and the opinion poll results.

From the voters' perspective, our findings reveal that strategic voting only emerges after opinion poll results are disclosed, as voters use this information to maximize their expected utility by supporting the most viable candidate in pivotal scenarios. Although ideological proximity remains a key factor in voting decisions, the centrist voter benefits the most from the increased flexibility in coalition possibilities. In contrast, left- and right-wing voters exhibit no incentives to vote for their direct ideological opponent, but may strategically support the centrist candidate when facing an unfavorable electoral landscape.

From the candidates' perspective, the decision to form a PEC is guided by a generalized Nash bargaining problem, in which each candidate compares the expected utility of running independently with that gained through coalition formation. A candidate will only form a PEC when the conditions of individual rationality and comparative advantage are simultaneously satisfied, ensuring they benefit more from joining forces than from competing separately or in a different coalition. Additionally, pairwise (three-sided) stability ensures that the formed PEC is multilaterally stable and strategically optimal, so that no candidate has an incentive to deviate from it.

The formation of these PECs has important political implications. Candidates must adapt coalition strategies to shifting public opinion, since voter perceptions and strategic voting directly affect electoral outcomes. Equally, transparency in coalition objectives is essential to sustain voter trust and prevent post-electoral fractures. Inaccurate or manipulated polling can cause miscoordination and wasted votes. Specifically, coalition timing must align with opinion poll dynamics. Because voters use polls to coordinate, premature announcements can weaken credibility. For instance, Spain's left bloc in the 2015 general election entered coalition talks too early without favorable poll signals, projecting division rather than strength. In contrast, France's 2017 presidential race showed how polarization reflected in the polls allowed centrists and moderates to secure leverage before the first round. Moreover, coalition credibility depends on ideological coherence. Alliances that appear purely opportunistic risk alienating supporters. Italy's 2013 and 2018 "grand coalitions" between ideologically distant parties, and the failed left–right alliances in Greece during the 2010s debt crisis, illustrate how such moves can generate electoral backlash despite short-term strategic logic. Finally, it is evident that the pivotal role of in bargaining of the centrist candidate as they can credibly align with either bloc. This flexibility allows them to extract policy or office concessions, as seen with MoDem in France's 2007 and 2017 elections, and Ciudadanos in Spain between 2015–2019, when their positioning repeatedly tilted coalition negotiations. When polls confirmed their pivotal role, their bargaining leverage increased. Ideological voters, meanwhile, may find it rational to support a centrist coalition partner to avoid an unfavorable outcome. This behavior was evident in France's 2002 and 2017 presidential runoffs, when left-wing voters backed centrists (Chirac, Macron) to block right-wing victories. Similar dynamics appeared in Latin American gubernatorial races, such as Brazil's 2014 elections, where opposition voters rallied behind compromise candidates to prevent ideological rivals from winning. Finally, institutional design shapes PEC effectiveness. Under the plurality rule, coalitions can reduce fragmentation but risk undermining representation if seen as opportunistic. Mechanisms such as mandatory pre-election coalition registration (common in several European parliamentary systems, e.g., Portugal and Germany) can improve transparency and voter coordination. Strengthening the regulation of polling practices is equally important, since biased or inaccurate polls distort both coalition bargaining and voter strategies.

Despite this, the simplified structure of our model presents two key limitations. First, the coalition bargaining process is modeled as a single-stage decision, whereas real-world negotiations are often complex and iterative. They typically involve multiple rounds of bargaining, signaling, and renegotiation, often shaped by external shocks (e.g., breaking news, changing polls, or shifts in voter sentiment). For example, in the 2019 Spanish elections, negotiations between PSOE and Unidas Podemos took several months and required repeated offers and counteroffers before an agreement was reached. Second, the model assumes fully rational voters with complete and truthful information, who rely exclusively on opinion polls to guide their strategic choices. In reality, voters face uncertainty, bounded rationality, and potential misinformation. Polls may be biased, inaccurate, or strategically manipulated by interested actors. For instance, in the 2016 US presidential election and the 2015 UK general election, systematic polling errors distorted voters' expectations, leading to miscoordination and "wasted votes." Future extensions could address these limitations by (i) introducing a sequential bargaining framework in which candidates negotiate over multiple stages, potentially with signaling and reputation effects (Rusinowska and De Swart, 2008), and (ii) incorporating imperfect or exogenous opinion polls, which would allow testing how voters behave when they either accept poll results at face value or act strategically, anticipating that others may interpret the polls differently (Feltham et al., 2025).

Furthermore, future research should examine how these dynamics play out in different electoral systems, especially in two-round runoff elections. The additional voting round in these elections can affect both candidate behavior and voter decision-making, introducing new strategic considerations. There are two reasons to extend our model to a runoff framework. First, it enables a direct comparison with the original model Shin (2019), which analyzed three-candidate competition under plurality and runoff systems. Our extension has only considered the plurality system thus far. Second, one-round plurality and two-round majority runoff elections are the two most common methods for presidential elections worldwide. Of the 100 countries that elect their president by popular vote, 74 use a two-round system and 22 use a single-round plurality system.

Overall, our findings would underscore the central role of PECs in plurality elections, demonstrating how strategic coalition formation before the election can reshape electoral landscapes, influence voter behavior, and ultimately determine democratic representation. However, as already mentioned at the beginning of this chapter, the findings identified thus far reflect the preliminary stage of the research and may evolve as the analysis progresses. For now, we have defined the environment in which pre-electoral dynamics take shape, but further investigation is needed to formulate statements capable of substantiating and strengthening our initial intuitions.

1.A Appendix 1.A - Mathematical proofs

1.A.1 Expected utilities when deviating from the first-best

Given equation 1.5, we explicitly write the expected utilities for a voter t_j, with $j \in \Psi$, when voting for candidate $k \in \Psi$.

For the sake of brevity, we drop the conditioning on σ. Additionally, with an abuse of notation, we also write $P(L1, L2)$ instead of $P(\{L1, L2\})$ (and similarly for all coalitions in VS). Then:

$$
\begin{aligned}
EU_{t_j}(L1,\sigma) =& P(L1,L2)U_{t_j}(L1) + P(L1,C)U_{t_j}(L1) + P(L1,R)U_{t_j}(L1) + P(L1,L2,C)U_{t_j}(L1) \\
&+ P(L1,L2,R)U_{t_j}(L1) + P(L1,C,R)U_{t_j}(L1) + P(L2,C,R)\frac{U_{t_j}(L2) + U_{t_j}(C) + U_{t_j}(R)}{3} \\
&+ P(C,R)\frac{U_{t_j}(C) + U_{t_j}(R)}{2} + P(L2,C)\frac{U_{t_j}(L2) + U_{t_j}(C)}{2} + P(L2,R)\frac{U_{t_j}(L2) + U_{t_j}(R)}{2} \\
&+ P(L1,L2,C,R)U_{t_j}(L1) + A
\end{aligned}
$$

$$
\begin{aligned}
EU_{t_j}(L2,\sigma) =& P(L1,L2)U_{t_j}(L2) + P(L1,C)\frac{U_{t_j}(L1) + U_{t_j}(C)}{2} + P(L1,R)\frac{U_{t_j}(L1) + U_{t_j}(R)}{2} \\
&+ P(L1,L2,C)U_{t_j}(L2) + P(L1,L2,R)U_{t_j}(L2) + P(L1,C,R)\frac{U_{t_j}(L1) + U_{t_j}(C) + U_{t_j}(R)}{3} \\
&+ P(L2,C,R)U_{t_j}(L2) + P(L2,C)U_{t_j}(L2) + P(L2,R)U_{t_j}(L2) + P(C,R)\frac{U_{t_j}(C) + U_{t_j}(R)}{2} \\
&+ P(L1,L2,C,R)U_{t_j}(L2) + A
\end{aligned}
$$

$$
\begin{aligned}
EU_{t_j}(C,\sigma) =& P(L1,L2)\frac{U_{t_j}(L1) + U_{t_j}(L2)}{2} + P(L1,C)U_{t_j}(C) + P(L1,R)\frac{U_{t_j}(L1) + U_{t_j}(R)}{2} \\
&+ P(L1,L2,C)U_{t_j}(C) + P(L1,L2,R)\frac{U_{t_j}(L1) + U_{t_j}(L2) + U_{t_j}(R)}{3} + P(L1,C,R)U_{t_j}(C) \\
&+ P(L2,C)U_{t_j}(C) + P(L2,R)\frac{U_{t_j}(L2) + U_{t_j}(R)}{2} + P(C,R)U_{t_j}(C) \\
&+ P(L1,L2,C,R)U_{t_j}(C) + A
\end{aligned}
$$

$$
\begin{aligned}
EU_{t_j}(R,\sigma) =& P(L1,L2)\frac{U_{t_j}(L1) + U_{t_j}(L2)}{2} + P(L1,C)\frac{U_{t_j}(L1) + U_{t_j}(C)}{2} + P(L1,R)U_{t_j}(R) \\
&+ P(L1,L2,C)\frac{U_{t_j}(L1) + U_{t_j}(L2) + U_{t_j}(C)}{3} + P(L1,L2,R)U_{t_j}(R) + P(L1,C,R)U_{t_j}(R) \\
&+ P(L2,C,R)U_{t_j}(R) + P(L2,C)\frac{U_{t_j}(L2) + U_{t_j}(C)}{2} + P(L2,R)U_{t_j}(R) + P(C,R)U_{t_j}(R) \\
&+ P(L1,L2,C,R)U_{t_j}(R) + A
\end{aligned}
$$

1.A.2 Proof of Lemma 1.1

Consider a voter t_j who has to cast a ballot for one of the four candidates in $\Psi = \{L1, L2, C, R\}$ aiming to maximize her expected utility. Each voter t_j type achieves the highest utility if her preferred candidate $j \in \Psi$ wins.

In the absence of an opinion poll σ, and when voters are assumed to be uniformly distributed among the four candidates, a voter t_j has convenience to deviate from her first-best candidate j and vote for another candidate k when $EU_{t_j}(j) - EU_{t_j}(k) < 0$. The probabilities of the different pivotal scenarios to occur depend only on their cardinality:

$$\begin{aligned}
&P(L1, L2) = P(L1, C) = P(L2, C) = P(L1, R) = P(L2, R) = P(C, R) = a \\
&P(L1, L2, C) = P(L1, L2, R) = P(L1, C, R) = P(L2, C, R) = b \\
&P(L1, L2, C, R) = c
\end{aligned} \tag{1.A1}$$

with $a, b, c \in (0, 1)$ and $a > b > c$.

Consider a voter $t_j = t_{L1}$ type who has to decide whether to cast a ballot for her first-best candidate $j = L1$ or one of the other three candidates $k \in \{L2, C, R\}$, knowing that: $U_{t_{L1}}(L1) = 1$, $U_{t_{L1}}(L2) = \frac{1}{2}$, $U_{t_{L1}}(C) = \frac{1}{4}$, $U_{t_{L1}}(R) = 0$. Then, we have to verify three possible inequalities:

1. $EU_{t_{L1}}(L1, \sigma) - EU_{t_{L1}}(L2, \sigma) > 0$

   where:

$$\begin{aligned}
&EU_{t_{L1}}(L1, \sigma) - EU_{t_{L1}}(L2, \sigma) = \\
&[P(L1, L2) + P(L1, L2, C) + P(L1, L2, R) + P(L1, L2, C, R)][U_{t_{L1}}(L1) - U_{t_{L1}}(L2)] \\
&+ P(L1, C)[U_{t_{L1}}(L1) - \frac{U_{t_{L1}}(L1) + U_{t_{L1}}(C)}{2}] + P(L1, R)[U_{t_{L1}}(L1) - \frac{U_{t_{L1}}(L1) + U_{t_{L1}}(R)}{2}] \\
&+ P(L1, C, R)[U_{t_{L1}}(L1) - \frac{U_{t_{L1}}(L1) + U_{t_{L1}}(C) + U_{t_{L1}}(R)}{3}] \\
&+ P(L2, C)[\frac{U_{t_{L1}}(L2) + U_{t_{L1}}(C)}{2} - U_{t_{L1}}(L2)] + P(L2, R)[\frac{U_{t_{L1}}(L2) + U_{t_{L1}}(R)}{2} - U_{t_{L1}}(L2)] \\
&+ P(L2, C, R)[\frac{U_{t_{L1}}(L2) + U_{t_{L1}}(C) + U_{t_{L1}}(R)}{3} - U_{t_{L1}}(L2)] > 0
\end{aligned} \tag{1.A2}$$

   Then, given the equality of pivotal probabilities, we reduce (1.A2) as:

$$a + \frac{4}{3}b + \frac{1}{2}c > 0$$

   which is verified as $a, b, c \in (0, 1)$. This result shows that there is no situation in which for a voter t_{L1} type the expected utility from voting her second-best $L2$ is higher compared to her first-best $L1$, in the absence of additional information from the opinion poll result.

2. $EU_{t_{L1}}(L1,\sigma) - EU_{t_{L1}}(C,\sigma) > 0$

   where:

$$
\begin{aligned}
&EU_{t_{L1}}(L1,\sigma) - EU_{t_{L1}}(C,\sigma) = \\
&[P(L1,C) + P(L1,L2,C) + P(L1,C,R) + P(L1,L2,C,R)][U_{t_{L1}}(L1) - U_{t_{L1}}(C)] \\
&+ P(L1,L2)\left[U_{t_{L1}}(L1) - \frac{U_{t_{L1}}(L1) + U_{t_{L1}}(L2)}{2}\right] + P(L1,R)\left[U_{t_{L1}}(L1) - \frac{U_{t_{L1}}(L1) + U_{t_{L1}}(R)}{2}\right] \\
&+ P(L1,L2,R)\left[U_{t_{L1}}(L1) - \frac{U_{t_{L1}}(L1) + U_{t_{L1}}(L2) + U_{t_{L1}}(R)}{3}\right] \\
&+ P(C,R)[\frac{U_{t_{L1}}(C) + U_{t_{L1}}(R)}{2} - U_{t_{L1}}(C)] + P(L2,C)[\frac{U_{t_{L1}}(L2) + U_{t_{L1}}(C)}{2} - U_{t_{L1}}(C)] \\
&+ P(L2,C,R)\left[\frac{U_{t_{L1}}(L2) + U_{t_{L1}}(C) + U_{t_{L1}}(R)}{3} - U_{t_{L1}}(C)\right] > 0
\end{aligned}
\tag{1.A3}
$$

   Substituting the value of utilities and the constant values for pivotal scenarios in (1.A3), we have:

$$\frac{3}{2}a + 2b + \frac{3}{4}c > 0$$

   which is verified as $a, b, c \in (0,1)$. This result confirms, as in the first inequality, that it never exists a situation in which, without the prior information σ, a voter t_{L1} type has a higher expected utility by deviating from her first-best candidate $L1$ in favor of the centrist C.

3. $EU_{t_{L1}}(L1,\sigma) - EU_{t_{L1}}(R,\sigma) > 0$

   where:

$$
\begin{aligned}
&EU_{t_{L1}}(L1,\sigma) - EU_{t_{L1}}(R,\sigma) = \\
&[P(L2,C) + P(L1,L2,C) + P(L2,C,R) + P(L1,L2,C,R)][U_{t_{L1}}(L2) - U_{t_{L1}}(C)] \\
&+ P(L1,L2)\left[U_{t_{L1}}(L2) - \frac{U_{t_{L1}}(L1) + U_{t_{L1}}(L2)}{2}\right] + P(L2,R)[U_{t_{L1}}(L2) - \frac{U_{t_{L1}}(L2) + U_{t_{L1}}(R)}{2}] \\
&+ P(L1,L2,R)[U_{t_{L1}}(L2) - \frac{U_{t_{L1}}(L1) + U_{t_{L1}}(L2) + U_{t_{L1}}(R)}{3}] \\
&+ P(L1,C)\left[\frac{U_{t_{L1}}(L1) + U_{t_{L1}}(C)}{2} - U_{t_{L1}}(C)\right] + P(C,R)\left[\frac{U_{t_{L1}}(C) + U_{t_{L1}}(R)}{2} - U_{t_{L1}}(C)\right] \\
&+ P(L1,C,R)[\frac{U_{t_{L1}}(L1) + U_{t_{L1}}(C) + U_{t_{L1}}(R)}{3} - U_{t_{L1}}(C)] > 0
\end{aligned}
\tag{1.A4}
$$

   Substituting the value of utilities and the constant values for pivotal scenarios in (1.A4), we have:

$$2a + \frac{8}{3}b + c > 0$$

   which is verified as $a, b, c \in (0,1)$. Similarly to the previous two cases, in the absence of an opinion poll result, there is no scenario for t_{L1} in which voting for R is preferred to voting for the first-best $L1$.

Then, we can conclude that $EU_{t_{L1}}(L1, \sigma) > EU_{t_{L1}}(k, \sigma) \quad \forall k \in \{L2, C, R\}$. Thus, Lemma 1.1 is validated for type t_{L1} voter.

Likewise, we can compute the corresponding inequalities for the other three types of voters – t_{L2}, t_C, t_R – obtaining analogous conditions. Thus, Lemma 1.1 is verified for all voter types.

1.A.3 Proof of Proposition 1.1

Consider a voter of type t_j who must cast a ballot among the set of available candidates $\Psi = \{L1, L2, C, R\}$ under an informative opinion poll result σ. The poll reveals the distribution of votes among candidates, influencing the likelihood of pivotal scenarios. Since each voter approximates the probabilities p_j using the observed vote distribution, given by $\frac{\sigma_j}{m}$, then we can redefine equation (1.2) as follows:

$$f\left(x_{L1}, x_{L2}, x_C, x_R; n, \frac{\sigma_{L1}}{m}, \frac{\sigma_{L2}}{m}, \frac{\sigma_C}{m}, \frac{\sigma_R}{m}\right) = \begin{cases} \frac{n!}{x_{L1}!x_{L2}!x_C!x_R!}(\frac{\sigma_{L1}}{m})^{x_{L1}}(\frac{\sigma_{L2}}{m})^{x_{L2}}(\frac{\sigma_C}{m})^{x_C}(\frac{\sigma_R}{m})^{x_R}, & \text{if } \sum_{j\in\{L1,L2,C,R\}} x_j = n, \\ 0, & \text{otherwise.} \end{cases} \tag{1.A5}$$

In this context, the optimal choice that maximizes a voter's t_j expected utility is not necessarily her first-best candidate j. Instead, she may strategically vote for a different candidate k if she perceives this candidate to have a higher likelihood of winning, guaranteeing a positive impact on her expected utility.

Given 1.A5, we can express the probability that each type of pivotal scenario (two candidates, three candidates, or four candidates) will occur as follows.

ⓐ The probability of a pivotal scenario between two candidates j and k can be formalized as follows. Given four generic candidates – j, k, i, and s – we assume that candidates j and k each receive an equal share of votes K, with $x_j = x_k = K$. The other two candidates, i and s, receive vote shares lower than K. This implies that their respective vote shares satisfy $x_i = h$, $x_s = n - 2K - h$, where $h < K$. Then,

$$\begin{aligned} &P(x_j = x_k = K, x_i = h, x_s = n - 2K - h, a < K) = \\ &\sum_{K=\frac{n}{4}}^{\frac{n}{2}} \sum_{h=0}^{n-2K} \frac{n!}{K!K!h!(n-2K-h)!} \left(\frac{\sigma_{x_j}}{m} \cdot \frac{\sigma_{x_k}}{m}\right)^K \left(\frac{\sigma_{x_i}}{m}\right)^h \left(\frac{\sigma_{x_s}}{m}\right)^{n-2K-h} \end{aligned} \tag{1.A6}$$

ⓑ The probability of a pivotal scenario between three candidates j, k, and i can be formalized as follows. Given four generic candidates – j, k, i, and s – we assume that candidates j, k and i each receive an equal share of votes K, with $x_j = x_k = x_i = K$. The remaining candidate s receives a vote share $n - 3K$. Then,

$$P\left(x_j = x_k = x_i = K, x_s = n - 3K, K > \frac{n}{4}\right) = \sum_{K=\frac{n}{4}}^{\frac{n}{3}} \frac{n!}{K!K!K!(n-3K)!} \left(\frac{\sigma_{x_j}}{m} \cdot \frac{\sigma_{x_k}}{m} \cdot \frac{\sigma_{x_i}}{m}\right)^K \left(\frac{\sigma_{x_s}}{m}\right)^{n-3K} \tag{1.A7}$$

ⓒ The probability of a pivotal scenario among the four candidates j, k, i, and s can be formalized as follows. We assume that all candidates receive equal shares K of the total votes n, where $K = \frac{n}{4}$. Then,

$$P(x_j = x_k = x_i = x_s) = \left(\frac{n}{4}!\right)^4 \left(\frac{\sigma_{x_j}}{m} \cdot \frac{\sigma_{x_k}}{m} \cdot \frac{\sigma_{x_i}}{m} \cdot \frac{\sigma_{x_s}}{m}\right)^{\frac{n}{4}} \tag{1.A8}$$

Now, given the conditions (1.A6)-(1.A8) on the probability of each type of pivotal scenario, we can analyze when inequality $EU_{t_j}(j, \sigma, \bar{s}) - EU_{t_j}(k, \sigma, \bar{s}) < 0$ holds for all $t_j = \{t_{L1}, t_{L2}, t_R\}$ and $k = \{L1, L2, C, R\}$, with $k \neq j$. This means that there will exist a critical threshold τ^* beyond which the voter finds it beneficial to vote strategically for another candidate k rather than their first-best choice j. This threshold $\tau^*_{j,k}$ marks the point where for t_j the expected utility of voting for j is no longer higher than that of voting for k.

Consider the case of a voter $t_j = t_{L1}$ type who has to decide to cast a ballot for her first-best candidate $j = L1$ or one of the other three candidates $k = \{L2, C, R\}$, knowing that her utility in case of victory of each of the candidates are the following: $U_{t_{L1}}(L1) = 1$, $U_{t_{L1}}(L2) = \frac{1}{2}$, $U_{t_{L1}}(C) = \frac{1}{4}$, $U_{t_{L1}}(R) = 0$. Given the probability of pivotal scenarios from (1.A6)-(1.A8), we can solve the following inequalities.

1. $EU_{t_{L1}}(L1, \sigma) - EU_{t_{L1}}(L2, \sigma) < 0$. If this inequality holds, a voter t_{L1} will find more advantageous, in expected value, to vote for candidate $L2$ rather than for $L1$.

   The inequality can be written as:

$$\begin{aligned}
&[P(L1, L2) + P(L1, L2, C) + P(L1, L2, R) + P(L1, L2, C, R)]\frac{1}{2} \\
&+ P(L1, C)\frac{3}{8} + P(L1, R)\frac{1}{2} + P(L1, C, R)\frac{7}{12} \\
&< P(L2, C)\frac{1}{8} + P(L2, R)\frac{1}{4} + P(L2, C, R)\frac{1}{4}
\end{aligned}$$

   Given the probability of pivotal scenarios, we have:

$$\begin{aligned}
&\sum_{K=\frac{n}{4}}^{\frac{n}{2}} \sum_{a=0}^{n-2K} \frac{n!}{K!K!a!(n-2K-a)!}\Bigg[\left(\frac{\sigma_{L1}}{m}\right)^K \Bigg(\frac{1}{2}\left(\frac{\sigma_{L2}}{m}\right)^K \left(\frac{\sigma_C}{m}\right)^a \left(\frac{\sigma_R}{n}\right)^{n-2K-a} + \frac{3}{8}\left(\frac{\sigma_C}{m}\right)^K \left(\frac{\sigma_{L2}}{m}\right)^a \left(\frac{\sigma_R}{n}\right)^{n-2K-a} \\
&\quad + \frac{1}{2}\left(\frac{\sigma_R}{m}\right)^K \left(\frac{\sigma_{L2}}{m}\right)^a \left(\frac{\sigma_C}{n}\right)^{n-2K-a}\Bigg)\Bigg] + \sum_{K=\frac{n}{4}}^{\frac{n}{3}} \frac{n!}{K!K!K!(n-3K)!}\Bigg[\left(\frac{\sigma_{L1}}{n}\right)^K \Bigg(\frac{1}{2}\left(\frac{\sigma_{L2}}{m}\frac{\sigma_C}{m}\right)^K \left(\frac{\sigma_R}{m}\right)^{n-3K} \\
&\quad + \frac{1}{2}\left(\frac{\sigma_{L2}}{m}\frac{\sigma_R}{m}\right)^K \left(\frac{\sigma_C}{m}\right)^{n-3K} + \frac{7}{12}\left(\frac{\sigma_C}{m}\frac{\sigma_R}{m}\right)^K \left(\frac{\sigma_{L2}}{m}\right)^{n-3K}\Bigg)\Bigg] + \frac{1}{2}\frac{n!}{(\frac{n}{4}!)^4}\left(\frac{\sigma_{L1}}{m}\frac{\sigma_{L2}}{m}\frac{\sigma_C}{m}\frac{\sigma_R}{m}\right)^{\frac{n}{4}} \\
&< \sum_{K=\frac{n}{4}}^{\frac{n}{2}} \sum_{a=0}^{n-2K} \frac{n!}{K!K!a!(n-2K-a)!}\Bigg[\left(\frac{\sigma_{L2}}{m}\right)^K (\frac{\sigma_{L1}}{m})^a \Bigg(\frac{1}{8}\left(\frac{\sigma_C}{m}\right)^K \left(\frac{\sigma_R}{m}\right)^{n-2K-a} + \frac{1}{4}\left(\frac{\sigma_R}{m}\right)^K \left(\frac{\sigma_C}{m}\right)^{n-2K-a}\Bigg)\Bigg] \\
&\quad + \sum_{K=\frac{n}{4}}^{\frac{n}{3}} \frac{n!}{K!K!K!(n-3K)!}\frac{1}{4}\left(\frac{\sigma_{L2}}{m}\frac{\sigma_C}{m}\frac{\sigma_R}{m}\right)^K \left(\frac{\sigma_L 1}{m}\right)^{n-3K}
\end{aligned}$$

Given this inequality, we define the threshold $\tau^*_{L1,L2}$ as the ratio between the terms on the right of the inequality and the terms on the left of the inequality.

This means that:

1. $\tau^*_{L1,L2} > 1 \quad \Rightarrow \quad t_{L1}$ prefers strategically voting for $L2$, instead of voting for her preferred candidate $L1$;

2. $\tau^*_{L1,L2} < 1 \quad \Rightarrow \quad t_{L1}$ votes for $L1$, when compared with the alternative of voting for $L2$;

3. $\tau^*_{L1,L2} = 1 \quad \Rightarrow \quad t_{L1}$ is indifferent between voting for $L1$ and voting for $L2$. In this case, we assume a voter will prefer voting for her preferred candidate, thus $L1$.

2. $EU_{t_{L1}}(L1,\sigma) - EU_{t_{L1}}(C,\sigma) < 0$. If this inequality holds, a voter t_{L1} will find more advantageous, in expected value, to vote for candidate C rather than for $L1$.

This can be written as:

$$\begin{aligned}
&[P(L1,C) + P(L1,L2,C) + P(L1,C,R) + P(L1,L2,C,R)]\frac{3}{4} \\
&+ P(L1,L2)\frac{1}{4} + P(L1,R)\frac{1}{2} + P(L1,L2,R)\frac{1}{2} + P(L2,C)\frac{1}{8} \\
&< P(C,R)\frac{1}{8}
\end{aligned}$$

Given the probability of pivotal scenarios, we have:

$$\begin{aligned}
&\sum_{K=\frac{n}{4}}^{\frac{n}{2}} \sum_{a=0}^{n-2K} \frac{n!}{K!K!a!(n-2K-a)!}\Bigg[\left(\frac{\sigma_{L1}}{m}\right)^K \Bigg(\left(\frac{\sigma_R}{m}\right)^{n-2K-a}\Bigg(\frac{3}{4}\left(\frac{\sigma_C}{m}\right)^K\left(\frac{\sigma_{L2}}{m}\right)^a + \frac{1}{4}\left(\frac{\sigma_{L2}}{m}\right)^K\left(\frac{\sigma_C}{m}\right)^a\Bigg) \\
&\quad + \frac{1}{2}\left(\frac{\sigma_R}{m}\right)^K\left(\frac{\sigma_C}{m}\right)^a\left(\frac{\sigma_{L2}}{m}\right)^{n-2K-a}\Bigg) + \frac{1}{8}\left(\frac{\sigma_{L2}}{m}\frac{\sigma_C}{m}\right)^K\left(\frac{\sigma_{L1}}{m}\right)^a \cdot \left(\frac{\sigma_R}{m}\right)^{n-2K-a}\Bigg] \\
&\quad + \sum_{K=\frac{n}{4}}^{\frac{n}{3}} \frac{n!}{K!K!K!(n-3K)!}\Bigg[\left(\frac{\sigma_{L1}}{m}\right)^K\Bigg(\frac{3}{4}\left(\frac{\sigma_{L2}}{m}\frac{\sigma_C}{m}\right)^K\left(\frac{\sigma_R}{m}\right)^{n-3K} + \frac{3}{4}\left(\frac{\sigma_C}{m}\frac{\sigma_R}{m}\right)^K\left(\frac{\sigma_{L2}}{m}\right)^{n-3K} \\
&\quad + \frac{1}{2}\left(\frac{\sigma_{L2}}{m}\frac{\sigma_R}{m}\right)^K\left(\frac{\sigma_C}{m}\right)^{n-3K}\Bigg)\Bigg] + \frac{3}{4}\frac{n!}{(\frac{n}{4}!)^4}\left(\frac{\sigma_{L1}}{m}\frac{\sigma_{L2}}{m}\frac{\sigma_C}{m}\frac{\sigma_R}{m}\right)^{\frac{n}{4}} \\
&< \frac{1}{8}\sum_{K=\frac{n}{4}}^{\frac{n}{2}} \sum_{a=0}^{n-2K} \frac{n!}{K!K!a!(n-2K-a)!}\left(\frac{\sigma_C}{m}\frac{\sigma_R}{m}\right)^K\left(\frac{\sigma_{L1}}{m}\right)^a\left(\frac{\sigma_{L2}}{m}\right)^{n-2K-a}
\end{aligned}$$

Given this inequality, we define the threshold $\tau^*_{L1,C}$ as the ratio between the terms on the right of the inequality and the terms on the left of the inequality.

Therefore, we can conclude that:

1. $\tau^*_{L1,C} > 1 \quad \Rightarrow \quad t_{L1}$ prefers strategically voting for C, instead of voting for her preferred candidate $L1$,

2. $\tau^*_{L1,C} < 1 \quad \Rightarrow \quad t_{L1}$ votes for $L1$, when compared with the alternative of voting for C,

3. $\tau^*_{L1,C} = 1 \quad \Rightarrow \quad t_{L1}$ is indifferent between voting for $L1$ and voting for C. In this case, we assume a voter will prefer voting for her preferred candidate, thus $L1$.

3. $EU_{t_{L1}}(L1,\sigma)-EU_{t_{L1}}(R,\sigma) < 0$. If this inequality holds, a voter t_{L1} will find more advantageous, in expected value, to vote for candidate R rather than for $L1$.

   This can be rewritten as:

$$\begin{aligned}
&[P(L1,R)+P(L1,L2,R)+P(L1,C,R)+P(L1,L2,C,R)]\\
&+P(L1,L2)\frac{1}{4}+P(L1,C)\frac{3}{8}+P(L1,L2,C)\frac{5}{12}\\
&+P(L2,R)\frac{1}{4}+P(C,R)\frac{1}{8}+P(L2,C,R)\frac{1}{4}<0
\end{aligned}$$

   This inequality suggests that there never exists a threshold after which a voter t_{L1} will prefer to vote for candidate R instead of voting for her first-best candidate $L1$. Hence, voting for R could never be an expected utility maximizing strategy for a voter t_{L1}.

Thus, we define $\tau^*_{L1} = \min\{\tau^*_{L1,L2}, \tau^*_{L1,C}\}$, and we can conclude that:

$$\sigma^*_{L1}(\sigma) = \begin{cases} L1 & \text{if} \quad \tau^*_{L1} \leq 1 \\ L2 \text{ or } C & \text{if} \quad \tau^*_{L1} > 1 \\ R & \quad\text{never} \end{cases}$$

Likewise, similar results can be drawn when we extend this analysis to voters t_{L2} type and t_R type, such that there exist τ^*_{L2} and τ^*_R such that,

$$\sigma^*_{L2}(\sigma) = \begin{cases} L2 & \text{if} \quad \tau^*_{L2} \leq 1 \\ L1 \text{ or } C & \text{if} \quad \tau^*_{L1} > 1 \\ R & \quad\text{never} \end{cases}$$

and

$$\sigma^*_{R}(\sigma) = \begin{cases} R & \text{if} \quad \tau^*_{R} \leq 1 \\ C & \text{if} \quad \tau^*_{R} > 1 \\ L1 \text{ or } L2 & \quad\text{never} \end{cases}$$

1.A.4 Proof of Corollary 1.1

From the inequalities in the proof of Proposition 1.1, for example when showing strategic voting of t_{L1} in favor of candidate $L2$, the result of this corollary can be easily obtained by replacing $\sigma_{L2} = \tau\sigma_{L1}$ and observing that the inequality is never verified when $\tau > 1$. Similarly, for the other inequalities.

1.A.5 Proof of Proposition 1.2

Consider a voter t_C type, whose order of preferences is given by: $C \succ L1 \sim C \sim R$. The voter has to cast a ballot by choosing a candidate in the set $\Psi = \{L1, L2, C, R\}$, knowing that her utilities for each candidate's victory are: $U_{t_C}(L1) = U_{t_C}(L2) = U_{t_C}(R) = \frac{1}{4}$, $U_{t_C}(C) = 1$. To determine if there exists a situation under which the voter's expected utility maximizing strategy is to support a candidate other than her first-best choice C, we need to analyze the conditions under which the expected utility of voting for an alternative candidate $k = \{L1, L2, R\}$ exceeds that of voting for C. This requires evaluating the following three inequalities:

1. $$EU_{t_C}(C,\sigma) - EU_{t_C}(L1,\sigma) < 0 \quad \Rightarrow \quad [P(L1,C) + P(L1,L2,C) + P(L1,C,R) + P(L1,L2,C,R)]\frac{3}{4} + P(L2,C)\frac{3}{8} + P(C,R)\frac{3}{8} + P(L2,C,R)\frac{1}{2} < 0$$

2. $$EU_{t_C}(C,\sigma) - EU_{t_C}(L2,\sigma) < 0 \quad \Rightarrow \quad [P(L2,C) + P(L1,L2,C) + P(L2,C,R) + P(L1,L2,C,R)]\frac{3}{4} + P(L1,C)\frac{3}{8} + P(C,R)\frac{3}{8} + P(L1,C,R)\frac{1}{2} < 0$$

3. $$EU_{t_C}(C,\sigma) - EU_{t_C}(R,\sigma) < 0 \quad \Rightarrow \quad [P(C,R) + P(L1,C,R) + P(L2,C,R) + P(L1,L2,C,R)]\frac{3}{4} + P(L1,C)\frac{3}{8} + P(L2,C)\frac{3}{8} + P(L1,L2,C)\frac{1}{2} < 0$$

which are never verified.

These inequalities suggest that there will never exist a $\sigma \in \Sigma$ after which a voter of type t_C would find it beneficial to vote for any alternative candidate $k \in \{L1, L2, R\}$ against her first-best C.

Hence, Proposition 1.2 is confirmed.

1.A.6 Candidates' status quo utilities

Given equation 1.7, we can explicitly define the four status quo positions for the four candidates as follows:

$$\begin{aligned}\overline{U}_{L1}^{PL}(\sigma) =& p_{L1}^{PL}(\sigma)U_{L1}(\theta = L1) + p_{L2}^{PL}(\sigma)U_{L1}(\theta = L2) + p_{C}^{PL}(\sigma)U_{L1}(\theta = C) + p_{R}^{PL}(\sigma)U_{L1}(\theta = R)\\ &+ p_{\xi_{L2,C}}^{PL}(\sigma)U_{L1}(\theta = \xi_{L2,C}) + p_{\xi_{C,R}}^{PL}(\sigma)U_{L1}(\theta = \xi_{C,R})\\ &= p_{L1}^{PL}(V+1) + p_{L2}^{PL}\frac{1}{2} + p_{C}^{PL}\frac{1}{4} + p_{\xi_{L2,C}}^{PL}\frac{3}{8} + p_{\xi_{C,R}}^{PL}\frac{1}{8}\end{aligned}$$

$$
\begin{aligned}
\overline{U}_{L2}^{PL}(\sigma) =& p_{L2}^{PL}(\sigma)U_{L2}(\theta = L2) + p_{L1}^{PL}(\sigma)U_{L2}(\theta = L1) + p_{C}^{PL}(\sigma)U_{L2}(\theta = C) + p_{R}^{PL}(\sigma)U_{L2}(\theta = R)\\
&+ p_{\xi_{L1,C}}^{PL}(\sigma)U_{L2}(\theta = \xi_{L1,C}) + p_{\xi_{C,R}}^{PL}(\sigma)U_{L2}(\theta = \xi_{C,R})\\
&= p_{L2}^{PL}(V+1) + p_{L1}^{PL}\frac{1}{2} + p_{C}^{PL}\frac{1}{4} + p_{\xi_{L1,C}}^{PL}\frac{3}{8} + p_{\xi_{C,R}}^{PL}\frac{1}{8}
\end{aligned}
$$

$$
\begin{aligned}
\overline{U}_{C}^{PL}(\sigma) =& p_{C}^{PL}(\sigma)U_{C}(\theta = C) + p_{L1}^{PL}(\sigma)U_{C}(\theta = L1) + p_{L2}^{PL}(\sigma)U_{C}(\theta = L2) + p_{R}^{PL}(\sigma)U_{C}(\theta = R)\\
&+ p_{\xi_{L1,L2}}^{PL}(\sigma)U_{C}(\theta = \xi_{L1,L2})\\
&= p_{C}^{PL}(V+1) + p_{L1}^{PL}\frac{1}{4} + p_{L2}^{PL}\frac{1}{4} + p_{R}^{PL}\frac{1}{4} + p_{\xi_{L1,L2}}^{PL}\frac{1}{4}
\end{aligned}
$$

$$
\begin{aligned}
\overline{U}_{R}^{PL}(\sigma) =& p_{R}^{PL}(\sigma)U_{R}(\theta = R) + p_{L1}^{PL}(\sigma)U_{R}(\theta = L1) + p_{L2}^{PL}(\sigma)U_{R}(\theta = L2) + p_{C}^{PL}(\sigma)U_{R}(\theta = C)\\
&+ p_{\xi_{L1,L2}}^{PL}(\sigma)U_{R}(\theta = \xi_{L1,L2}) + p_{\xi_{L1,C}}^{PL}(\sigma)U_{R}(\theta = \xi_{L1,C}) + p_{\xi_{L2,C}}^{PL}(\sigma)U_{R}(\theta = \xi_{L2,C})\\
&+ p_{\xi_{L1,L2,C}}^{PL}(\sigma)U_{C}(\theta = \xi_{L1,L2,C})\\
&= p_{R}^{PL}(V+1) + p_{C}^{PL}\frac{1}{4} + p_{\xi_{L1,C}}^{PL}\frac{1}{8} + p_{\xi_{L2,C}}^{PL}\frac{1}{8} + p_{\xi_{L1,L2,C}}^{PL}\frac{1}{12}
\end{aligned}
$$

1.A.7 Candidates' utilities in PECs

Before evaluating whether forming a PEC is beneficial, we first estimate the utility of each candidate – $L1$, $L2$, C, and R – under any of the five admissible PECs.

For the sake of brevity, in the proof we drop the conditioning on σ.

① Coalition $\xi_{L1,L2}$. Consider the case of a PEC between the two left-wing candidates $L1$ and $L2$. Hence, our maximization problem (1.8) can be presented as follows:

$$
\max_{U_{L1}^{\xi_{L1,L2}},U_{L2}^{\xi_{L1,L2}}} \quad (U_{L1}^{\xi_{L1,L2}} - \overline{U}_{L1}^{PL}(\sigma)) \cdot (U_{L2}^{\xi_{L1,L2}} - \overline{U}_{L2}^{PL}(\sigma))
$$

st:

$$
\begin{aligned}
&U_{L1}^{\xi_{L1,L2}} + U_{L2}^{\xi_{L1,L2}} \leq P_{\xi_{L1,L2}}(V + \frac{5}{6} + \frac{2}{3}) + P_C(\frac{1}{4} + \frac{1}{4}) + P_R(0+0)\\
&U_{L1}^{\xi_{L1,L2}} \geq \overline{U}_{L1}^{PL}(\sigma)\\
&U_{L2}^{\xi_{L1,L2}} \geq \overline{U}_{L2}^{PL}(\sigma)
\end{aligned}
$$

Solving we have that:

$$
U_{L1}^{\xi_{L1,L2}} = \overline{U}_{L1}^{PL} + \lambda_{L1,L2}
$$

$$
U_{L2}^{\xi_{L1,L2}} = \overline{U}_{L2}^{PL} + \lambda_{L1,L2}
$$

where $\lambda_{L1,L2} = P_{\xi_{L1,L2}}(\frac{V}{2} + \frac{3}{4}) + P_C\frac{1}{4} - \overline{U}_{L1}\frac{1}{2} - \overline{U}_{L2}\frac{1}{2}$.

Therefore,

$$U_{L1}^{\xi_{L1,L2}} = P_{L1}(\frac{V}{2}+\frac{1}{4}) - P_{L2}(\frac{V}{2}+\frac{1}{4}) + P_C\frac{1}{4} + P_{\xi_{L2,C}}\frac{3}{16} + P_{\xi_{L1,L2}}(\frac{V}{2}+\frac{3}{4}) - P_{\xi_{L1,C}}\frac{3}{16}$$

$$U_{L2}^{\xi_{L1,L2}} = P_{L2}(\frac{V}{2}+\frac{1}{4}) - P_{L1}(\frac{V}{2}+\frac{1}{4}) + P_C\frac{1}{4} + P_{\xi_{L1,C}}\frac{3}{16} + P_{\xi_{L1,L2}}(\frac{V}{2}+\frac{3}{4}) - P_{\xi_{L2,C}}\frac{3}{16}$$

② Coalition $\xi_{L1,C}$. Consider the two-candidates coalition between the leftist $L1$ and the centrist C. Here, problem (1.8) can be formalized as:

$$\max_{U_{L1}^{\xi_{L1,C}},U_C^{\xi_{L1,C}}} \quad (U_{L1}^{\xi_{L1,C}} - \overline{U}_{L1}^{PL}(\sigma)) \cdot (U_C^{\xi_{L1,C}} - \overline{U}_C^{PL}(\sigma))$$

$$\text{st:}$$

$$\begin{aligned} &U_{L1}^{\xi_{L1,C}} + U_C^{\xi_{L1,C}} \leq P_{\xi_{L1,C}}(V+\frac{5}{6}+\frac{5}{12}) + P_{L2}(\frac{1}{2}+\frac{1}{4}) + P_R(0+\frac{1}{4}) \\ &U_{L1}^{\xi_{L1,C}} \geq \overline{U}_{L1}^{PL}(\sigma) \\ &U_C^{\xi_{L1,C}} \geq \overline{U}_C^{PL}(\sigma) \end{aligned}$$

Solving we have that:

$$U_{L1}^{\xi_{L1,C}} = \overline{U}_{L1}^{PL} + \lambda_{L1,C}$$
$$U_C^{\xi_{L1,C}} = \overline{U}_C^{PL} + \lambda_{L1,C}$$

where $\lambda_{L1,C} = P_{\xi_{L1,C}}(\frac{V}{2}+\frac{5}{8}) + P_{L2}\frac{3}{8} + P_R\frac{1}{8} - \overline{U}_{L1}\frac{1}{2} - \overline{U}_C\frac{1}{2}$.

Therefore,

$$U_{L1}^{\xi_{L1,C}} = P_{L1}(\frac{V}{2}+\frac{3}{8}) - P_C(\frac{V}{2}+\frac{3}{8}) + P_{L2}\frac{1}{2} + P_{\xi_{L2,C}}\frac{3}{16} + P_{\xi_{C,R}}\frac{1}{16} + P_{\xi_{L1,C}}(\frac{V}{2}+\frac{5}{8}) - P_{\xi_{L1,L2}}\frac{1}{8}$$

$$U_C^{\xi_{L1,C}} = P_C(\frac{V}{2}+\frac{3}{8}) - P_{L1}(\frac{V}{2}+\frac{3}{8}) + P_{L2}\frac{1}{4} + P_R\frac{1}{4} + P_{\xi_{L1,L2}}\frac{1}{8} + P_{\xi_{L1,C}}(\frac{V}{2}+\frac{5}{8}) - P_{\xi_{L2,C}}\frac{3}{16} - P_{\xi_{C,R}}\frac{1}{16}$$

③ Coalition $\xi_{L2,C}$. Since both left-wing candidates share the same position in the electoral space, the utilities derived from the coalition between the leftist candidate $L2$ and the centrist candidate C will be symmetrical to those of the coalition $\xi_{L1,C}$:

$$U_{L2}^{\xi_{L2,C}} = P_{L2}(\frac{V}{2}+\frac{3}{8}) - P_C(\frac{V}{2}+\frac{3}{8}) + P_{L1}\frac{1}{2} + P_{\xi_{L1,C}}\frac{3}{16} + P_{\xi_{C,R}}\frac{1}{16} + P_{\xi_{L2,C}}(\frac{V}{2}+\frac{5}{8}) - P_{\xi_{L1,L2}}\frac{1}{8}$$

$$U_C^{\xi_{L2,C}} = P_C(\frac{V}{2}+\frac{3}{8}) - P_{L2}(\frac{V}{2}+\frac{3}{8}) + P_{L1}\frac{1}{4} + P_R\frac{1}{4} + P_{\xi_{L1,L2}}\frac{1}{8} + P_{\xi_{L2,C}}(\frac{V}{2}+\frac{5}{8}) - P_{\xi_{L1,C}}\frac{3}{16} - P_{\xi_{C,R}}\frac{1}{16}$$

④ Coalition $\xi_{C,R}$. Consider the two-candidates coalition between the right candidate R and the centrist C. Then, the problem (1.8) becomes:

$$\max_{U_R^{\xi_{R,C}}, U_C^{\xi_{R,C}}} \quad (U_R^{\xi_{R,C}} - \overline{U}_R^{PL}(\sigma)) \cdot (U_C^{\xi_{R,C}} - \overline{U}_C^{PL}(\sigma))$$

st:

$$U_R^{\xi_{R,C}} + U_C^{\xi_{R,C}} \leq P_{\xi_{R,C}}(V + \frac{5}{6} + \frac{5}{12}) + P_{L2}(\frac{1}{2} + \frac{1}{4}) + P_R(0 + \frac{1}{4})$$
$$U_R^{\xi_{R,C}} \geq \overline{U}_R^{PL}(\sigma)$$
$$U_C^{\xi_{R,C}} \geq \overline{U}_C^{PL}(\sigma)$$

Solving we have that:

$$U_R^{\xi_{R,C}} = \overline{U}_R^{PL} + \lambda_{R,C}$$
$$U_C^{\xi_{R,C}} = \overline{U}_C^{PL} + \lambda_{R,C}$$

where $\lambda_{R,C} = P_{\xi_{R,C}}(\frac{V}{2} + \frac{5}{8}) + P_{L1}\frac{1}{8} + P_{L2}\frac{1}{} + P_{\xi_{L1,L2}}\frac{1}{8} - \overline{U}_R^{PL}\frac{1}{2} - \overline{U}_C^{PL}\frac{1}{2}$.

Therefore,

$$U_R^{\xi_{R,C}} = P_R(\frac{V}{2} + \frac{3}{8}) - P_C(\frac{V}{2} + \frac{3}{8}) + P_{\xi_{L1,C}}\frac{1}{16} + P_{\xi_{L2,C}}\frac{1}{16} + P_{\xi_{L1,L2,C}}\frac{1}{24} + P_{\xi_{C,R}}(\frac{V}{2} + \frac{5}{8})$$

$$U_C^{\xi_{R,C}} = P_C(\frac{V}{2}+\frac{3}{8}) - P_R(\frac{V}{2}+\frac{3}{8}) + P_{L1}\frac{1}{4} + P_{L2}\frac{1}{4} + P_{\xi_{L1,L2}}\frac{1}{4} + P_{\xi_{C,R}}(\frac{V}{2}+\frac{5}{8}) - P_{\xi_{L1,C}}\frac{1}{16} - P_{\xi_{L2,C}}\frac{1}{16} - P_{\xi_{L1,L2,C}}\frac{1}{24}$$

⑤ Coalition $\xi_{L1,L2,C}$. Consider the unique admissible case of a three-tie PEC among the two left-wing candidates, $L1$ and $L2$, and the centrist, C. Then, problem (1.8) can be formalized as follows

$$\max_{U_{L1}^{\xi_{L1,L2,C}}, U_{L2}^{\xi_{L1,L2,C}}, U_C^{\xi_{L1,L2,C}}} \quad (U_{L1}^{\xi_{L1,L2,C}} - \overline{U}_{L1}^{PL}(\sigma)) \cdot (U_{L2}^{\xi_{L1,L2,C}} - \overline{U}_{L2}^{PL}(\sigma)) \cdot (U_C^{\xi_{L1,L2,C}} - \overline{U}_C^{PL}(\sigma))$$

subject to:

$$U_{L1}^{\xi_{L1,L2,C}} + U_{L2}^{\xi_{L1,L2,C}} + U_C^{\xi_{L1,L2,C}} \leq P_{\xi_{L1,L2,C}}(V + \frac{5}{6} + \frac{7}{12} + \frac{1}{3}) + P_R(0 + 0 + \frac{1}{4})$$
$$U_{L1}^{\xi_{L1,L2,C}} \geq \overline{U}_{L1}^{PL}(\sigma)$$
$$U_{L2}^{\xi_{L1,L2,C}} \geq \overline{U}_{L2}^{PL}(\sigma)$$
$$U_C^{\xi_{L1,L2,C}} \geq \overline{U}_C^{PL}(\sigma)$$

Solving, we obtain:

1. $U_{L1}^{\xi_{L1,L2,C}} = \overline{U}_{L1}^{PL} + \lambda_{L1,L2,C}$
2. $U_{L2}^{\xi_{L1,L2,C}} = \overline{U}_{L2}^{PL} + \lambda_{L1,L2,C}$
3. $U_{C}^{\xi_{L1,L2,C}} = \overline{U}_{C}^{PL} + \lambda_{L1,L2,C}$

where $\lambda_{L1,L2,C} = P_{\xi_{L1,L2,C}}(\frac{V}{3} + \frac{7}{12}) + P_R\frac{1}{12} - \overline{U}_{L1}\frac{1}{3} - \overline{U}_{L2}\frac{1}{3} - \overline{U}_C\frac{1}{3}$

Therefore,

$$
\begin{aligned}
U_{L1}^{\xi_{L1,L2,C}} =& P_{L1}(\frac{2V}{3} + \frac{5}{12}) - P_{L2}(\frac{V}{3} + \frac{1}{12}) - P_C(\frac{V}{3} + \frac{1}{12}) + P_{\xi_{L2,C}}\frac{1}{4} + P_{\xi_{C,R}}\frac{1}{24} + P_{\xi_{L1,L2,C}}(\frac{V}{3} + \frac{7}{12}) \\
&- P_{\xi_{L1,C}}\frac{1}{8} - P_{\xi_{L1,L2}}\frac{1}{12}
\end{aligned}
$$

$$
\begin{aligned}
U_{L2}^{\xi_{L1,L2,C}} =& P_{L2}(\frac{2V}{3} + \frac{5}{12}) - P_{L1}(\frac{V}{3} + \frac{1}{12}) - P_C(\frac{V}{3} + \frac{1}{12}) + P_{\xi_{L1,C}}\frac{1}{4} + P_{\xi_{C,R}}\frac{1}{24} + P_{\xi_{L1,L2,C}}(\frac{V}{3} + \frac{7}{12}) \\
&- P_{\xi_{L2,C}}\frac{1}{8} - P_{\xi_{L1,L2}}\frac{1}{12}
\end{aligned}
$$

$$
\begin{aligned}
U_{C}^{\xi_{L1,L2,C}} =& P_C(\frac{2V}{3} + \frac{7}{12}) - P_{L1}(\frac{V}{3} + \frac{1}{3}) - P_{L2}(\frac{V}{3} + \frac{1}{3}) + P_{\xi_{L1,L2}}\frac{1}{6} + P_{\xi_{L1,L2,C}}(\frac{V}{3} + \frac{7}{12}) - P_{\xi_{L1,C}}\frac{1}{8} \\
&- P_{\xi_{L2,C}}\frac{1}{8} - P_{\xi_{C,R}}\frac{1}{12} - P_R\frac{1}{12}
\end{aligned}
$$

1.A.8 Proof of Proposition 1.3

Consider the candidate $j = L1$ who has to decide whether to form a PEC and with whom. We know that the status quo utility of $L1$ is:

$$\overline{U}_{L1}^{PL}(\sigma) = P_{L1}^{PL}(V+1) + P_{L2}^{PL}\frac{1}{2} + P_C^{PL}\frac{1}{4} + P_{\xi_{L2,C}}^{PL}\frac{3}{8} + P_{\xi_{C,R}}^{PL}\frac{1}{8}$$

while her utilities in PECs are:

$$U_{L1}^{\xi_{L1,L2}} = P_{L1}(\frac{V}{2} + \frac{1}{4}) - P_{L2}(\frac{V}{2} + \frac{1}{4}) + P_C\frac{1}{4} + P_{\xi_{L2,C}}\frac{3}{16} + P_{\xi_{L1,L2}}(\frac{V}{2} + \frac{3}{4}) - P_{\xi_{L1,C}}\frac{3}{16}$$

$$U_{L1}^{\xi_{L1,C}} = P_{L1}(\frac{V}{2} + \frac{3}{8}) - P_C(\frac{V}{2} + \frac{3}{8}) + P_{L2}\frac{1}{2} + P_{\xi_{L2,C}}\frac{3}{16} + P_{\xi_{C,R}}\frac{1}{16} + P_{\xi_{L1,C}}(\frac{V}{2} + \frac{5}{8}) - P_{\xi_{L1,L2}}\frac{1}{8}$$

$$
\begin{aligned}
U_{L1}^{\xi_{L1,L2,C}} =& P_{L1}(\frac{2V}{3} + \frac{5}{12}) - P_{L2}(\frac{V}{3} + \frac{1}{12}) - P_C(\frac{V}{3} + \frac{1}{12}) + P_{\xi_{L2,C}}\frac{1}{4} + P_{\xi_{C,R}}\frac{1}{24} + P_{\xi_{L1,L2,C}}(\frac{V}{3} + \frac{7}{12}) \\
&- P_{\xi_{L1,C}}\frac{1}{8} - P_{\xi_{L1,L2}}\frac{1}{12}
\end{aligned}
$$

To evaluate when there is convenience to form one of these PECs or compete individually, we compute the difference between the utility form a PEC and the disagreement point of the status quo for each possible scenario:

1. $U_{L1}^{\xi_{L1,L2}} - \overline{U}_{L1}^{PL}(\sigma) \geq 0 \quad \Rightarrow$

$$P_{\xi_{L1,L2}}(\frac{V}{2}+\frac{3}{4}) \geq P_{L1}(\frac{V}{2}+\frac{3}{4}) + P_{L2}(\frac{V}{2}+\frac{3}{4}) + P_{\xi_{L2,C}}(\frac{3}{16}) + P_{\xi_{L1,C}}\frac{3}{16} + P_{\xi_{C,R}}^{PL}\frac{1}{8}$$

2. $U_{L1}^{\xi_{L1,C}} - \overline{U}_{L1}^{PL}(\sigma) \geq 0 \quad \Rightarrow$

$$P_{\xi_{L1,C}}(\frac{V}{2}+\frac{5}{8}) \geq P_{L1}(\frac{V}{2}+\frac{5}{8}) + P_{C}(\frac{V}{2}+\frac{5}{8}) + P_{\xi_{L2,C}}\frac{3}{16} + P_{\xi_{C,R}}\frac{1}{16} + P_{\xi_{L1,L2}}\frac{1}{8}$$

3. $U_{L1}^{\xi_{L1,L2,C}} - \overline{U}_{L1}^{PL}(\sigma) \geq 0 \quad \Rightarrow$

$$P_{\xi_{L1,L2,C}}(\frac{V}{3}+\frac{7}{12}) \geq P_{L1}(\frac{V}{3}+\frac{7}{12}) + P_{L2}(\frac{V}{3}+\frac{7}{12}) + P_{C}(\frac{V}{3}+\frac{1}{3}) + P_{\xi_{L2,C}}\frac{1}{8} + P_{\xi_{C,R}}\frac{1}{12} + P_{\xi_{L1,C}}\frac{1}{8} + P_{\xi_{L1,L2}}\frac{1}{12}$$

With these three inequalities, we can claim that:

$$BR(L1,\sigma) = \begin{cases} \xi_{L1,L2} & \text{if } P_{\xi_{L1,C}}(\frac{V}{2}+\frac{5}{8}) \geq P_{L1}(\frac{V}{2}+\frac{5}{8}) + P_{C}(\frac{V}{2}+\frac{5}{8}) + P_{\xi_{L2,C}}\frac{3}{16} + P_{\xi_{C,R}}\frac{1}{16} + P_{\xi_{L1,L2}}\frac{1}{8}, \\ \\ L1 & \text{otherwise.} \end{cases}$$

$$BR(L1,\sigma) = \begin{cases} \xi_{L1,C} & \text{if } P_{\xi_{L1,C}}(\frac{V}{2}+\frac{5}{8}) \geq P_{L1}(\frac{V}{2}+\frac{5}{8}) + P_{C}(\frac{V}{2}+\frac{5}{8}) + P_{\xi_{L2,C}}\frac{3}{16} + P_{\xi_{C,R}}\frac{1}{16} + P_{\xi_{L1,L2}}\frac{1}{8}, \\ \\ L1 & \text{otherwise.} \end{cases}$$

$$BR(L1,\sigma) = \begin{cases} \xi_{L1,L2,C} & \text{if } P_{\xi_{L1,L2,C}}(\frac{V}{3}+\frac{7}{12}) \geq P_{L1}(\frac{V}{3}+\frac{7}{12}) + P_{L2}(\frac{V}{3}+\frac{7}{12}) + P_{C}(\frac{V}{3}+\frac{1}{3}) + P_{\xi_{L2,C}}\frac{1}{8} \\ & \qquad +P_{\xi_{C,R}}\frac{1}{12} + P_{\xi_{L1,C}}\frac{1}{8} + P_{\xi_{L1,L2}}\frac{1}{12}, \\ \\ L1 & \text{otherwise.} \end{cases}$$

This result proves the individual rationality condition of Proposition 1.3 for candidate $L1$.

In the same way, we can validate the Proposition for all the other candidates. Specifically, for candidate $L2$, since the two left-wing candidates occupy the same position in the space, the best responses are specular to those of $L1$. Therefore,

$$BR(L2,\sigma) = \begin{cases} \xi_{L1,L2} & \text{if } P_{\xi_{L2,C}}(\frac{V}{2}+\frac{5}{8}) \geq P_{L2}(\frac{V}{2}+\frac{5}{8}) + P_{C}(\frac{V}{2}+\frac{5}{8}) + P_{\xi_{L1,C}}\frac{3}{16} + P_{\xi_{C,R}}\frac{1}{16} + P_{\xi_{L1,L2}}\frac{1}{8}, \\ \\ L2 & \text{otherwise.} \end{cases}$$

$$BR(L2,\sigma) = \begin{cases} \xi_{L2,C} & \text{if } P_{\xi_{L2,C}}(\frac{V}{2}+\frac{5}{8}) \geq P_{L2}(\frac{V}{2}+\frac{5}{8}) + P_C(\frac{V}{2}+\frac{5}{8}) + P_{\xi_{L1,C}}\frac{3}{16} + P_{\xi_{C,R}}\frac{1}{16} + P_{\xi_{L1,L2}}\frac{1}{8}, \\ \\ L2 & \text{otherwise.} \end{cases}$$

$$BR(L2,\sigma) = \begin{cases} \xi_{L1,L2,C} & \text{if } P_{\xi_{L1,L2,C}}(\frac{V}{3}+\frac{7}{12}) \geq P_{L2}(\frac{V}{3}+\frac{7}{12}) + P_{L1}(\frac{V}{3}+\frac{7}{12}) + P_C(\frac{V}{3}+\frac{1}{3}) + P_{\xi_{L1,C}}\frac{1}{8} \\ & \quad +P_{\xi_{C,R}}\frac{1}{12} + P_{\xi_{L2,C}}\frac{1}{8} + P_{\xi_{L1,L2}}\frac{1}{12}, \\ \\ L2 & \text{otherwise.} \end{cases}$$

When we consider the convenience of coalescing the right-wing candidate R, we have to impose only one inequality:

$U_R^{\xi_{C,R}} - \overline{U}_R^{PL}(\sigma) \geq 0 \quad \Rightarrow \quad P_{\xi_{C,R}}(\frac{V}{2}+\frac{5}{8}) \geq P_R(\frac{V}{2}+\frac{5}{8}) + P_C(\frac{V}{2}+\frac{1}{8}) + P_{\xi_{L1,C}}\frac{1}{16} + P_{\xi_{L2,C}}\frac{1}{16} + P_{\xi_{L1,L2,C}}\frac{1}{24}$

Therefore, we can claim that:

$$BR(R,\sigma) = \begin{cases} \xi_{C,R} & \text{if } P_{\xi_{C,R}}(\frac{V}{2}+\frac{5}{8}) \geq P_R(\frac{V}{2}+\frac{5}{8}) + P_C(\frac{V}{2}+\frac{1}{8}) + P_{\xi_{L1,C}}\frac{1}{16} + P_{\xi_{L2,C}}\frac{1}{16} + P_{\xi_{L1,L2,C}}\frac{1}{24}, \\ \\ R & \text{otherwise.} \end{cases}$$

Thus, we validate the individual rationality condition of Proposition 1.3 for candidate C.

Finally, we examine the potential benefits for the center candidate C in forming a PEC. This candidate is in the most strategic position, as she has the highest number of admissible coalitions, aligning with either the left or the right candidate. Hence, we consider the following four inequalities:

1. $U_C^{\xi_{L1,C}} - \overline{U}_C^{PL}(\sigma) \quad \Rightarrow$

$$P_{\xi_{L1,C}}(\frac{V}{2}+\frac{5}{8}) \geq P_C(\frac{V}{2}+\frac{5}{8}) + P_{L1}(\frac{V}{2}+\frac{1}{8}) + P_{\xi_{L1,L2}}\frac{1}{8} + P_{\xi_{L2,C}}\frac{3}{16} + P_{\xi_{C,R}}\frac{3}{16}$$

2. $U_C^{\xi_{L2,C}} - \overline{U}_C^{PL}(\sigma) \quad \Rightarrow$

$$P_{\xi_{L2,C}}(\frac{V}{2}+\frac{5}{8}) \geq P_C(\frac{V}{2}+\frac{5}{8}) + P_{L2}(\frac{V}{2}+\frac{1}{8}) + P_{\xi_{L1,L2}}\frac{1}{8} + P_{\xi_{L1,C}}\frac{3}{16} + P_{\xi_{C,R}}\frac{3}{16}$$

3. $U_C^{\xi_{C,R}} - \overline{U}_C^{PL}(\sigma) \quad \Rightarrow$

$$P_{\xi_{C,R}}(\frac{V}{2}+\frac{5}{8}) \geq P_C(\frac{V}{2}+\frac{5}{8}) + P_R(\frac{V}{2}+\frac{1}{8}) + P_{\xi_{L1,C}}\frac{1}{16} + P_{\xi_{L2,C}}\frac{1}{16} + P_{\xi_{L1,L2,C}}\frac{1}{24}$$

4. $U_C^{\xi_{L1,L2,C}} - \overline{U}_C^{PL}(\sigma) \quad \Rightarrow$

$$P_{\xi_{L1,L2,C}}(\frac{V}{3}+\frac{7}{12}) + P_{\xi_{L1,L2}}\frac{5}{12} \geq P_C(\frac{V}{3}+\frac{5}{12}) + P_{L1}(\frac{V}{3}+\frac{1}{12}) + P_{L2}(\frac{V}{3}+\frac{1}{12}) + P_R\frac{1}{6} + P_{\xi_{L1,C}}\frac{1}{8} + P_{\xi_{L2,C}}\frac{1}{8} + P_{\xi_{C,R}}\frac{1}{12}$$

Given these four inequalities, we can claim that Proposition 1.3 is confirmed for candidate C according to the following best responses:

$$BR(C,\sigma) = \begin{cases} \xi_{L1,C} & \text{if } P_{\xi_{L1,C}}(\frac{V}{2}+\frac{5}{8}) \geq P_C(\frac{V}{2}+\frac{5}{8}) + P_{L1}(\frac{V}{2}+\frac{1}{8}) + P_{\xi_{L1,L2}}\frac{1}{8} + P_{\xi_{L2,C}}\frac{3}{16} + P_{\xi_{C,R}}\frac{3}{16}, \\ C & \text{otherwise.} \end{cases}$$

$$BR(C,\sigma) = \begin{cases} \xi_{L2,C} & \text{if } P_{\xi_{L2,C}}(\frac{V}{2}+\frac{5}{8}) \geq P_C(\frac{V}{2}+\frac{5}{8}) + P_{L2}(\frac{V}{2}+\frac{1}{8}) + P_{\xi_{L1,L2}}\frac{1}{8} + P_{\xi_{L1,C}}\frac{3}{16} + P_{\xi_{C,R}}\frac{3}{16}, \\ C & \text{otherwise.} \end{cases}$$

$$BR(C,\sigma) = \begin{cases} \xi_{C,R} & \text{if } P_{\xi_{C,R}}(\frac{V}{2}+\frac{5}{8}) \geq P_C(\frac{V}{2}+\frac{5}{8}) + P_R(\frac{V}{2}+\frac{1}{8}) + P_{\xi_{L1,C}}\frac{1}{16} + P_{\xi_{L2,C}}\frac{1}{16} + P_{\xi_{L1,L2,C}}\frac{1}{24}, \\ C & \text{otherwise.} \end{cases}$$

$$BR(C,\sigma) = \begin{cases} \xi_{L1,L2,C} & \text{if } P_{\xi_{L1,L2,C}}(\frac{V}{3}+\frac{7}{12}) + P_{\xi_{L1,L2}}\frac{5}{12} \geq P_C(\frac{V}{3}+\frac{5}{12}) + P_{L1}(\frac{V}{3}+\frac{1}{12}) + P_{L2}(\frac{V}{3}+\frac{1}{12}) \\ & \quad + P_R\frac{1}{6} + P_{\xi_{L1,C}}\frac{1}{8} + P_{\xi_{L2,C}}\frac{1}{8} + P_{\xi_{C,R}}\frac{1}{12}, \\ C & \text{otherwise.} \end{cases}$$

1.A.9 Proof of Proposition 1.4

To establish the comparative advantage condition, we calculate the comparison between differences in utility for each candidate $j = \{L1, L2, C\}$ based on the PEC selected from their available coalition options. We exclude $j = R$ from this analysis because, under our assumed policy-seeking approach, candidate R can only form a single coalition with candidate C. As a result, the bargaining process for candidate R is governed solely by the individual rationality condition of Proposition 1.3.

Consider candidate $j = L1$, whose set of available coalitions is $\xi_{L1,\cdot} = \{\xi_{L1,L2}, \xi_{L1,C}, \xi_{L1,L2,C}\}$. Then, from the comparison between them, we have:

1. $U_{L1}^{\xi_{L1,L2}} \geq [U_{L1}^{\xi_{L1,C}} + U_{L1}^{\xi_{L1,L2,C}}] \quad \Rightarrow$

$$P_C(40V+34) + P_{\xi_{L1,L2}}(24V+46) \geq P_{L1}(32V+26) + P_{L2}(8V+32) + P_{\xi_{L2,C}}(12) + P_{\xi_{L1,C}}(24V+33) + P_{\xi_{L1,L2,C}}(16V+28) + P_{\xi_{C,R}}(5)$$

2. $U_{L1}^{\xi_{L1,C}} \geq [U_{L1}^{\xi_{L1,L2}} + U_{L1}^{\xi_{L1,L2,C}}] \quad \Rightarrow$

$$P_{L2}(32V+40) + P_{\xi_{L1,C}}(24V+45) + P_{\xi_{L1,L2,C}}(16V+28) \geq P_{L1}(32V+14) + P_C(8V+26) + P_{\xi_{L2,C}}(12) + P_{\xi_{L1,L2}}(24V+38)$$

3. $U_{L1}^{\xi_{L1,L2,C}} \geq [U_{L1}^{\xi_{L1,L2}} + U_{L1}^{\xi_{L1,C}}] \quad \Rightarrow$

$$P_{L2}(8V) + P_C(8V+2) + P_{\xi_{L1,L2,C}}(16V+28) \geq P_{L1}(16V+10) + P_{L2}(16) + P_{\xi_{L2,C}}(6) + P_{\xi_{C,R}}(1) + P_{\xi_{L1,C}}(24V+27) + P_{\xi_{L1,L2}}(24V+34)$$

These three inequalities explicitly state the conditions under which a candidate $L1$ has the convenience to coalesce with one candidate against another. Based on these, the best response for candidate $L1$ is determined as follows:

$$BR(L1,\sigma) = \begin{cases} \xi_{L1,L2} & \text{if} \quad U_{L1}^{\xi_{L1,L2}} \geq [U_{L1}^{\xi_{L1,C}} + U_{L1}^{\xi_{L1,L2,C}}] \\ \xi_{L1,C} & \text{if} \quad U_{L1}^{\xi_{L1,C}} \geq [U_{L1}^{\xi_{L1,L2}} + U_{L1}^{\xi_{L1,L2,C}}] \\ \xi_{L1,L2,C} & \text{if} \quad U_{L1}^{\xi_{L1,L2,C}} \geq [U_{L1}^{\xi_{L1,L2}} + U_{L1}^{\xi_{L1,C}}] \end{cases}$$

Likewise, we can estimate the conditions under which a given coalition is the best response for a candidate $j = L2$ by considering $L2$'s set of possible coalitions $\xi_{L2,\cdot} = \{\xi_{L1,L2}, \xi_{L2,C}, \xi_{L1,L2,C}\}$, which replicates that of candidate $L1$ already examined. Therefore, we can make the same comparisons again, but in terms of $L2$ instead of $L1$:

1. $U_{L2}^{\xi_{L1,L2}} \geq [U_{L2}^{\xi_{L2,C}} + U_{L2}^{\xi_{L1,L2,C}}] \quad \Rightarrow$

$$P_C(40V+34) + P_{\xi_{L1,L2}}(24V+46) \geq P_{L2}(32V+26) + P_{L1}(8V+32) + P_{\xi_{L1,C}}(12) + P_{\xi_{L2,C}}(24V+33) + P_{\xi_{L1,L2,C}}(16V+28) + P_{\xi_{C,R}}(5)$$

2. $U_{L2}^{\xi_{L2,C}} \geq [U_{L2}^{\xi_{L1,L2}} + U_{L2}^{\xi_{L1,L2,C}}] \quad \Rightarrow$

$$P_{L1}(32V+40) + P_{\xi_{L2,C}}(24V+45) + P_{\xi_{L1,L2,C}}(16V+28) \geq P_{L2}(32V+14) + P_C(8V+26) + P_{\xi_{L1,C}}(12) + P_{\xi_{L1,L2}}(24V+38)$$

3. $U_{L2}^{\xi_{L1,L2,C}} \geq [U_{L2}^{\xi_{L1,L2}} + U_{L2}^{\xi_{L2,C}}] \quad \Rightarrow$

$$P_{L1}(8V) + P_C(8V+2) + P_{\xi_{L1,L2,C}}(16V+28) \geq P_{L2}(16V+10) + P_{L1}(16) + P_{\xi_{L1,C}}(6) + P_{\xi_{C,R}}(1) + P_{\xi_{L2,C}}(24V+27) + P_{\xi_{L1,L2}}(24V+34)$$

Based on these, the best response for candidate $L2$ is determined as follows:

$$BR(L2,\sigma) = \begin{cases} \xi_{L1,L2} & \text{if} \quad U_{L2}^{\xi_{L1,L2}} \geq [U_{L2}^{\xi_{L2,C}} + U_{L2}^{\xi_{L1,L2,C}}] \\ \\ \xi_{L2,C} & \text{if} \quad U_{L2}^{\xi_{L2,C}} \geq [U_{L2}^{\xi_{L1,L2}} + U_{L2}^{\xi_{L1,L2,C}}] \\ \\ \xi_{L1,L2,C} & \text{if} \quad U_{L2}^{\xi_{L1,L2,C}} \geq [U_{L2}^{\xi_{L1,L2}} + U_{L2}^{\xi_{L2,C}}] \end{cases}$$

Finally, we can determine the conditions under which a particular coalition is the best response for candidate C, by examining C's set of potential coalitions: $\xi_{C,\cdot} = \{\xi_{L1,C}, \xi_{L2,C}, \xi_{C,R}, \xi_{L1,L2,C}\}$. Due to C's central political position and the policy-seeking approach, this candidate has the highest number of admissible coalitions available to them. Thus, we make the following comparisons:

1. $U_C^{\xi_{L1,C}} \geq [U_C^{\xi_{L2,C}} + U_C^{\xi_{C,R}} + U_C^{\xi_{L1,L2,C}}] \quad \Rightarrow$

$$P_{L2}(20V+17) + P_R(12V+11) + P_{\xi_{L1,C}}(12V+24) \geq P_{L1}(4V+13) + P_C(28V+23) + P_{\xi_{L2,C}}(12V+15)$$
$$+P_{\xi_{C,R}}(12V+13) + P_{\xi_{L1,L2}}(10) + P_{\xi_{L1,L2,C}}(8V+13)$$

2. $U_C^{\xi_{L2,C}} \geq [U_C^{\xi_{L1,C}} + U_C^{\xi_{C,R}} + U_C^{\xi_{L1,L2,C}}] \quad \Rightarrow$

$$P_{L1}(20V+17) + P_R(12V+11) + P_{\xi_{L2,C}}(12V+24) \geq P_{L2}(4V+13) + P_C(28V+23) + P_{\xi_{L1,C}}(12V+15)$$
$$+P_{\xi_{C,R}}(12V+13) + P_{\xi_{L1,L2}}(10) + P_{\xi_{L1,L2,C}}(8V+13)$$

3. $U_C^{\xi_{C,R}} \geq [U_C^{\xi_{L1,C}} + U_C^{\xi_{L2,C}} + U_C^{\xi_{L1,L2,C}}] \quad \Rightarrow$

$$P_{L1}(20V+17) + P_{L2}(20V+17) + P_{\xi_{C,R}}(12V+20) \geq P_R(12V+19) + P_C(28V+23) + P_{\xi_{L1,L2}}(4)$$
$$+P_{\xi_{L1,C}}(12V+9) + P_{\xi_{L2,C}}(12V+12) + P_{\xi_{L1,L2,C}}(8V+15)$$

4. $U_C^{\xi_{L1,L2,C}} \geq [U_C^{\xi_{L1,C}} + U_C^{\xi_{L2,C}} + U_C^{\xi_{C,R}}] \quad \Rightarrow$

$$P_{L1}(4V) + P_{L2}(4V) + P_R(12V) + P_{\xi_{L1,L2,C}}(8V+15) \geq P_C(20V+13) + P_{L1}(11) + P_{L2}(11) + P_R(5) + P_{\xi_{L1,L2}}(8)$$
$$+ P_{\xi_{L1,C}}(12V+12) + P_{\xi_{L2,C}}(12V+12) + P_{\xi_{C,R}}(12V+9)$$

These four inequalities explicitly state the conditions under which a candidate C has the convenience to coalesce with one candidate against another. Based on these, the best response for candidate C is determined as follows:

$$BR(C,\sigma) = \begin{cases} \xi_{L1,C} & \text{if} \quad U_C^{\xi_{L1,C}} \geq [U_C^{\xi_{L2,C}} + U_C^{\xi_{C,R}} + U_C^{\xi_{L1,L2,C}}] \\ \\ \xi_{L2,C} & \text{if} \quad U_C^{\xi_{L2,C}} \geq [U_C^{\xi_{L1,C}} + U_C^{\xi_{C,R}} + U_C^{\xi_{L1,L2,C}}] \\ \\ \xi_{C,R} & \text{if} \quad U_C^{\xi_{C,R}} \geq [U_C^{\xi_{L1,C}} + U_C^{\xi_{L2,C}} + U_C^{\xi_{L1,L2,C}}] \\ \\ \xi_{L1,L2,C} & \text{if} \quad U_C^{\xi_{L1,L2,C}} \geq [U_C^{\xi_{L1,C}} + U_C^{\xi_{L2,C}} + U_C^{\xi_{C,R}}] \end{cases}$$

1.A.10 Proof of Lemma 1.4

Consider a PEC assignment $\mu \in \mathcal{X}$, with U_j^{μ} denoting the utility of the candidate j under the current assignment μ, and U_j^{ξ} the utility that j would obtain if she joined an alternative coalition $\xi \in \mathcal{X}$.

By the individual rationality condition of point 1, no candidate can improve by leaving her PEC to act individually. Hence, every candidate in a PEC may have at least as much utility as in her outside option, as already verified in the proof of Proposition 1.3.

By the feasibility of point 2, we know that a PEC assignment μ is pairwise (three-sided) stable if and only if there exists no alternative coalition $\xi \in \mathcal{X}$ such that:

1. $\forall j \in \xi : U_j^{\xi} \geq U_j^{\mu} \Rightarrow$ all members weakly prefer ξ over their current PEC;
2. $\exists j \in \xi : U_j^{\xi} > U_j^{\mu} \Rightarrow$ at least one member strictly prefers ξ.

For instance, consider three candidates L_1, L_2, C and the current PEC assignment $\mu = \{\{L_1, L_2\}, \{C\}\}$. Suppose that their utilities under μ are $U_{L_1}^{\mu} = 3, \quad U_{L_2}^{\mu} = 2, \quad U_C^{\mu} = 1$. Additionally, candidates $L1$ and C know that if they form an alternative coalition $\xi = \{L_1, C\}$, their utilities become $U_{L_1}^{\xi} = 4, \quad U_C^{\xi} = 2$.

Then, we have that $U_{L_1}^{\xi} = 4 > U_{L_1}^{\mu} = 3$ and $U_C^{\xi} = 1 > U_C^{\mu} = 2$.

Since both individual rationality and feasibility criteria are not satisfied, ξ is a blocking coalition and the current PEC assignment μ is not stable or strategically optimal.

Alternatively, suppose that $L2$ and C can also form an alternative coalition $\xi = \{L_2, C\}$, knowing that their utilities will be $U_{L_2}(\xi) = 2, \quad U_C(\xi) = 1$. Hence, no member strictly improves. In this case, ξ does not block μ, and μ is stable and strategically optimal.

Chapter 2

More ambiguity, more sincere voting? Evidence on the neglected role of primary elections.

Keywords: Ambiguity, Duverger's Law, Primary election, Sincere voting

JEL codes: C92; D72; D81; P16

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2.1 Introduction

Elections are the cornerstone of democratic societies, allowing citizens to express preferences and influence governance. However, the electoral process inherently involves ambiguity, as voters must make decisions under uncertain conditions, such as preference distribution, candidate viability, and policy outcomes. In this context, primary elections are pivotal in providing a preliminary stage for voters to express their preferences. Against this backdrop, this chapter aims to formalize and investigate how ambiguity in primary elections affects voter strategy and shapes equilibrium outcomes in the electoral process.

Primary elections (commonly known as primaries) are a preliminary electoral process through which political parties internally select their candidates for an upcoming general election (Sandri et al., 2015). This mechanism allows party members or, in some cases, all eligible voters, to participate in choosing the individual who will represent their party on the ballot.[1] Primaries are designed to democratize candidate selection, giving voters a direct role in determining political contenders.

Given this unique dynamic, primary elections gained significance in the United States, initially at the country-state level during the 1890s, and then at the local level during the 1900s. Since then, they have become a regular feature, with at least one political party in all 50 country-states conducting primaries before each forthcoming general election. Moreover, since the year 2000, primary elections have also been adopted by political parties in an additional 24 countries worldwide, including 6 in the Americas, 10 in Europe, 3 in Asia, 4 in Africa, and 1 in Oceania, before at least one general election.[2]

Although primaries democratize candidate selection, they also introduce additional ambiguity and strategic complexity into the electoral process, since they are frequently scheduled by political parties based on their own calendars, according to each party's priorities or internal rules. For voters participating in these primaries, this means that multiple electoral sequences may overlap, with their schedules not necessarily synchronized. This lack of alignment creates a source of *outcome ambiguity*, as voters for a given party A have to outguess who their favorite candidate will meet in the next round from another party B.

Compounding this is the inherent *ambiguity in preference distribution* under primaries. Unlike general elections, where ideological divides between parties are more clearly delineated, primaries involve competition among candidates within the same political alignment, with the same core values. This blurs the boundaries of voter preferences, making it harder to predict the viability of individual candidates.

Given these two types of ambiguity, voters define their voting strategy by balancing the psychological and mechanical effects of the electoral process (Duverger, 1951; Blais and Carty, 1991; Van der Straeten et al., 2010). The mechanical effect consists of transforming votes into a distribution of seats through the application of electoral rules; the psychological effect influences voter behavior by prompting them to account for the consequences of their votes.[3] Therefore, psychological effects shape voter strategies by creating a trade-off between two types of equilibria: *Sincere voting* or *Duverger's Law*. Sincere voting equilibrium occurs when voters cast their ballots for their most preferred candidate, prioritizing ideological alignment over strategic considerations, regardless of the candidate's likelihood

[1] Primaries can be classified into four types based on voter eligibility and participation rules: (i) *closed primaries*, where only registered party members can vote, ensuring candidate selection is determined solely by party affiliates; (ii) *open primaries*, where any eligible voter, regardless of party affiliation, can participate, broadening the voter base; (iii) *semi-closed primaries*, where both registered party members and independent or unaffiliated voters can participate; and (iv) *top-two or jungle primaries*, where all candidates, regardless of party affiliation, compete in a single primary, and the top two contenders advance to the general election. For a detailed analysis of the different types of primaries, voter eligibility, and their influence on electoral outcomes, see Rosenstone (1993).

[2] In the Americas: Argentina (2011, 2023), Canada (2013, 2017), Chile (2013, 2017), Colombia (2006, 2010), Costa Rica (2001, 2009, 2013, 2017, 2021), and Uruguay (2004, 2009, 2014, 2019). In Europe: Armenia (2007, 2017), France (2011, 2016, 2021), Germany (2013), Hungary (2019), Italy (2005, 2007, 2009, 2013, 2017, 2019, 2023), Poland (2019, 2020), Portugal (2014), Russia (2007, 2011, 2016, 2017), Spain (2014) and United Kingdom (2010, 2015). In Asia: Hong Kong (2020), Republic of Korea (2019), and South Korea (2017). In Africa: South Africa (2014, 2019, 2024), Kenya (2017), Nigeria (2015, 2019, 2023), and Ghana (2016). Australia is the only nation in Oceania where primary elections have been held so far (2013, 2016).

[3] See, e.g., Attanasi et al. (2014), Attanasi et al. (2017), and the literature review therein for discussions on risk aversion as a primary driver of voter behavior.

of winning. In contrast, Duverger's Law equilibrium reflects strategic behavior in competitive systems, where voters aim to maximize their expected utility by supporting a viable contender with a strong chance of winning, even if this contender is not their first preference. This approach minimizes the risk of "wasting" votes (Duverger, 1951; Cox and Shugart, 1996; Cox, 1997; Lago, 2008).

Therefore, the main purpose of this chapter is to theoretically formalize and experimentally examine how the two types of outcome and preference ambiguity, typical of primary elections, shape voter behavior, influencing their tendency to converge toward either a Duverger's Law equilibrium or a Sincere voting equilibrium (i.e., non-Duverger's Law equilibrium). We specifically focus on primaries because, although they have barely been considered in the existing literature, the ambiguity inherent in these elections and the consequences they generate for general elections can be substantial.

To proceed in this investigation, we adopt the theory-based experimental approach of Bouton et al. (2017) as our benchmark model. In their study, the authors examine whether, in plurality elections, the presence of aggregate uncertainty can lead to the emergence of non-Duverger's law equilibria. By aggregate uncertainty, they refer to voters' ignorance of the overall preference distribution in the electorate, which we define as preference ambiguity. To explore this, they design a one-stage election environment with three candidates competing for the same office. Each participant, acting as a voter, must cast a ballot for one of the three candidates under two alternative conditions: one in which the aggregate preference distribution is publicly known (no preference ambiguity) and one in which it is not (preference ambiguity). Their findings suggest that in the absence of preference ambiguity, subjects are able to correctly anticipate the expected ranking and coordinate their votes around the strongest contender, thereby voting strategically. However, they observe a significant shift towards a massive sincere voting strategy in scenarios with preference ambiguity, thereby converging to the namesake equilibrium.

Given these premises, our intervention in the benchmark model is two-fold. First, we reinterpret the environment proposed by Bouton et al. (2017), which examines a single-stage plurality election under preference ambiguity, as the preliminary stage of a primary election. In our context, this refers specifically to a closed primary election, which we term the *intra-positional election* (as it occurs within a single political position). This reinterpretation closely mirrors real-world primary elections for the straightforward re-election of a party's internal representative at the end of their term, such as those conducted by the Democratic Party in Italy, and it is not directly related to participation in subsequent national or supranational elections.

Second, we extend the model to include a second stage, representing the general election. Here, candidates selected during the intra-positional election compete against one another for the same office. We term this the *inter-positional election.* This reflects the sequential nature of U.S. primaries, where candidates from major parties, such as Republicans and Democrats, vie to nominate their party's representative for the upcoming presidential election. Under this two-stage framework, voters can experience simultaneously *preference ambiguity* and *outcome ambiguity.*

Our primary contribution, therefore, lies in using *a theory-driven experiment to examine whether a Sincere voting equilibrium persists when preference ambiguity is compounded by outcome ambiguity in a sequential (two-stage) voting game, thereby extending and generalizing the findings of Bouton et al. (2017).*

From a theoretical perspective, we propose a two-stage sequential voting game by defining an economic system characterized by three distinct political positions, each represented by three candidates. Within each political position,[4] a fixed number of voters are divided into types based on two dimensions of preference: intra-positional preferences (preferences for specific candidates within their political position) and inter-positional preferences (preferences for candidates from other political positions). In Stage 1 of the model – before the intra-positional election – each voter type forms beliefs about the distribution of preferences and the potential outcome, incorporating these beliefs into their voting strategy. Beliefs' formation depends on the informativeness of a public signal, which provides voters with information about the distribution of preferences within their own political position, determining if the election is characterized by preference ambiguity or not. However, no public signal is provided on the distribution of preferences across other political positions. As a result, voters face outcome ambiguity. Based on the formed belief, voters define a voting strategy that maximizes their expected utility, converging toward a sincere voting strategy as the information available decreases, and hence as ambiguity increases.

From an experimental perspective, we investigate voters' behavior as ambiguity increases, according to four configurations. The first two configurations are our **two control treatments**, as they replicate the experimental design proposed by Bouton et al. (2017). Subjects are involved in an intra-positional election featuring three exogenous candidates: two majoritarian (namely, Blue and Red) and one minoritarian (Gray). Each participant is assigned a ball corresponding to the color of one of the two majoritarian parties, representing their political preference. Additionally, they are aware of two possible states of nature (referred to as Blue or Red jar), with the strongest contender corresponding to the verified state of nature. Indeed, the Blue (resp., Red) jar contains more Blue (resp., Red) balls, and the distribution of these balls is determined through random draws from the selected jar. Subjects are then tasked with casting a ballot for one of the three candidates under two different treatments: a no preference ambiguity (henceforth, NPA) treatment and a preference ambiguity (henceforth, PA) treatment.[5] Under the *NPA treatment*, voters know from which of the two jars their balls were randomly drawn. Hence, they have complete information about voters' preferences for their political position. Conversely, under the *PA treatment*, voters do not know from which jar their votes were randomly drawn. Hence, they have incomplete information about the distribution of voters' preferences within their political position.[6] These two control treatments allow us to examine behavioral deviations in voting strategies. Under NPA conditions, best-response dynamics and iterated belief reasoning predict convergence toward strategic coordination on the most viable candidate (a Duvergerian equilibrium), since pivot probabilities are sufficiently asymmetric and commonly anticipated (Cox and Shugart, 1996). By contrast, the PA condition, by removing common knowledge of the preference distribution, reduces the perceived differences in pivot probabilities and weakens the higher-order beliefs required for coordination (as in global-games logic), making sincere voting a robust and "justifiable" default strategy (Morris and Shin, 1998, on ambiguity and coordination). In addition, if voters are ambiguity averse (as widely documented since Ellsberg, 1961 and formalized by Gilboa and Schmeidler, 1989; Klibanoff et al., 2005; Schmeidler, 1989), they tend to overestimate worst-case

[4]Each political position is analogous to the others, and functions as proposed by Bouton et al. (2017). However, since Bouton et al. (2017) examines a single-stage voting game involving only preference ambiguity, a single political position is sufficient. In our model, the introduction of a second-stage election necessitates multiple political positions.

[5]In the notation of Bouton et al. (2017), the two treatments are indicated respectively as no aggregate uncertainty (henceforth, NAU) treatment about the preferences distribution in the electorate and aggregate uncertainty (henceforth, AU) treatment.

[6]For the sake of simplicity, we refer with "no preference ambiguity vs. preference ambiguity" to the dichotomy of "voters' certainty vs. uncertainty on the prior distribution of preferences about the blue and red candidates".

scenarios about others' preferences. This discourages strategic desertion that might backfire, further reinforcing the tendency to vote sincerely.[7]

The other two configurations constitute the **two main treatments** of our experimental setting, with the introduction of Stage 2 of the inter-positional election. With this second stage, we induce the outcome ambiguity. After subjects cast a ballot for one of the three candidates (Blue, Red, or Gray) in their political position, under the NPA or PA scenario, the winner of Stage 1 election is announced and participates in Stage 2 election competition with two other unknown candidates from opposite political positions (i.e., Green and Black). All candidates have an equal probability of 1/3 of winning, and a random draw determines the electoral outcome. With this, we perform the general electoral scenario by adding two new treatments to the original protocol. *NPA+OA (no preference ambiguity but outcome ambiguity) treatment* reproduces the NPA treatment as a sequence primary election-general election where, absent ambiguity about preference distribution, the second draw brings ambiguity about the electoral outcome. *PA+OA (both preference and outcome ambiguity)* reproduces PA treatment as a sequence of primary-general election in which ambiguity about preference distribution during primary elections is complemented by ambiguity about outcome (OA) in the general ones. Under this framing, we interpret the two control treatments of Bouton et al. (2017), NPA and PA, as two voting environments without outcome ambiguity.[8] Introducing this second stage of a general election with exogenous outcome risk, we increase payoff variance conditional on the identity of the primary winner. Under NPA+OA, strategic voting becomes the risk-dominant behavior: coordinating on the most viable intra-positional candidate hedges against downside risk by maximizing the probability that one's position advances a competitively strong nominee into the uncertain second stage (Harsanyi and Selten, 1988; Selten, 1995). By contrast, under PA+OA treatment, voters face compound uncertainty. Under ambiguity-averse preferences (see, e.g., Gilboa and Schmeidler, 1989; Schmeidler, 1989 and Klibanoff et al., 2005), the incentive to vote strategically diminishes further.

Throughout our theoretical formalization and experimental investigation, we posit that outcome ambiguity should amplify the opposite behaviors experienced in NPA vs. PA. Under the NPA+OA treatment, where only outcome ambiguity exists, voters' motivation to vote for the most representative candidate is expected to increase compared to the NPA scenario. Since outcome ambiguity is not directly influenced by voting choices and each candidate is aware of the strongest contender, strategic voting becomes more prevalent, leading to a Duverger's Law equilibrium. With each candidate having an equal probability of winning (1/3), resulting in a lower expected payoff, voters tend to coordinate toward strategic voting during the primary election in the NPA+OA treatment more so than in the NPA scenario (where they should already do so), to avoid further minimizing their payoff. In contrast, under PA+OA treatment, voters experience simultaneously preference and outcome ambiguities, further limiting their decision process. Thus, as in PA treatment, the only rational behavior is to support their preferred candidate. Ambiguity about preferences' distribution guides the voters' conduct, and absorbing ambiguity about the electoral outcome boosts the convergence to the sincere voting strategy (first-best candidate) more than under the PA treatment.

An additional contribution, from an experimental perspective, is in the investigation of cross-country differences in voters' strategies under preference and/or outcome ambiguity during primaries. To achieve this, we conducted our experimental study in two countries – Italy and Japan – under

[7]See also Attanasi et al. (2014; 2017) on the role of risk attitudes in voting under uncertainty.

[8]We do not use the notation NPA+NOA and PA+NOA, to avoid overburdening the reading of the article.

the same experimental conditions. The selection of these two democracies was not arbitrary but influenced by the electoral dynamics that define them. Italy has traditionally embraced a system of primaries and, apart from the US, is the country where primaries have been held most often for national elections. Since its establishment in 2007, the Democratic Party has consistently organized primary elections. In contrast, political parties in Japan have never conducted primary elections. Despite this, the two countries are comparable in terms of liberalism and democratic standards.[9] We leverage this contrast to check whether participants exhibit similar voting strategies when confronted with the same situations of ambiguity, regardless of the political context in which they reside.

The remainder of the chapter is organized as follows. Section 2.2 discusses the relationship between our work and the existing literature. Section 2.3 reports on the theoretical formalization. Section 2.4 describes the experimental design and formulates the behavioral hypotheses. Section 2.5 presents the main results. Section 2.6 concludes.

2.2 Related literature

This chapter relates to the vast literature that seeks to understand if and to what extent significant differences in voting strategies exist, considering different states of the world – from more unambiguous to more ambiguous scenarios – and whether such differences are related to cultural dissimilarities in the policy perception.

Voting strategies in multi-candidate elections have been extensively investigated under various electoral systems (see, among others, Downs, 1957; McKelvey, 1972; Cox and Shugart, 1996; Alvarez and Nagler, 2000), and trace back to the psychological effect identified by Duverger's Law (Duverger, 1951),[10] which contrasts with Sincere voting. Bouton (2013) and Bouton et al. (2022) provided, respectively, theoretical and experimental support to Duverger's prediction of strategic voting under unambiguous scenarios, showing coordination around the strongest contender across diverse electoral systems, even if with varying impacts on voters' welfare. More precisely, Bouton et al. (2022) compared the properties of majority runoff and plurality rule elections in a laboratory setting, focusing on Duverger's prediction that plurality rule leads to higher levels of strategic voting. They showed that voters' strategic behavior is affected by the electoral rules; a result that has recently been experimentally replicated and confirmed by Hausladen et al. (2024). Blais et al. (2007, 2011) and Bouton (2013), comparing one-round versus two-round elections, highlight a strong tendency to Duverger's Law equilibria by strategically abandoning the preferred candidate for the most viable in both systems. However, this trend is more pronounced in one-round elections, where information about distributional preferences is less complex (i.e., less ambiguous).

[9] The Democracy Index shows that, in the past nine years, from 2015 to 2023, both Italy and Japan consistently ranked in the top one-third of global democracies, with average scores of 7.75 and 8.10 on a scale from 0 to 10 for democracy, respectively. Furthermore, according to the *Freedom in the World Index* published by Freedom House, which evaluates political rights and civil liberties worldwide, both countries are recognized as the most democratic countries. On a scale from 0 to 100, Italy generally receives scores between 89-91, while Japan scores between 96-98, indicating high levels of liberalism and democratic standards.

[10] The psychological impact of Duverger's Law can be illustrated by considering a simple majority single-ballot system with more than two parties. In such a system, voters realize that consistently supporting a third party renders their votes ineffective. Consequently, they tend to consolidate their support behind a single candidate (see, for example, Palfrey, 1988; Taagepera and Shugart, 1989; Blais and Carty, 1991; Dolez and Laurent, 2010; Xefteris, 2019). Further research indicates that the effect of Duverger's Law equilibrium persists even when three candidates receive a positive fraction of votes (Bouton and Gratton, 2015; Bouton et al., 2017).

Our study extends this strand of literature, showing that differences in strategic voting depend not only on the electoral system itself, but also on the different types and levels of ambiguity that voters face, focusing on the dimension of the primary election and hence increasing the barely existing literature in this domain.

From the most relevant works, Cherry and Kroll (2003) explored, through a laboratory experiment, strategic voting in primary elections, revealing how voter behavior shifts across the four different primary formats (closed, semi-closed, open, and two-top primaries), often resulting in unconventional electoral outcomes. Then Culbert (2015), based on survey data from American presidential primaries, which spans from 1984 to 2004, demonstrated that voters tend to adopt a more strategic approach by prioritizing candidates with better prospects in the general election. These studies align with the traditional findings of a natural convergence toward Duverger's Law equilibrium when no preference ambiguity occurs (Forsythe et al., 1993; Myerson and Weber, 1993; Fey, 1997). This is verified because, under complete information, voters' strategies aim to maximize their expected utility, which is a combination of preferences and beliefs about the likely outcomes (Abramson et al., 1992; Abramson et al., 2004; Bouton and Castanheira, 2012). Xefteris (2019) demonstrates that such strategic voting persists when voting is either costless and mandatory or costly and voluntary. However, when ambiguity is introduced, it impacts the rational-voter model (Dewan and Myatt, 2007; Myatt, 2007; Mandler, 2012; Bouton, 2013; Myatt, 2017) and thus Duverger's Law equilibria become fragile, in favor of a Sincere voting strategy. This fragility is better examined in studies that compare voters' behaviors in ambiguous and unambiguous scenarios (Fisher and Myatt, 2002; Bouton et al., 2017; Fisher and Myatt, 2017). Incomplete information on others' preferences and beliefs determines coordination failure (Louis et al., 2022), while complete information favors coordination and avoids the Condorcet loser winning (Reitz et al., 1998). Merrill (1982) sets a model that describes how strategic voting behavior acts strongly under conditions of uncertainty (risk and/or ambiguity). Building upon one of these studies (Bouton et al., 2017), our experimental setup extends previous studies that consider both scenarios – with and without preference ambiguity – by exploring the interplay of various dimensions of ambiguity.

This interplay between different types of ambiguity can be perceived differently according to cultural differences related to the country. It should be noted that while numerous studies have investigated similarities and differences between different political-electoral systems – such as Italy and Japan (Reed, 1994; Giannetti and Grofman, 2011; Samuels, 2019) – only a handful have delved into the pivotal role of the voter. For instance, Cox and Schoppa (2002) explore voters' behavior under electoral competition in Italy and Japan, suggesting that Duverger's Law equilibrium may not always apply. Likewise, Reed (2001) identifies a trend of abandoning strategic behavior, particularly when distinguishing between losing candidates becomes challenging, leading to convergence to a Sincere voting equilibrium. Both studies report similar patterns of voting behavior in these two democracies. Our study is closely related to these comparative analyses. To our knowledge, ours is the first comparative study of electoral competition in Italy and Japan using an experimental approach.

2.3 Theoretical model

2.3.1 The model

Consider an economic system S characterized by three distinct political positions $P = \{P_1, P_2, P_3\} \in S$. Each political position P consists of a set of three candidates, $\Psi = \{A_{P_i}, B_{P_i}, C_{P_i}\}$, for every $i = \{1, 2, 3\}$, each motivated by the same political ideology but different political priorities.[11] For each political position P_i, the electorate is a finite and fixed set of pure policy-oriented voters $N = \{1, 2, ..., n\}$, who has to cast a ballot to select one of the three candidates – $A_{P_i}, B_{P_i}, C_{P_i}$ – in their political position. The selected candidate will then compete against the selected candidates from the other political positions for the same office.

The electoral rule is based on a plurality system. In the first stage, the candidate who secures the most votes for each political position advances. In the second stage, the top candidates from these positions compete and the winner, determined by receiving the most votes, assumes office.

Each i voter in the economic system S has a complete order of preferences within their political position – i.e., intra-positional preferences – and across candidates from other political positions – i.e., inter-positional preferences. Let $T = \{t_{A_{P_i}}, t_{B_{P_i}}, t_{C_{P_i}}\}$ represent the set of three mutually exclusive voter types within P_i. Then, the order of preferences for each voter type within the same political position is as follows:

$$\begin{aligned} t_{A_{P_i}} &: A_{P_i} \succ B_{P_i} \succ C_{P_i} \\ t_{B_{P_i}} &: B_{P_i} \succ A_{P_i} \succ C_{P_i} \\ t_{C_{P_i}} &: C_{P_i} \succ A_{P_i} \sim B_{P_i} \end{aligned} \tag{2.1}$$

Considering the intra-positional preferences, the electorate is divided into two main groups: a majority group consisting of $n_{A_iB_i}$ voters who view C_{P_i} as the least desirable option, and a minority group of n_{C_i} voters who prefer C_{P_i} to all other candidates. Within the majority group, there is a further disagreement: type $t_{A_{P_i}}$ voters prefer A_{P_i} over B_{P_i}, while type $t_{B_{P_i}}$ voters prefer B_{P_i} over A_{P_i}.

Additionally, voters within the same political position P_i may also differ in their inter-positional preferences. For example, consider the order of preferences for the three types in P_1, we can assume that:

$$\begin{aligned} t_{A_{P_1}} &: A_{P_1} \succ B_{P_1} \succ C_{P_1} \succ A_{P_2} \succ B_{P_2} \succ C_{P_2} \succ A_{P_3} \succ B_{P_3} \succ C_{P_3} \\ t_{B_{P_1}} &: B_{P_1} \succ A_{P_1} \succ C_{P_1} \succ B_{P_3} \succ A_{P_3} \succ C_{P_3} \succ B_{P_2} \succ A_{P_2} \succ C_{P_2} \\ t_{C_{P_1}} &: C_{P_1} \succ A_{P_1} \sim B_{P_1} \succ C_{P_2} \succ A_{P_2} \sim B_{P_2} \succ C_{P_3} \succ A_{P_3} \sim B_{P_3} \end{aligned} \tag{2.2}$$

Type $t_{A_{P_1}}$ voters strongly prioritize their political position, ranking candidates, as shown in (2.1). Among candidates outside P_1, they prefer those in P_2 over those in P_3, following a specific ranking

[11] Although the candidates within each political position support the same core values and fundamental principles, they may differ in their areas of interest (e.g., prioritizing economic, social, or environmental issues), leadership styles, affiliations with more moderate or radical internal factions, positions on the political establishment, or appeal to specific demographic groups (such as youth, older voters, or cultural minorities).

order within each political position. In contrast, type $t_{B_{P_1}}$ voters also prioritize P_1, but their second preference lies in P_3 rather than P_2, again maintaining a distinct ranking order for candidates outside of their position.

Similar patterns of inter-positional preferences can also be observed for the three voter types in P_2 and P_3, where voters prioritize their political position while differing in their rankings of candidates from other positions.

2.3.2 Two-elections timeline

The electoral process consists of two sequential stages: the *intra-positional election* and the *inter-positional election*. In the first stage – i.e., intra-positional election – each voter group selects a candidate from within their political position, aiming to identify a strong representative to advance. In the second stage – i.e., inter-positional election – the chosen candidates for each political position compete against each other for the same office. According to the plurality system, the candidate with the most votes wins in both stages.

The timeline of this two-stage sequential voting game can be summarized in Table 2.1. From *Time 0* to *Time 3*, the model follows that of Bouton et al. (2017), whereas *Time 4* is the main innovation of our model.

Table 2.1: Time sequence of the game

Stage 1: Intra-positional election		
	Time 0	State of nature is randomly assigned.
	Time 1	Voter types are randomly assigned.
	Time 2	Public signal about the state of nature is revealed.
	Time 3	1^{st} Election day: voters select candidates to represent their political position.
Stage 2: Inter-positional election		
	Time 4	2^{nd} Election day: the winner is selected from the candidates representing each political position.

Before starting, given the intra-positional election and according to the order of intra-positional preferences, we assume (following Bouton et al., 2017) that for the minority group of voters, type $t_{C_{P_i}}$ voters, voting for C_{P_i} is their dominant strategy. For the majority group of voters, comprised of type $t_{A_{P_i}}$ and type $t_{B_{P_i}}$ voters, their votes are split between A_{P_i} and B_{P_i} based on their strict preferences. As a result, to defeat C_{P_i}, either A_{P_i} and B_{P_i} must secure at least n_{C_i} votes. Therefore, we consider the case in which C_{P_i} represents a large minority, such that $n_{A_iB_i} - 1 > n_{C_i} > \frac{n_{A_iB_i}}{2}$. This implies that C_{P_i} is a Condorcet loser, preferred by fewer voters in head-to-head competition, but can still win if the majority of voters split their votes between A_{P_i} and B_{P_i}.

Let $\omega_i \in \Omega = \{a_i, b_i\}$ be the set of the two possible states of nature within each political position i, i.e., $\omega_i = a_i$ when the majority originates from A_{P_i} and $\omega_i = b_i$ when the majority comes from B_{P_i}.

At **Time 0**, one of the two states of nature, either a_i or b_i, is randomly selected with probability $q(a_i)$ and $q(b_i) = 1 - q(a_i)$, respectively. Formally, $q : \Omega \Rightarrow [0, 1], q(a_i) + q(b_i) = 1$. There is a random draw for every political position.

At **Time 1**, each voter under a political position P_i is assigned a type $t_i \in T = \{t_{A_{P_i}}, t_{B_{P_i}}\}$ through an independent and identically distributed random draw, from a binomial distribution with conditional probabilities dependent on the state of nature. Let $r(t_i|\omega_i)$ be the conditional probability of being assigned to a type t_i given the state $\omega_i \in \Omega$. It should satisfy the two following conditions:

(i) $0 < r(t_i|\omega_i) < 1$, for all $t_i \in T$ and $\omega_i \in \Omega$

(ii) $r(t_{A_{P_i}}|\omega_i) + r(t_{B_{P_i}}|\omega_i) = 1$, for all $\omega_i \in \Omega$

Conditional probability $r(t_i|\omega_i)$ is common knowledge and varies depending on the state of nature. For instance, in state a_i, type $t_{A_{P_i}}$ is more likely than in state b_i since $r(t_{A_{P_i}}|a_i) > r(t_{B_{P_i}}|b_i)$.

Given conditional probability, the distribution of voter types could be *unbiased* if $r(t_{A_{P_i}}|a_i) = r(t_{B_{P_i}}|b_i)$, i.e., the probability of the majority type is equal in the two states of nature, or *biased* if $r(t_{A_{P_i}}|a_i) \neq r(t_{B_{P_i}}|b_i)$, i.e., the probability of the majority type differs across states.

By convention, to ensure a clear probabilistic framework, we focus on the case where type $t_{A_{P_i}}$ is that with the highest density across the two states of nature, i.e., $r(t_{A_{P_i}}|\omega_i) + r(t_{B_{P_i}}|\omega_i) \geq 1$.

At **Time 2**, a public signal on the state of nature, $s_i \in S = \{s_0, s_a, s_b\}$, is observed by members of the same political position P_i. Importantly, no public signal is provided regarding the state of nature of the other political positions.

We consider two polar scenarios with respect to the informativeness of the public signal s_i:

1. *Partial informative signal:* with probability 1, the signal is s_a (resp., s_b) if the state of nature is a (resp., b). The signal fully identifies the state of nature in P_i, but voters remain uncertain about the state of nature in the other two political positions P_j and P_k.

2. *Uninformative signal:* with probability 1, the signal is s_0, regardless of the actual state of nature. In this case, the signal does not provide information about the state of nature in P_i, leaving voters within and outside the political position with their prior beliefs.

Given the public signal s_i, voters update their belief about the state of nature in the intra-positional scenario, and hence about the potential winner of the 2^{nd} election day.

For the two-stage election, the cumulative belief for a type t_i voter can be expressed as follows.

$$\mu(\omega_i, \omega_j, \omega_k|t_i, s_i) = \beta(\omega_i|t_i, s_i) \times \eta(\omega_j|t_i) \times \eta(\omega_k|t_i) \tag{2.3}$$

where:

$$\beta(\omega_i|t_i, s_i) = \begin{cases} 1 & \text{if } s_i \in \{a_i, b_i\}, \\ \frac{q(\omega_i)\cdot r(t_i|\omega_i)}{q(a_i)\cdot r(t_i|a_i)+q(b_i)\cdot r(t_i|b_i)} & \text{if } s_i = s_0. \end{cases}$$

and

$$\eta(\omega_j|t_i) = \frac{q(\omega_j)\cdot r(t_i|\omega_j)}{\sum_{\omega_j\in\Omega} q(\omega_j)\cdot r(t_i|\omega_j)},$$

$$\eta(\omega_k|t_i) = \frac{q(\omega_k)\cdot r(t_i|\omega_k)}{\sum_{\omega_k\in\Omega} q(\omega_k)\cdot r(t_i|\omega_k)}.$$

The parameter β captures the intra-positional belief about the state of nature ω_i for their political position P_i, based on their type t_i and the given signal s_i. For $s_i = s_0$, β can be identified as a proxy of the level of intra-positional ambiguity, i.e., *preference ambiguity.* Likewise, the parameter η captures the voter's belief about the state of nature outside their political position P_i, unaffected by s_i and relying solely on their prior probabilities $q(\omega_j)$ and $q(\omega_k)$, calibrated by the voter's type t_i. Therefore, this parameter can be seen as a proxy for the degree of ambiguity outside the political position, i.e., *outcome ambiguity.*

At **Time 3**, each type t_i voter casts a ballot for one of the three candidates of their political position P_i. Therefore, $\Psi = \{A_{P_i}, B_{P_i}, C_{P_i}\}$ is the action set. At the end of the intra-positional election, according to the plurality rule, the candidate with the highest number of votes wins and becomes the representative for the political position. In case of a tie, the winner is determined by a fair dice roll.

At **Time 4**, the representatives elected from each political position compete for the same office. Each representative has an equal probability of winning the election, and the winner is declared by a fair dice roll.[12]

2.3.3 Voting strategy

Before defining the voting strategy, we preserve an important assumption from the Bouton et al. (2017) model, i.e., voters of the same type and signal behave in the same way. This assumption simplifies the analysis by allowing us to focus solely on symmetric pure strategies.

Given the electoral system, we define the voting strategy as a function $\sigma : T \times P \times S \to \Delta(\Psi)$ which maps the voter's type, the political position, and the public signal to a probability distribution over the action set Ψ. The strategy $\sigma_{t_i,P_i,s_i}(\Psi)$ specifies the probability that a type t_i voter, who comes from the political position P_i, under a public signal s_i, plays action $\psi_i \in \Psi$. Then, we denote with Λ the set of all possible strategies. For each type t_i voter, the best response in the election is related to her type, her political position, the results from the public signal, and the set of available strategies, i.e., $\sigma_i : T \times P \times S \times \Lambda \to \Delta(\Psi)$.

Voters assume a strategy and cast a ballot for a candidate while facing preference distribution and/or electoral outcome ambiguity. The ambiguity about the preference distribution is influenced by the informativeness of the public signal s_i. In fact, within their political position, voters know their type, but not the types of others. However, they know the probability distribution of other types and have access to a public signal (informative or uninformative) about the state of nature. The ambiguity about the electoral outcome arises from factors outside their political position since voters lack any information about the probability distribution of the types and the state of nature in the other political positions, nor have information about the inter-positional preferences of the others within their own political position. Under these ambiguities, each type t_i voter has to form a belief that guides their choice.

Specifically, we focus exclusively on the admissible voting strategies for the 1^{st} election day under the inter-positional stage. This stage is the only one where we assume voters engage in a voting strategy. In contrast, no strategy is admitted in the second stage of the inter-positional election.

[12] If we exclude Time 4, and hence the inter-positional election, the problem is reduced to Bouton et al. (2017) original model, where no outcome ambiguity occurs.

Here, the only rational strategy for voters is to cast their ballot for the candidate already selected from their preferred political position.

Given a strategy σ_i, the expected vote share for an action ψ_i in state ω_i and a political position P_i can be written as:

$$\tau_{\psi_i}^{\omega_i} = \sum_{t_i \in T} \sum_{P_i \in P} \sum_{s_i \in S} \sigma_{t_i,P_i,s_i}(\psi_i) \cdot r(t_i|\omega_i)$$

Hence, the expected value of the ballots cast by active voters for an action ψ_i in state ω_i is $E(x(\psi_i)|\omega_i, \sigma_i) = \tau_{\psi_i}^{\omega_i} \cdot n$.

Each type t_i voter will play a strategy and cast a ballot according to the choice that maximizes their expected utility:

$$EU_{t_i}(\psi_i|\sigma_i, \mu_i) = \sum_{\omega_i \in \Omega_i} \sum_{\omega_j \in \Omega_j} \sum_{\omega_k \in \Omega_k} u(\psi_i, \omega_i, \omega_j, \omega_k) \cdot \beta(\omega_i|t_i, s_i) \cdot \eta(\omega_j|t_i) \cdot \eta(\omega_k|t_i) \cdot \tau_{\psi_i}^{\omega_i} \tag{2.4}$$

Hence, under symmetric pure strategies, the best response $\sigma_i(t_i, P_i, s_i, \lambda_i)$ for a type t_i voter is the action $\psi_i \in \Psi_i$ that maximizes their expected utility:

$$\psi_{t_i}^* = \arg\max_{\psi_i \in \Psi} EU_{t_i}(\psi_i|\sigma_i, \mu_i) \tag{2.5}$$

Given these assumptions and following Bouton et al. (2017),[13] we can derive the stable equilibrium condition.

Definition 2.1 *A strategy profile σ_i^* is an expectationally stable equilibrium if for any voter type $t_i \in T$, political position $P_i \in P$, public signal $s_i \in S$, and for any arbitrarily small perturbation $\epsilon > 0$, the following two conditions hold:*

1. *If $\sigma_{t_i,P_i,\mu_i}^*(\psi_i) > 0$, then*

$$EU_{t_i}(\psi_i|\sigma_i, \mu_i) \geq EU_{t_i}(\psi_i'|\sigma_i^*, \mu_i) \quad \forall \psi_i' \in \Psi.$$

2. *For any $\sigma_{t_i,P_i,s_i}'(\psi_i) \in [\sigma_{t_i,P_i,\mu_i}^*(\psi_i) - \epsilon, \sigma_{t_i,P_i,\mu_i}^*(\psi_i) + \epsilon] \cap [0,1]$, with the condition that $\sigma_{t_i,P_i,s_i}'(\psi_i) + \sigma_{t_i,P_i,s_i}'(\psi_i') = 1$, it must hold that*

$$EU_{t_i}(\psi_i|\sigma_i', \mu_i) < EU_{t_i}(\psi_i|\sigma_i^*, \mu_i) \quad \textit{and} \quad EU_{t_i}(\psi_i'|\sigma_i', \mu_i) > EU_{t_i}(\psi_i'|\sigma_i^*, \mu_i).$$

The two conditions of Definition 2.1 ensure that the profile of strategy σ_i^* is both the best response for the voter i and the most robust to small deviations in their strategy. Specifically, the first condition guarantees that voters will only select the action ψ_i that maximizes their expected utility, given their strategy and beliefs. Then, the second condition enforces the stability of the equilibrium. Suppose a voter i slightly changes their strategy σ_i', within a small neighborhood $\epsilon > 0$ around the equilibrium strategy σ_i^*. Specifically, the voter assigns probabilities to ψ_i and ψ_i' that are close to $\sigma_{t_i,P_i,s_i}^*(\psi_i)$

[13] Bouton et al. (2017) derives their equilibrium concept from Fey (1997), where the authors analyzed the stability of equilibria using the concept developed by Palfrey and Rosenthal (1990).

and ensures that the probabilities sum to 1. If such a deviation occurs, the expected utility of the originally chosen action ψ_i decreases compared to the equilibrium utility, while the expected utility of the alternative action ψ_i' increases compared to the equilibrium utility. By iteratively applying this deviation process, the sequence of strategies $\{\sigma^m\}_{m=1}^{+\infty}$, where σ^{m+1} represents the best response to σ^m, must converge to the equilibrium strategy σ^*. This dynamic mirrors the concept of stability in Cournot competition, where deviations lead back to the equilibrium.

Given Definition 2.1, we can state Lemma 2.1.

Lemma 2.1 *If an equilibrium σ_i^* is strict, i.e., all voters have a strict best response, then it is necessarily stable. The converse is not true.*

2.3.4 Equilibria conditions

Given the expectationally stable equilibrium, we proceed by evaluating at which type of equilibrium voters under ambiguous scenarios will naturally converge.

Bouton et al. (2017) suggest that two types of equilibria will co-exist: *Duverger's Law equilibria* and *Sincere voting equilibrium*.

Moving from the traditional analysis of Palfrey (1988) and the intuition of Bouton et al. (2017), we define the Duverger's Law equilibria as follows:

Definition 2.2 *Duverger's Law equilibria occur when only two candidates obtain a strictly positive share of votes. These equilibria always exist and are expectationally stable, regardless of the information about the state of nature.*

Duverger's Law equilibria arise from the pivotality of different voter types. Consider our economic system S with three generic candidates: two majorities – A and B – and a minority C. Suppose that the majority A and the minority C have an equal share of votes, higher than B. Then, the probability of being pivotal for the voters of candidate B tends to be zero. To avoid wasting their vote, type t_B voter will cast a ballot for their second-best, i.e., the other majority party A. This dynamic occurs regardless of the level of information voters have about the state of nature since the latter becomes irrelevant to determine the party's ranking when its vote share is proxy to zero. Under the Uninformative signal, the only feasible Duverger's Law equilibria involve voters casting their ballots for their preferred candidate, i.e., $\sigma_{t_i,P_i,s_i}(\psi_i) = 1$ for every $t_i \in \{t_{A_i}, t_{B_i}\}$ and $\psi_i \in \{A_i, B_i\}$. Under the Partial informative signal, additional equilibria emerge. Due to the lack of full information (since only the state of nature inside their political position is revealed, while there is no information on the state of nature and the probability distribution in the other political positions nor on the preferences of others), voters can coordinate in different ways: (i) they may still coordinate around their first-best candidate, i.e., voting for A (resp., B) when their type is t_A (resp., t_B) but the state of nature is b (resp., a); (ii) or they may coordinate around the candidate perceived as favorable within their political alignment, i.e., voting for A (resp., B) when the state of nature is a (resp., b). Hence, we derive Proposition 2.1.

Proposition 2.1 *Duverger's Law equilibria exist and are expectationally stable under both Partial informative signal and Uninformative signal.*

Proof of Proposition 2.1. See Appendix 2.A.2

Conditional on the information provided to the voters, another equilibrium type occurs: Sincere voting equilibrium.

Definition 2.3 *Sincere voting equilibrium occurs when, given a public signal s_i, each type t_i voter casts a ballot for their first-best.*

According to Definition 2.3, Sincere voting equilibrium emerges when voters, given the available information about the state of nature, observe a nearly identical vote share between the two majority candidates (see Bouton et al., 2017 for an extensive explanation). Then, strategic voting is not advantageous, and the only rational behavior is to cast a ballot for the first-best alternative. Hence, we introduce Lemma 2.2.[14]

Lemma 2.2 *Under an intra-positional election with an informative signal about the state of nature, for every $n_{A_iB_i}, n_{C_i}$ and a public signal $s_{\omega_i} \in \{s_{a_i}, s_{b_i}\}$, the sincere voting equilibrium exists and is expectationally stable if and only if $|r(t_{A_i}|\omega_i) - \frac{1}{2}| < \delta(n_{A_iB_i}, n_{C_i})$, with $\delta(n_{A_iB_i}, n_{C_i}) > 0$.*

Given the strong assumption of Lemma 2.2, then we can assert that a sincere voting equilibrium continues to exist and is reinforced when an intra-positional election with informative signal about the state of nature is followed by an inter-positional election where no signal about the state of nature is provided. Therefore, we state Proposition 2.2.

Proposition 2.2 *If Sincere voting equilibrium exists and is expectationally stable under single-stage intra-positional election with $s_{\omega_i} = \{s_{a_i}, s_{b_i}\}$, then it also exists and remains expectationally stable when a second stage of inter-positional election is introduced. Then, under the Partial informative signal sincere voting equilibrium exists and is expectationally stable.*

Proof of Proposition 2.2. See Appendix 2.A.3

The intuition behind Proposition 2.2 is straightforward. When an inter-positional election with an uninformative signal is introduced, voters already coordinating around a sincere voting strategy in the intra-positional election have no incentive to deviate from it. Without additional information, voting for their first-best choice remains the most rational behavior. As a result, the sincere voting equilibrium retains its expectational stability.

At this point, the sincere voting equilibrium will also exist and be more stable when the inter-positional election with an uninformative signal is preceded by an intra-positional election without an informative signal. Therefore, we derive Proposition 2.3

Proposition 2.3 *If Sincere voting equilibrium exists under Partial informative signal, then it also exists under Uninformative signal.*

Proof of Proposition 2.3. See Appendix 2.A.4

The converse of Proposition 2.3 is not necessarily true. A Sincere voting equilibrium can exist and be stable when voters have no information (i.e., an uninformative signal), as their only rational choice

[14] For a mathematical formalization of Lemma 2.2, see Bouton et al. (2017).

is to vote according to their true preferences. However, when voters receive even partial information, sincere voting may no longer be the optimal strategy. With additional information, voters may deviate from sincere voting to maximize their expected utility based on the revealed state of nature. Thus, partial information can introduce incentives for strategic voting, which can reduce the stability of the sincere voting equilibrium.

As a result, as the available information about the state of nature diminishes, the expectational stability of the sincere voting equilibrium is strengthened. The consequent lack of information regarding the state of nature leads to an increased level of ambiguity, making sincere voting the only reasonable choice. Hence, we derive Proposition 2.4.

Proposition 2.4 *As long as the information decreases, the degree of ambiguity increases. Then, a sincere voting equilibrium exists and is the most likely to be selected.*

Proof of Proposition 2.4. See Appendix 2.A.5

2.4 Experimental Design and Behavioral Hypotheses

2.4.1 Experimental design

The experimental design follows the same structure as the model in Section 2.3, with the two sequential stages of intra-positional (Stage 1) and inter-positional (Stage 2) election. Stage 1 perfectly replicates the environmental design in Bouton et al. (2017), with the only type of preference ambiguity (PA). Stage 2 is the main novelty of our design, with the introduction of a second round election, outside their own political position, and hence of the second type of ambiguity, i.e., the electoral outcome ambiguity (OA). These two types of ambiguity are the two treatment variables of our design.

Stage 1. Participants are involved in a voting lottery game with three candidates: blue, red, and gray. Each participant assumes the role of an active voter and is assigned to a group of $n = 6$ active voters. Then, the computer supplements the group with $\frac{n}{2} + 1$, hence 4, passive voters. With this, the total number of votes is $(3 \cdot \frac{n}{2}) + 1$, hence 10.[15] Therefore, for either the blue or red candidate to win without a tie, 5 votes from the 6 active voters are needed. In the event of a blue-gray or red-gray tie, one of the two candidates with 4 votes is selected randomly.

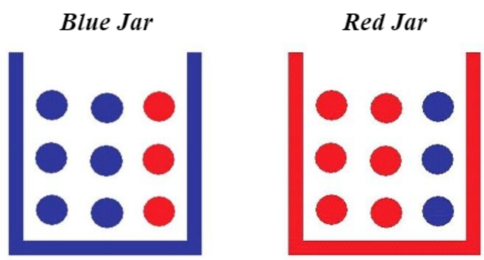
Active voters are instructed about the presence of two possible states of nature: a blue jar and a red jar, the blue jar containing $\frac{2}{3}$ blue balls and $\frac{1}{3}$ red balls, the red jar containing $\frac{2}{3}$ red balls and $\frac{1}{3}$ blue balls, thus maintaining an unbiased distribution (see Figure 2.1).

The computer randomly selects one of the two jars with equal probability for each group. In the **no preference ambiguity (NPA) treatment**, voters are informed about the color of the selected jar for their group; whereas, in the **preference ambiguity (PA) treatment**, the color of the selected jar remains unknown to voters until the end of all stages election.

Then, each active voter is assigned a color – blue or red – defining their type, determined by a random draw of a ball from the selected jar, with replacement. Each voter only knows the color of their own ball.

[15] The reduction in group size compared to Bouton et al. (2017) (i.e., 6 rather than 12 active voters) was necessary to adapt the experiment to the dimension of the laboratory in Japan in order to guarantee subjects' anonymity within a group. This also explains why the number of passive voters in our study is $3 + 1 = 4$ while in Bouton et al. (2017) is $6 + 1 = 7$, thereby maintaining the same rule of half of the size of the number of active voters plus one.

Figure 2.1: The two jars.



After the jar and ball assignment, each active voter casts a ballot for one of the three candidates – blue, red, or gray – knowing that the computer would surely cast 4 votes (passive voters) for gray.

The winner of the Stage 1 election is determined by the color that obtains the highest number of votes. This color represents the so-called *group decision*.

Stage 2. The electoral **outcome ambiguity (OA) treatment** occurs. The color winner of the Stage 1 election faces two candidates from two opposing political positions: green and black. Therefore, the computer adds the ball representing the winner of Stage 1 (i.e., the color representing the group decision) into an urn together with a green ball and a black ball. Then, the computer randomly selects one of the three balls (each ball having $\frac{1}{3}$ probability of being selected). The selected ball represents the winner of the Stage 2 election.

Treatments and payoffs. The final payoff of each voter is based on their type (i.e., the color of the assigned ball) and the final election winner (i.e., the winner of Stage 1 or Stage 2 election), based on the selected treatment.

We distinguish four different treatments:

Treatment 1. (NPA treatment) Voters are involved in a voting lottery game with only Stage 1 (i.e., intra-positional) election, with revealed information about the jar color before voting (i.e., no layer of ambiguity occurs).

Treatment 2. (PA treatment) Voters are involved in a voting lottery game with only Stage 1 (i.e., intra-positional) election, with unrevealed information about the color of the jar before voting (i.e, the sole layer of preference ambiguity occurs).

Treatment 1 and *Treatment 2* are pure replications of Bouton et al. (2017), where voters only experienced the preference ambiguity treatment and not the outcome ambiguity (since Stage 2 does not occur). This situation reflects the primary election, where the competition is only within their own political position for the election of a representative.[16]

In Figure 2.2, we report the payoff matrix, with payoffs in ECU (Experimental Currency Units) for treatments 1 and 2. The figure shows that gray is the minority candidate since both blue and red (majority candidates) are preferred by all active voters. Suppose that the color of the winner matches the participant's ball color (i.e., the preferred majority candidate wins the election), then the voter's payoff is 10 times as much as if the minority candidate wins. If the other majority candidate wins, the voter's payoff is 5.5 times as much.

[16]Detailed instructions provided to the participants for Treatment 1 and Treatment 2 are reported in Appendix 2.C, Section 2.C.1.

Figure 2.2: The payoff matrix in treatments NPA and PA.

		Group Decision		
		Blue	Red	Gray
Your Ball	Blue	200	110	20
	Red	110	200	20

Treatment 3. (NPA+OA treatment) Voters are involved in a voting lottery game with two stages of elections, i.e., Stage 1 and Stage 2. Since there is no preference ambiguity, the jar color inside their group is revealed before casting a ballot in Stage 1, whereas outcome ambiguity imposes that no information about the outcome is provided when moving from Stage 1 to Stage 2.

Treatment 4. (PA+OA treatment) Voters are involved in a voting lottery game with two stages of elections, i.e., Stage 1 and Stage 2. Since there is preference ambiguity, the jar color inside their group is revealed only after the Stage 1 election is over, and they are unaware of the outcome (i.e., OA) of Stage 2.

Treatment 3 and *Treatment 4*, involving Stage 2 election, are the main innovation treatments, even if voters are active only in Stage 1. Stage 1 reflects the primary election, while Stage 2 reproduces the upcoming general election.[17]

In Figure 2.3, we report the payoff matrix, with payoffs in ECU (Experimental Currency Units), which implicitly shows the comparison between the control treatments NPA and PA (Figure 2.2) and, respectively, the main treatments NPA+OA and PA+OA.[18] In this case, if the drawn ball in Stage 2 matches the group's decision of Stage 1, then the group decision is applied, and the payoff structure is the same as in Figure 2.2. Otherwise, the group decision is not applied. In this latter case, the voter's payoff is either 5 ECU or 15 ECU with equal probability, both lower than the lowest payoff they get when the group decision is applied (i.e., when the minority candidate wins the elections). In particular, a black (resp., green) color in the second round gives 15 ECU to voters with blue (resp., red) preference in the first round.[19]

[17]Detailed instructions provided to the participants for Treatment 3 and Treatment 4 are reported in Appendix 2.C, Section 2.C.2.

[18]We adopt this payoff structure for two reasons. First, this type of structure is frequently used in traditional experimental papers investigating the voting strategies and equilibrium conditions (see, e.g., Forsythe et al., 1993; Forsythe et al., Forsythe et al. (1996)); Gerber et al., 1998; Reitz et al.; 1998). Second, it guarantees full comparability with the results in Bouton et al. (2017).

[19]The difference in payoff between black and green is introduced to represent that in-group voters also have a preference over out-group candidates, even though the latter are not preferred over any in-group candidates. Thus, the black-blue and green-red combination of payoffs is just a color code with no strategic impact on voters. A black-red and green-blue combination of payoffs would give the same incentives to hope that the winning candidate in the second round is the one coming out of the primary elections within one's own group of voters. Furthermore, note that the parametrization of the payoff from out-group candidates winning the elections is such that the sum of the payoff from out-group winning is equal to the payoff from the in-group minority candidate winning.

Figure 2.3: The payoff matrix in treatments NPA+OA and PA+OA.

		Group Decision Applied (probability = 1/3)			**Group Decision NOT Applied**	
		Blue	Red	Gray	Green (probability = 1/3)	**Black (probability = 1/3)**
Your Ball	Blue	200	110	20	5	15
	Red	110	200	20	15	5

2.4.2 Participants and Procedures

Experiments were conducted at CIMEO, the Experimental Economics Laboratory of Sapienza University of Rome (Italy) and the Experimental Economics Laboratory at Kochi University of Technology (Japan): sessions in the former laboratory involved 138 Italian participants, and sessions in the latter involved 120 Japanese participants. The overall sample of 258 graduate and undergraduate students presents a prevalence of men (63.95%) compared to women (36.05%), and an overwhelming majority of Economics students (approximately 73.64%).

Each subject participated in only one session and each session was conducted using *z-Tree software* (Fischbacher, 2007). Multiple sessions were run for each treatment, with the number of subjects per session ranging from 24 to 36, as outlined in Table 2.B1 in Appendix 2.B. Each experimental session lasted approximately 80 minutes and followed identical procedures, as described below.

Before the experiment started, participants received detailed written instructions, which were read aloud by one of the experimenters (see Experimental Instructions in Appendix 2.B). Subsequently, participants answered a series of control questions to ensure their comprehension of the experimental game and procedures. Once the experiment began, participants engaged in one of the four treatments (NPA, PA, NPA+OA, PA+OA) at a *between-subject level*. The treatment-dependent voting lottery game described in section 2.4.1 was played for 60 consecutive rounds, with fixed groups of subjects (*paired matching*).[20] At the end of each of the 60 rounds, participants received feedback regarding (a) the number of votes assigned to each color in their group, (b) the selected jar, (c) the group decision, (d) the winner of the election, and (e) the final payoff for that round.

After the 60-round repeated experimental game, participants completed a final questionnaire providing socio-demographic information, including age, gender, education level, field of study, levels of trust and risk aversion, and the importance of religion and politics in their lives.[21]

At the end of the experiment, the computer randomly selected 6 out of the 60 rounds to determine

[20] The total number of rounds was reduced from 80 in Bouton et al. (2017) to 60 in our experimental design. This adjustment was necessary because of our extension with a second type of uncertainty, which involved an additional random draw in the two main treatments, NPA+OA and PA+OA, to implement outcome uncertainty, thereby increasing participants' decision time and information processing per round. This 25% reduction in the original number of rounds allowed us to prevent potential "participant fatigue" – where individuals may become tired, bored, or disengaged, potentially compromising data quality – in the final rounds of the main treatments NPA+OA and PA+OA. This helped minimize distortions relative to the control treatments, NPA and PA. Additionally, it enabled us to maintain the same average duration for the experimental sessions in these new treatments as in the 80-round NPA and PA sessions of Bouton et al. (2017).

[21] Trust (resp., risk) attitude was assessed using a Likert scale ranging from 1 to 5, where 1 indicates strong trust reluctance (resp., full risk aversion), whereas 5 indicates a strong inclination towards trust (resp., full risk acceptance). Similarly, the importance of religion (resp., politics) in their lives was measured on a Likert scale from 1 to 4, where 1 stands for "not important at all" and 4 stands for "very important".

the final earnings of participants. Each of the 60 rounds had an equal probability of being selected.[22] Participants' earnings for these rounds were computed based on an exchange rate where 100 ECU = 1€ for Italian participants and 100 ECU = 200¥ for Japanese participants. This disparity in exchange rates between the two countries was crucial to maintaining purchasing power parity. On average, subjects earned 9.50€ (including the show-up fee of 4€) in Italy and 1616.31¥ (including the show-up fee of 1000¥) in Japan.[23]

2.4.3 Behavioral Hypotheses

In this Section, in line with the model and Propositions 1-4 derived in Section 2.3, we formulate our behavioral hypotheses.

Moving from Bouton et al. (2017) replication, we know that when the preference distribution of voters about the candidates of their political position (i.e., intra-positional) under a single stage (primary) election is known (NPA treatment), then an obvious strongest contender emerges. To avoid wasting their votes, the party's voters defect from "non-viable" candidates to support "viable" ones by voting strategically (Lago, 2008). This means voting for the candidate with the highest probability of victory (Duverger, 1951). However, when there is ambiguity about preference distribution (PA treatment), which is not revealed, voters lack a reasonable incentive to vote for a candidate other than their first choice, leading sincere voting to become the prevailing strategy (Bouton et al., 2017). Therefore, replicating the same environmental condition proposed by Bouton et al. (2017) in the context of a primary election for a party's representative (i.e., Stage 1 of intra-positional election), without the pressure of an upcoming general election (i.e., without the Stage 2 of inter-positional election), we expect that two opposite trends emerge: the PA treatment fosters sincere voting strategy while the NPA treatment prompts strategic voting under Duverger's Law equilibrium. Hence, we test, as a control check, the following Hypothesis 0.

Hypothesis 0. ***(NPA vs PA)*** *Absent a general election, in a primary election sincere voting emerges only when there is ambiguity about the preference distribution inside their political position.*

Given Hypothesis 0, it is straightforward that under an intra-positional (primary) election characterized by no preference ambiguity (NPA treatment), without a subsequent inter-positional (general) election, voters are inclined to strategically vote for the strongest contender perceived as the most suitable representative within the political position. However, when primaries are conducted in anticipation of an upcoming general election (as is the most typical case of US primary elections), the absence of ambiguity about the preference distribution inside the political position contrasts with the ambiguity regarding the political opponent that will be encountered in Stage 2 (NPA+OA treatment). The introduction of outcome ambiguity, while it may destabilize voters' certainties, primarily pushes them to vote more strategically. In response to the outcome uncertainty, voters tend to increase their

[22] This is again comparable to the payment procedure of Bouton et al. (2017), who randomly selected 8 out of the 80 rounds (see previous footnote).

[23] The 100 ECU higher show-up fee in Japan compared to Italy was justified by the greater effort required of Japanese students to physically reach the laboratory, which is located on a different university campus from where they typically attend classes. This was not an issue for Italian students, as the laboratory is in the same building where they attend classes. Despite this, there is no difference in the average payout of subjects since in Japan they earned 1616.31¥ ≈ 9.90€ (including the show-up fee of 1000¥ ≈ 6€).

level of coordination and select the candidate within their party who is perceived as the strongest and has the highest probability of success in the subsequent general election (Culbert, 2015), abandoning sincere voting for the first-best. This is perceived as the only rational behavior to increase their expected utility, which ultimately boosts the incentive to vote strategically in NPA+OA treatment (which already is the predicted behavior in NPA treatment). From this, we derive Hypothesis 1.

Hypothesis 1. ***(NPA+OA)*** *With a general election bringing outcome ambiguity, strategic voting due to the knowledge of the strongest contender inside their own political position is boosted.*

If strategic voting arises due to the knowledge of the strongest contender inside their own political position, knowledge tied to the revelation of preference distributions in Stage 1, then under conditions of preference ambiguity, voters have no incentive to strategize. In such cases, rational behavior dictates voting for the preferred candidate (Hypothesis 0). Now, if the preference ambiguity is combined with the outcome ambiguity (PA+OA treatment), we expect that the trend toward sincere voting will strengthen. The coexistence of these two types of ambiguity dictates that the only rational behavior is to vote sincerely for the preferred candidate: given the (even more) unpredictable outcome, voters align (even more) their choices with their political preferences. From this, we test Hypothesis 2.

Hypothesis 2. ***(PA+OA)*** *With a general election bringing outcome ambiguity, sincere voting due to preference ambiguity inside their own political position is boosted.*

With Hypothesis 1 and Hypothesis 2, we state that the impact of outcome ambiguity on voting behavior is not unidirectional. Intuitively, it should be expected that outcome ambiguity, as is the case for preference ambiguity, should lead to strategic voting. Instead, we state it depends on the interplay with preference ambiguity. In the NPA+OA treatment, where there is no preference ambiguity, voters are inclined to remain loyal to the candidate identified as the strongest contender within their political position and vote strategically for that candidate, even more so than in the absence of outcome ambiguity (NPA treatment). Conversely, in the PA+OA treatment, where preference and outcome ambiguity coexist, voters lack sufficient information to make a strategically rational choice. In this context, preference ambiguity drives outcome ambiguity toward a sincere voting strategy, even more than under the sole preference ambiguity (PA treatment). Based on this premise, we propose Hypothesis 3 as an extension of Hypothesis 0 to a two-stage voting environment with outcome ambiguity.

Hypothesis 3. ***(NPA+OA vs PA+OA)*** *With a general election bringing outcome ambiguity, sincere voting emerges only when there is ambiguity about the preference distribution inside their own political position.*

The outcome ambiguity in Stage 2 acts as a catalyst for the effects observed in Stage 1 regarding preference ambiguity (resp., no preference ambiguity), boosting sincere voting (resp., strategic voting).

Finally, since we conduct our analysis on two different subsamples, Italian and Japanese, we propose a last hypothesis, which works as a robustness check for hypotheses 0-3

Hypothesis 4. ***(No-country difference)*** *Voters' strategic behavior is independent from the subjects' sample (Italy vs. Japan) and country-related cultural differences.*

Regardless of the actual cultural and political systems in which subjects are involved (Italy vs. Japan), common elements of preference and outcome ambiguity drive individuals to act in the same way (Reed, 2001; Cox and Schoppa, 2002). What drives voters to cast their ballot sincerely or strategically is solely related to the treatment-specific strategic factors and is independent of voters' political or cultural orientation. The latter eventually has second-order effects.

2.5 Experimental Results

In this section, we present the main results of the test of the behavioral hypotheses we elaborated in Section 2.4.3. First, in Section 2.5.1, we validate *Hypothesis 0*, confirming Bouton et al. (2017) results on the divergent voting strategies when we only account for the ambiguity or not of preference distribution. Then, in Section 2.5.2, we examine how the introduction of a second stage of outcome ambiguity influences the voting strategy according to the information provided about the preference distribution in the first stage (*Hypothesis 1-3*). Finally, in Section 2.5.4, we verify through a thorough regression analysis if the context matters for the voting strategy, to validate *Hypothesis 4*, although Italy-Japan comparisons are preliminary performed through non-parametric statistics in Sections 2.5.1-2.5.2, when testing Hypotheses 0-3.

2.5.1 The effect of preference ambiguity in one-stage (primary) election: NPA treatment vs. PA treatment

Before conducting an in-depth analysis of the behavioral voting strategy adopted under outcome ambiguity and the resulting equilibrium when transitioning from a one-stage to a two-stage election, we provide a summary analysis of the results when comparing the two control treatments, à la Bouton et al. (2017), i.e., NPA vs. PA. This preliminary step is intended to validate *Hypothesis 0* and lay a robust foundation for our investigation.

First, to analyze voters' behavior across 60 rounds of elections, we focus on the frequency with which they adopt and maintain a certain strategy. Specifically, we isolate a set of seven possible strategies: voting for blue, for red, for gray, sincere (i.e., voting for the color that matches their ball), opposite to sincere (i.e., the voter's decision is based on the majority/group decision, which does not correspond to the ball color), voting for the jar (i.e., voting for the color corresponding to the jar, so with the highest probability of winning), and voting opposite to the jar (i.e., for the majority color opposite to that of the selected jar). Only five of the seven strategies are viable when the preference distribution is not revealed (PA treatment).[24] Adapting the method of Bouton et al. (2017) to our design, we identify a player's strategy as identified if they make the same choice for at least five consecutive rounds. If the player adopts more than one strategy within a period of rounds, we assign them the one employed most frequently over the 60 rounds.

In Table 2.2, examining the NPA treatment, we observe that when the state of nature is revealed

[24]The last two strategies – voting for the jar and opposite to the jar – are not viable because participants lack the necessary information about the state of nature to form a strategy either in its favor or against it.

(i.e., the jar color is known), participants overwhelmingly adopt strategic behavior almost immediately, with 94.61% of choices reflecting this alignment. This confirms that, in the absence of ambiguity, individuals are highly capable of evaluating and adopting the necessary strategic behavior to maximize their utility (Tyszler and Schram, 2016). However, we find a statistically significant difference between Italy and Japan (Wilcoxon-Mann-Whitney test, $z = -2.258$, $p = 0.024$) in the degree of strategic behavior, with Japanese participants more likely to adopt strategic behavior that maximizes their utility compared to Italians. Interestingly, the modal strategy is *Jar*, even if its adoption is significantly higher in Japan compared to Italy (Wilcoxon-Mann-Whitney test, $z = -1.761$, $p = 0.093$). This difference suggests that Japanese voters exhibit more conservative behaviors in making their choices, possibly opting for more predictable and stable strategies.[25]

Then, moving to the PA treatment, we notice that in the absence of information on the state of nature, the overall percentage of *Identified strategies* decreases by approximately 20 percentage points compared to the NPA treatment. Interestingly, while the reduction is more pronounced for Italy, the decrease in Japan is relatively smaller. This difference is statistically significant (Wilcoxon-Mann-Whitney test, $z = -2.204$, $p = 0.032$), confirming that Japanese are more conservative and good at strategizing to maximize their utility. Taking into account the full sample, the modal strategy is *Sincere*. This is confirmed for the Italian subsample, but not for the Japanese one. In the latter, voters equally split their votes between *Sincere* and *Blue*. This result gives support to Bouton et al. (2017) predictions and experimental findings of no unique type of strategy under preference ambiguity.[26]

Table 2.2: Frequencies of identified strategies in NPA and PA treatments

Strategies	**NPA Treatment**			**PA Treatment**		
	All	*Italy*	*Japan*	*All*	*Italy*	*Japan*
Blue	0.05	0.00	0.09	36.41	19.77	**51.60**
Red	12.18	25.37	0.09	5.44	10.97	0.38
Gray	0.00	0.00	0.00	0.00	0.00	0.00
Sincere	12.45	16.37	8.86	**54.11**	**61.73**	47.17
Opposite Sincere	0.05	0.10	0.00	4.04	7.54	0.84
Jar	**75.21**	**58.06**	**90.95**	–	–	–
Opposite Jar	0.05	0.10	0.00	–	–	–
% Identified Strategies	94.61	90.51	98.70	72.22	66.33	90.83

Note: % *Identified Strategies* represents the overall proportion of rounds (out of 60) in which a strategy was adopted. Instead, the frequency of individual strategies is calculated as the proportion of times each specific strategy was chosen relative to the total time that any strategy was adopted. In bold, the modal strategy for each country in each treatment.

In Table 2.3, we provide a direct comparison of the two main types of strategies, classified according to the two equilibria described in Section 2.3. *Sincere* strategy involves casting a ballot for the color that matches the voter's ball, aligning with the Sincere voting equilibrium. On the other hand,

[25] More extensive analyses on the aggregate and individual strategic behavior under NPA treatment are reported in Appendix 2.B, Section 2.B.2.

[26] More extensive analyses on the aggregate and individual strategic behavior under PA treatment are reported in Appendix 2.B, Section 2.B.3.

strategies that are consistent with Duverger's Law equilibria include those where voters coordinate their votes on *Blue* or *Red* (in both NPA and PA treatments), as well as those who vote for *Jar* or *Opposite Jar* (only in PA treatment). We state that among the identified strategies, the absence of clear information leads voters to express their true preference, with a Sincere voting strategy hovering only around 12% in NPA treatment, but never lower than about half in PA treatment. Simultaneously, Duverger's Law dominates under NPA treatment and declines in PA treatment. This drop suggests that ambiguity disrupts voters' ability to coordinate effectively on the more strategic equilibria. In addition, the overall proportion of identified strategies decreases in PA treatment, with a larger reduction for Italian voters compared to Japanese. This difference suggests that the latter maintains a more consistent adherence to strategic behavior even under ambiguity.

Table 2.3: Comparison of voting strategies across NPA and PA treatments

	% in NPA	% in PA	Wilcoxon-Mann-Whitney
PANEL A - All			
Sincere	12.45	54.11	$p < 0.001$***
Duverger's Law	87.44	41.85	$p < 0.001$***
Identified strategies	94.61	72.22	$p = 0.004$**
PANEL B - Italy			
Sincere	16.37	61.73	p=0.004**
Duverger's Law	83.43	30.74	p=0.004**
Identified strategies	90.51	66.33	p=0.009**
PANEL C - Japan			
Sincere	8.86	47.17	p=0.038*
Duverger's Law	91.13	51.98	p=0.038*
Identified strategies	98.70	90.83	p=0.038*

Note: *** p < 0.001, ** p < 0.01, * p < 0.05.

Result 1: *Information plays a crucial role in enabling voters to coordinate on specific types of equilibria. In the presence of ambiguity (PA treatment), sincere voting emerges as a safer and more straightforward choice, as uncertainty complicates strategic coordination. Conversely, when complete information is available (NPA treatment), Duverger's Law strategies dominate.*

Overall, Result 1 validates Hypothesis 0.

2.5.2 The effect of outcome ambiguity in two-stages (general) election: NPA+OA treatment vs. PA+OA treatment

This section extends our analysis by examining voters' strategies when Stage 2 of the inter-positional election is introduced, requiring them to cast a ballot under outcome ambiguity. First, we separately analyze the two possible scenarios: (i) when outcome ambiguity in Stage 2 is preceded by no preference ambiguity in Stage 1 (NPA+OA treatment), and (ii) when it is preceded by preference ambiguity in

Stage 1 (PA+OA treatment). Subsequently, we compare these two treatments to assess the extent to which preference ambiguity influences voters' behavior under outcome ambiguity.

NPA+OA: Voters' behavior under no preference ambiguity but outcome ambiguity.

In NPA+OA treatment, we observe what happens to voters' strategies when preference distribution is revealed during Stage 1 of the intra-positional (primary) election, while Stage 2 introduces an inter-positional (general) election without information about the outcome.

First, comparing NPA+OA treatment with NPA, we observe that voters' behavior remains largely consistent. With access to a public signal about the state of nature (i.e., the jar's color) in Stage 1 and an understanding of the potential for higher payoffs, if the second draw aligns with their group's decision, participants predominantly adopt a strategic approach, casting votes for the jar. This behavior accounts for 86.87% of the choices across the 60 rounds, even if with a significant difference between Japanese participants and Italian ones (94.39% vs. 79.35%, Wilcoxon-Mann-Whitney test, $z = 2.739$, $p = 0.004$). This difference between countries suggests that Japanese participants are generally more inclined to coordinate around the best predictive alternative and maintain this behavior over time. As in the NPA treatment, this tendency of voting for the jar is associated with a higher level of sincere voting, chosen 65.35% of the time across all rounds (62.13% for Italy and 68.56% for Japan). This result is not surprising, as two-thirds of the balls received by voters remain compatible with the jar's color, reinforcing sincere voting. These findings confirm that, even in the absence of knowledge about their future opponents, individuals tend to follow Duverger's Law Equilibrium by voting for the randomly selected jar. Then, in Table 2.4, we display the distribution of the identified strategies in NPA+OA treatment, overall and by country. The modal strategy is voting for the *Jar*, which is chosen in more than three-fourths of the cases. The frequency is consistently higher in Japan compared to Italy, suggesting that, as under NPA treatment, the Japanese are good at strategizing and coordinating around the voting strategy that allows us to maximize their expected utility (Wilcoxon-Mann-Whitney test, $z = 1.826$, $p = 0.008$). This behavior is also consolidated by the *% Identified Strategies*, where the frequency in Japan is relatively higher compared to that of Italy (Wilcoxon-Mann-Whitney test, $z = 2.739$, $p = 0.004$).[27] Furthermore, no other strategy appears to be played consistently, resulting in the group's decision consistently aligning with the color of the selected jar.

[27] More extensive analyses of aggregate and individual behavior in groups under NPA+OA treatment are provided in Appendix 2.B, Section 2.B.4.

Table 2.4: Frequencies of identified strategies in NPA+OA treatment

Strategies	*All*	*Italy*	*Japan*
Blue	0.37	0.76	0.00
Red	0.21	0.44	0.00
Gray	0.00	0.00	0.00
Sincere	7.30	8.01	6.63
Opposite Sincere	1.99	3.91	0.19
Jar	**88.15**	**82.78**	**93.19**
Opposite Jar	1.99	4.10	0.00
% identified strategies	82.68%	73.38	93.83

Note: % *Identified Strategies* represents the overall proportion of rounds (out of 60) in which a strategy was adopted. Instead, the frequency of individual strategies is calculated as the proportion of times each specific strategy was chosen relative to the total time that any strategy was adopted. In bold, the modal strategy for each country in each treatment.

In order to test *Hypothesis 1* of a higher persistence of Duverger's Law strategic voting under NPA+OA treatment compared to NPA treatment, Table 2.5, we report the frequency with which the two main strategies – Sincere and Duverger's Law – are adopted across the two treatments. We note that the presence of outcome uncertainty diminishes voters' ability to establish and maintain a consistent strategy over time. This is evident in the significance of *Identified strategies* coefficient. However, when considering only the rounds in which a strategy is adopted, there are no significant differences. In scenarios featuring solely outcome ambiguity, individuals, much like in NPA treatment, persist in strategic voting behavior, leaning towards a Duverger's Law Equilibrium and voting for the selected jar more than in NPA treatment (with no outcome ambiguity). Indeed, the frequency of strategic voting according to Duverger's Law is not significantly higher in NPA+OA treatment with respect to NPA treatment. However, this might be because this frequency was already quite high (more than 90% in the Japanese subsample, more than 80% in the Italian subsample) in NPA treatment, hence empirically there was not much room left for a significant increase. The fact that the frequency of sincere voting decreases (although not significantly so) in both subsamples supports our interpretation.

Result 2: *When outcome ambiguity is introduced, information on preference distribution strengthens voters' strategic behavior of supporting the strongest contender (i.e., the jar color).*

Overall, Result 2 validates Hypothesis 1.

Table 2.5: Comparison of behavioral strategies across NPA and NPA+OA treatment

	% in NPA	% in NPA+OA	Wilcoxon-Mann-Whitney
PANEL A - All			
Sincere	12.45	7.30	p=0.379
Duverger's Law	87.44	88.73	p=0.786
Identified strategies	94.61	82.68	p=0.009**
PANEL B - Italy			
Sincere	16.37	8.01	p=0.240
Duverger's Law	83.43	83.98	p=0.589
Identified strategies	90.51	73.38	p=0.004**
PANEL C - Japan			
Sincere	8.86	6.63	p=0.931
Duverger's Law	91.13	93.19	p=1
Identified strategies	98.70	93.83	p=0.048*

Note: *** p < 0.001, ** p < 0.01, * p < 0.05.

PA+OA: Voters' behavior under preference and outcome ambiguity

In PA+OA treatment, voters are influenced simultaneously by preference ambiguity in Stage 1 and outcome ambiguity in Stage 2. Under these dual ambiguous conditions, voters predominantly vote sincerely – choosing the color of their ball – in 79.34% of cases across all rounds, regardless of possible strategies. This behavior is more prevalent among Japanese participants (85.33%) compared to Italian participants (73.34%), suggesting that the Japanese adopt a more conservative approach and better coordinate around the most straightforward choice even under complex, ambiguous conditions (Wilcoxon-Mann-Whitney test, $z = 2.008$, $p = 0.052$). Interestingly, in both subsamples, the frequency of sincere voting exceeds that observed in PA treatment. This supports the idea that, in the absence of information about both the internal preference distribution and external opponents, voters gravitate toward a sincere voting equilibrium, selecting the color that matches their ball.

In Table 2.6, we focus exclusively on rounds in which a strategy from the identified set is employed. We observe that the modal choice is *Sincere*, corresponding to more than three-fourths of the identified strategies, with no country differences. The remaining one-fourth of the identified strategies are roughly equally split between *Blue* and *Red*, with *Blue* being more common in the Italian subsample and *Red* in the Japanese subsample. Furthermore, *% Identified Strategies* presents lower frequencies, with a statistically significant difference between the two subsamples (Wilcoxon-Mann-Whitney test, $z = 2.556$, $p = 0.009$). This finding reinforces the observation that Japanese participants exhibit a greater tendency to coordinate around a defined strategy.[28]

In order to test whether outcome ambiguity influences preference ambiguity – and validate Hypothesis 2 on voters' strategic behavior – in Table 2.7 we compare the frequency of the two main strategies in PA and PA+OA treatments. We observe that, in general, voters exhibit a similar ability

[28] More detailed analyses of the aggregate and individual behavior in groups are reported in Appendix 2.B, Section 2.B.5.

Table 2.6: Frequencies of identified strategies in PA+OA treatment

Strategies	*All*	*Italy*	*Japan*
Blue	8.03	15.58	1.71
Red	11.66	4.92	17.30
Gray	0.00	0.00	0.00
Sincere	**78.28**	**76.85**	**79.47**
Opposite Sincere	2.03	2.65	1.52
% identified strategies	73.23	61.20	87.66

Note: % *Identified Strategies* represents the overall proportion of rounds (out of 60) in which a strategy was adopted. Instead, the frequency of individual strategies is calculated as the proportion of times each specific strategy was chosen relative to the total time that any strategy was adopted. In bold, the modal strategy for each country in each treatment.

to identify and adopt a conservative voting strategy over 60 rounds, regardless of the type of ambiguity they face, as shown by the percentage of *Identified strategies*. However, when broken down by country, there is a noticeable reduction in *Identified strategies* for both Italian and Japanese participants when the outcome ambiguity is introduced alongside the preference ambiguity. This appears to push the voters toward a stronger preference for *Sincere* strategy, with an overall increase of approximately 24 percentage points. Although these shifts in strategy are substantial, the differences are not statistically significant. This suggests that, while the presence of additional ambiguity influences behavior to some extent, the overall strategic approach remains largely consistent.

Table 2.7: Comparison of behavioral strategies across PA and PA+OA treatments

	% in PA	% in PA+OA	Wilcoxon-Mann-Whitney
PANEL A - All			
Sincere	54.11	78.28	p=0.095
Duverger's Law	41.85	19.69	p=0.201
Identified strategies	72.22	73.23	p=0.503
PANEL B - Italy			
Sincere	61.73	76.85	p=0.429
Duverger's Law	30.74	20.50	p=0.537
Identified strategies	66.33	61.20	p=0.537
PANEL C - Japan			
Sincere	47.17	79.47	p=0.191
Duverger's Law	51.98	19.01	p=0.191
Identified strategies	90.83	87.66	p=0.556

Note: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$.

Result 3: *When outcome ambiguity follows preference ambiguity, sincere voting prevails, although the overall strategic behavior does not differ significantly from PA treatment.*

Overall, Result 3 partially validates Hypothesis 2.

NPA+OA vs PA+OA: The effect of (no)preference ambiguity in the environment of outcome ambiguity

In this section, we extend our investigation by directly comparing the NPA+OA and PA+OA treatments, where the outcome ambiguity in Stage 2 remains constant, but the knowledge of the preference distribution in Stage 1 differs. In Table 2.8, comparing the two main voting strategies, we observe that *Sincere* is the modal strategy only in PA+OA treatment, where both preference and outcome ambiguity are present, while *Duverger's Law* remains the dominant strategy in NPA+OA treatment, where outcome ambiguity is coupled with the absence of preference ambiguity. The significant difference in the frequency with which these two strategies are adopted between the two treatments ($p < 0.001$) indicates that knowledge about the preference distribution in Stage 1 plays a crucial role in shaping voters' strategic choices. In NPA+OA treatment, where voters are unaware of the preference distribution in Stage 1, the outcome ambiguity leads voters to gravitate towards *Duverger's Law*, reflecting a strategic decision to align with the majority in a way that may consolidate support for a particular outcome. On the other hand, in PA+OA treatment, where voters are exposed to preference ambiguity in Stage 1, they tend to rely more on *Sincere*, choosing the color of their ball, possibly due to the combination of unclear preferences and outcome uncertainty, which pushes them toward simpler, non-strategic choices.

Table 2.8: Comparison of behavioral strategies across NPA+OA and PA+OA treatments

	% in NPA+OA	% in PA+OA	Wilcoxon-Mann-Whitney
PANEL A - All			
Sincere	7.30	78.28	p<0.001***
Duverger's Law	88.73	19.69	p<0.001***
Identified strategies	82.68	73.23	p=0.120
PANEL B - Italy			
Sincere	8.01	76.85	p= 0.002**
Duverger's Law	83.98	20.50	p=0.002**
Identified strategies	73.38	61.20	p=0.015*
PANEL C - Japan			
Sincere	6.63	79.47	p=0.008**
Duverger's Law	93.19	19.01	p=0.008**
Identified strategies	93.83	87.66	p=0.254

Note: *** p < 0.001, ** p < 0.01, * p < 0.05.

This comparison between NPA+OA and PA+OA treatment yields results consistent with those obtained when comparing the control treatments NPA and PA, albeit with a higher significance overall and in both subsamples.

Result 4: *Outcome ambiguity amplifies the effects triggered by preference ambiguity, reinforcing the convergence toward Duverger's Law. Similarly, when there is no preference ambiguity, outcome ambiguity intensifies the emergence of the sincere voting strategy, making it the dominant choice.*

Overall, Result 4 validates Hypothesis 3.

2.5.3 Cross-country comparison

Since the experiment was implemented in two national settings, Italy and Japan, which differ substantially in their electoral institutions and political culture, this section discusses a direct comparison of the results across the four different treatments. This comparison evaluates whether our findings reflect universal behavioral patterns or are conditioned by country-specific factors, taking into account that in Italy, primaries have been a feature of political life in the last twenty years, while in Japan, they are absent.

Results from Tables 2.3, 2.5, 2.7 and 2.8 already show that subjects exposed to the same ambiguous treatments adopt the same voting strategies, i.e., a sincere voting strategy under preference ambiguity and a strategic one under no preference ambiguity, with effect boosted with the introduction of outcome ambiguity (in line with the findings of Reed, 2001 and Cox and Schoppa, 2002). However, the intensity with which these strategies are adopted differs slightly by country. Table 2.9 highlights this variation, showing that the only statistically significant difference across Italy and Japan concerns the variable *Identified strategies*, which reflects exactly the frequency with which participants adopt and preserve a given strategy over time.

In general, Japanese participants display more conservative behavior: they tend to adopt a specific voting strategy within the first 5–10 rounds of the game and maintain it consistently until the end. By contrast, Italian participants show more variability: they require more rounds before settling on a stable strategy and are more likely to change their approach multiple times over the 60 rounds, indicating a lower ability to sustain a consistent voting pattern.

These behavioral patterns are linked to the different institutional and cultural contexts in which the two subsamples of participants reside. Japanese are accustomed to stability and continuity in political dynasties (Miwa et al., 2023), and are characterized by a peaceful and cooperative approach to the electoral system, which justifies their conservative behavior. Italians, on the other side, are accustomed to continuous political instability and distrust in the electoral system, making them more vulnerable in their choices (Sandri and Seddone, 2015).

Table 2.9: Cross-country comparison of behavioral strategies by treatment

	% in Italy	% in Japan	Wilcoxon-Mann-Whitney
PANEL A - NPA treatment			
Sincere	16.37	8.86	p=0.180
Duverger's Law	83.43	91.13	p=180
Identified strategies	90.51	98.70	p=0.024*
PANEL B - PA treatment			
Sincere	61.73	47.17	p=0.556
Duverger's Law	30.74	51.98	p=0.413
Identified strategies	66.33	90.83	p=0.032*
PANEL C - NPA+OA treatment			
Sincere	8.01	6.63	p=0.429
Duverger's Law	83.98	93.19	p=0.126
Identified strategies	73.38	93.83	p=0.004**
PANEL D - PA+OA treatment			
Sincere	76.85	79.47	p=1
Duverger's Law	20.50	19.01	p=0.931
Identified strategies	61.20	87.66	p=0.004**

Note: *** p < 0.001, ** p < 0.01, * p < 0.05.

Result 5: *Regardless of the country, subjects exposed to the same ambiguous scenario adopt the same voting strategy. However, Japanese participants are more adept at maintaining strategic behavior over time and across outcome ambiguity, consistently coordinating around the strategy that maximizes their expected utility.*

Overall, Result 5 partially validates Hypothesis 4.

2.5.4 Regression analysis

Across all treatments, participants from Japan and Italy exhibit the same behavioral patterns across types and combinations of ambiguity, supporting the theory of no-country difference in voting strategies. However, in Section 2.5.3, we notice significant differences in the percentages of identified strategies, indicating that Japanese participants were more inclined to adopt strategic behaviors compared to Italians, and tended to be more conservative in their choices.

Therefore, we employ a Tobit regression analysis to inform our discussion of the differences in subjects' strategic behavior. The model is specified as follows:

$$y_i = \beta_1 \times Country + \beta_2 \times Treatment + \beta_3 \times Country \times Treatment + \beta_4 \times X_i + \varepsilon_i \tag{2.6}$$

The outcome of interest y_i is a continuous variable ranging from 0 to 1, representing the relative frequency with which subjects adopt a voting strategy (either sincere voting or strategic voting) over the 60 rounds of the voting game.[29] *Country* is a dummy variable assuming value 1 for Japan and 0 otherwise. *Treatment* refers to the treatment of interest, assuming NPA treatment as the reference variable. X_i includes a vector of socio-demographic controls (e.g., Age, Gender, Year of Education, Economics studies, Risk and Trust attitude, Religion, and Politics).[30] Finally, ε_i is the error term.

The results of this analysis are reported in Table 2.10. For completeness, in Model 1, we report all variables without the interaction term, while in Model 2, we report the same variables but after the interaction. *Age* shows a small and non-significant coefficient in Model 1 and Model 2, suggesting that age does not have a significant impact on the likelihood of adopting a voting strategy. Similarly, *Gender*, a dummy variable that assumes value 0 for males and 1 for females, has a negative but non-significant coefficient in both models, suggesting that gender may not be a significant predictor of the strategic behavior of participants. Conversely, *Year of Education* has a positive and significant coefficient in both models, i.e., as the level of education increases, subjects are more inclined to adopt a long-term voting strategy. *Economics*, a dummy variable which assumes value 1 if subjects are Economics students and 0 otherwise, returns a non-significant coefficient, i.e., studying Economics has no impact on adopting a long-term voting strategy. *Risk*, *Religion* and *Politics* have negative and non-significant coefficients in both models, while *Trust* has a positive and non-significant one. Interestingly, *Country* shows a positive and statistically significant coefficient only in Model 1, suggesting that the country of residence significantly influences the frequency of adopting a voting strategy. Specifically, using Italy as a reference variable, we observe that participants from Japan tend to adopt a voting strategy much more frequently than Italians and are more conservative in their voting strategies. Moreover, assuming *Treatment NPA* as the reference variable for the treatment condition, and comparing it with *Treatment PA*, *Treatment NPA+OA*, and *Treatment PA+OA*, we observe that the introduction of an ambiguity condition reduces the likelihood of strategic behavior. This effect is strongest when considering preference ambiguity ($p < 0.001$ for Treatments PA or PA+OA) compared to solely outcome ambiguity ($p < 0.05$ for Treatment NPA+OA). Similar results in both Model 1 and Model 2 confirm our prediction that as the layers of ambiguity increase, individuals are less able to define and preserve a strategy, and this trend is mostly driven by preference ambiguity. Finally, in Model 2, the introduction of the interaction term between the country of residence and the treatment variables yields no significant correlation, indicating that the relationship between the country of residence and the treatment conditions does not have a significant impact on the outcome variable, thus confirming that differences in the frequency of adopting a voting strategy (which is higher in the Japanese sample) do not convert into significant differences in the adopted voting strategy, given the treatment.

Result 6: *Under the same ambiguous conditions, voters' strategic behavior does not depend on their country of origin or cultural differences. There is no variation in the choice of strategy, but at the utmost in the degree to which that strategy is adopted.*

[29] Recall that a subject is assigned a strategy if and only if they make the same voting choice for at least 5 consecutive rounds.

[30] In Table 2.B6 of Appendix 2.B we report summary statistics of these variables, including mean and standard deviation of the whole sample, checking if there is a significant statistical difference between countries.

Table 2.10: Tobit regression of strategic behavior over 60 rounds

	Model 1	Model 2
Age	0.006	0.008
	(0.009)	(0.009)
Gender	-0.402	-0.042
	(0.034)	(0.034)
Year of Education	0.039**	0.036*
	(0.015)	(0.015)
Economics	-0.026	-0.022
	(0.044)	(0.043)
Risk	-0.020	-0.020
	(0.019)	(0.019)
Trust	0.017	0.018
	(0.016)	(0.016)
Religion	-0.038	-0.040
	(0.020)	(0.020)
Politics	-0.035	-0.038
	(0.021)	(0.021)
Country	0.202***	0.131
	(0.048)	(0.071)
Treatment PA	-0.243***	-0.286***
	(0.046)	(0.060)
Treatment NPA+OA	-0.126**	-0.161**
	(0.046)	(0.060)
Treatment PA+OA	-0.279***	-0.331***
	(0.045)	(0.060)
Country × Treatment NPA		0.103
		(0.093)
Country × Treatment NPA+OA		0.078
		(0.090)
Country × Treatment PA+OA		0.118
		(0.089)
logSigma	-1.457***	-1.466***
	(0.055)	(0.055)
Observations	258	258

Note: ***p<0.001, **p<0.01, *p<0.5 Robust standard errors are reported in parenthesis.

2.6 Conclusion

This chapter has examined how the preference and outcome ambiguities generated by primary elections influence the convergence of voters' choices toward the Sincere voting equilibrium, throughout a theory-driven experiment. Although one may expect that ambiguity triggers a higher degree of coordination on sincere voting, our results show that its impact on voting strategies may vary, depending on the different configurations experienced.

First, comparing NPA vs PA treatment, we confirm Bouton et al. (2017) findings: in absence of preference ambiguity, voters correctly anticipate the expected ranking and coordinate their votes around the strongest contender, thereby voting strategically following Duverger's Law. However, when preference ambiguity occurs, there is a strong convergence toward a sincere voting strategy. These findings provide internal validity to Bouton et al. (2017) results, as we conducted our experiments in two countries different from the one where their study was run (Spain), and culturally different among them (Italy and Japan). Second, by combining one-stage preference ambiguity with a second-stage outcome ambiguity, we confirm our theoretical prediction of the amplification of the opposite behaviors observed in NPA vs. PA. Comparing NPA with NPA+OA, voters converge on the most viable candidate in both cases, but strategic coordination is stronger under NPA+OA. Since outcome ambiguity is exogenous and each candidate has the same probability of winning with a lower expected payoff, voters have an even greater incentive to back the strongest contender to mitigate risk. Conversely, when comparing PA with PA+OA, the coexistence of preference and outcome ambiguity further undermines coordination, reinforcing sincere voting as the safer and more justifiable choice. The absence of significant differences between a one-stage primary election and a two-stage primary-general election may be due to opposite effects that our design is not meant to assess. Introducing an additional electoral stage could, on the one hand, complicate the calculation of expectations regarding the electoral outcome. On the other hand, it might stimulate a fear-of-regret strategy: the former diminishes while the latter enhances the psychological motivation for strategic voting. Disentangling these two motivations at the level of individual voters exceeds the scope of this chapter and warrants further investigation, despite its significance. For example, if voters fear regretting their primary election choices, this could increase their skepticism toward democratic processes. Such concerns have been reflected in various countries through surveys or even through violent protests in response to unexpected but legitimate electoral outcomes. Finally, when we examine whether these results vary between the two countries in which the experiments are conducted, we notice that subjects exposed to the same ambiguous scenarios adopt the same voting strategies, even if the degree to which a certain voting strategy is adopted varies slightly according to the country of residence and the correlated political-institutional perception.

Overall, these results support our research question, indicating that different types of ambiguity lead to different voting behaviors and that cultural context is important for the development of voting strategies.

Although these results provide clear evidence for the behavioral role of ambiguity, their external validity requires caution. Laboratory environments exclude many real-world factors that shape electoral behavior. For example, in actual primaries, voters are influenced by media narratives about candidate viability, polling data, and strategic endorsements. Our design abstracts from these informational cascades, which could mitigate or exacerbate the effects of ambiguity. Similarly, our model treats primary and general elections as sequential but insulated processes. In reality, primary outcomes often shift perceptions of electability in the general election. For instance, Emmanuel Macron's rise in France's 2017 presidential election was partly enabled by divisions in the left primary and voters' perceptions of second-round viability. Finally, our controlled setting excludes broader contextual variables – such as turnout heterogeneity, campaign shocks, or social identities – that are central in the field.

Moreover, we underline two other limitations of our study that deserve further investigation. First, we chose not to incorporate the endogenous probability of winning the general elections based on the number of votes the winning candidate would receive in the primaries. We avoided adding this further manipulation in order to maintain consistency with the approach of Bouton et al. (2017) and avoid the introduction of confounders. Second, strategic behavior during a primary election may depend on other primaries simultaneously or sequentially performed by opposite political parties. We acknowledge that this would require a much more sophisticated design, which might be weaker in terms of experimental controls. However, it would dramatically increase the external validity of experimental voting games in explaining electoral competition in democracies, to which our study has tried to provide a first contribution.

2.A Appendix 2.A - Mathematical proofs

2.A.1 Pivotal probabilities and payoffs

Since we have assumed that in each political position P_i, voting for the minority candidate C_i is a dominated strategy for both types t_{A_i} and t_{B_i} voters while it is dominant for type t_{C_i} voter, who is indifferent between A_i and B_i. Then, each type t_{A_i} and t_{B_i} voter makes their voting decision for A_i and B_i, considering their type and the belief formed after the public signal. Since they do not know the type distribution inside P_i nor outside, they base their decision on the expected value of each action, which depends on the pivotal events.

Denoting $piv_{Q_iR_i}$ the event in which a voter can be pivotal in determining the outcome voting for Q_i instead of R_i, we focus on the specific case in which C_i-voters are a large minority with n_{C_i} voters (i.e., $C_i = n_{C_i}$), such that $n_{A_iB_i} - 1 > n_{C_i} > \frac{n_{A_iB_i}}{2}$. This means that A_i and B_i will never be pivotal, hence $piv_{A_iB_i} = 0$.

The probabilities of pivotal events are essentially two, and occur only when the two candidates have exactly an equal share of votes or at least one vote of difference:

$$p_{A_iC_i} = Pr(piv_{A_iC_i}|\omega_i) = \frac{(n-1)!}{2} \frac{\left(\tau_{A_i}^{\omega_i}\right)^{n_{C_i}-1} \left(\tau_{B_i}^{\omega_i}\right)^{n_{A_iB_i}-n_{C_i}-1}}{(n_{C_i}-1)!(n_{A_iB_i}-n_{C_i}-1)!} \left(\frac{\tau_{A_i}^{\omega_i}}{n_{C_i}} + \frac{\tau_{B_i}^{\omega_i}}{(n-n_{C_i})}\right)$$

$$p_{B_iC_i} = Pr(piv_{B_iC_i}|\omega_i) = \frac{(n-1)!}{2} \frac{\left(\tau_{B_i}^{\omega_i}\right)^{n_{C_i}-1} \left(\tau_{A_i}^{\omega_i}\right)^{n_{A_iB_i}-n_{C_i}-1}}{(n_{C_i}-1)!(n_{A_iB_i}-n_{C_i}-1)!} \left(\frac{\tau_{B_i}^{\omega_i}}{n_{C_i}} + \frac{\tau_{A_i}^{\omega_i}}{(n-n_{C_i})}\right)$$

Now, to characterize the equilibrium, we consider the difference in the payoff between actions A_i and B_i. For the sake of brevity, we drop the conditioning on σ, and we have:

$$G(A_i|t_{A_i}, s_i, P_i, \mu_i) = \mu(a_i, \omega_j, \omega_k|t_{A_i}, s_i) \cdot U(A_i|t_{A_i}) \cdot P^{a_i}_{t_{A_iC_i}} + \mu(b_i, \omega_j, \omega_k|t_{A_i}, s_i) \cdot U(A_i|t_{A_i}) \cdot P^{b_i}_{t_{A_iC_i}}$$

and

$$G(B_i|t_{A_i}, s_i, P_i, \mu_i) = \mu(a_i, \omega_j, \omega_k|t_{A_i}, s_i) \cdot U(A_i|t_{A_i}) \cdot P^{a_i}_{t_{B_iC_i}} + \mu(b_i, \omega_j, \omega_k|t_{A_i}, s_i) \cdot U(A_i|t_{A_i}) \cdot P^{b_i}_{t_{B_iC_i}}$$

Therefore,

$$\begin{aligned} G(A_i \mid t_{A_i}, s_i, P_i, \mu_i) - G(B_i \mid t_{A_i}, s_i, P_i, \mu_i) = \mu(a_i, \omega_j, \omega_k \mid t_{A_i}, s_i) \cdot U(A_i \mid t_{A_i}) \cdot \left(P^{a_i}_{t_{A_iC_i}} - P^{a_i}_{t_{B_iC_i}}\right) \\ + \mu(a_i, \omega_j, \omega_k \mid t_{A_i}, s_i) \cdot U(A_i \mid t_{A_i}) \cdot \left(P^{b_i}_{t_{A_iC_i}} - P^{b_i}_{t_{B_iC_i}}\right) \end{aligned} \tag{2.A1}$$

Likewise,

$$G(A_i \mid t_{B_i}, s_i, P_i, \mu_i) - G(B_i \mid t_{B_i}, s_i, P_i, \mu_i) = \mu(b_i, \omega_j, \omega_k \mid t_{B_i}, s_i) \cdot U(B_i \mid t_{B_i}) \cdot \left(P^{a_i}_{t_{A_i C_i}} - P^{a_i}_{t_{B_i C_i}}\right) + \mu(b_i, \omega_j, \omega_k \mid t_{B_i}, s_i) \cdot U(B_i \mid t_{B_i}) \cdot \left(P^{b_i}_{t_{A_i C_i}} - P^{b_i}_{t_{B_i C_i}}\right) \tag{2.A2}$$

Since we have assumed that the utility of voting for $C_i = 0$ for every $t_{A_i}, t_{B_i} \in P_i$ and is equal to $V > 0$ for t_{A_i} (resp., t_{B_i}) if $P_i = A_i$, (resp., $P_i = B_i$) and $v \in (0, V)$, and vice versa for t_{A_i} (resp., t_{B_i}) if $P_i = B_i$, (resp., $P_i = A_i$), it is straightforward that (2.A1) $\geq$ (2.A2).

2.A.2 Proof of Proposition 2.1

Proposition 2.1. *Duverger's Law equilibria exist and are expectationally stable under both Partial informative signal and Uninformative signal.*

Proof. Consider a voter i who has to cast a ballot, and hence define the voting strategy σ_i, under the Partial informative signal. This implies that $s_{\omega_i} = s_{a_i}$, while $s_{\omega_j} = s_{\omega_k} = s_0$. Then, $p_{A_i C_i} > p_{B_i C_i}$.

Thus, for a type t_{A_i} voter, from Equation (2.A1), we have:

$$G(A_i \mid t_{A_i}, s_{a_i}, P_i, \mu_i) - G(B_i \mid t_{A_i}, s_{a_i}, P_i, \mu_i) > 0$$

Likewise, for a type t_{B_i} voter, from Equation (2.A2), we have:

$$G(A_i \mid t_{B_i}, s_{a_i}, P_i, \mu_i) - G(B_i \mid t_{B_i}, s_{a_i}, P_i, \mu_i) > 0$$

Hence, Duverger's Law is an equilibrium strategy under the Partial informative signal, with its expectational stability derived from the strictness of this equilibrium, as explained in Lemma 2.1.

Now, consider the same voter i who has to cast a ballot, and hence define the voting strategy σ_i, under the Uninformative signal. This implies $s_{\omega_i} = s_{\omega_j} = s_{\omega_k} = s_0$. Then, $p_{A_i C_i} > p_{B_i C_i}$. Assume, for example, the case in which $\sigma_{t_{a_i}, s_0, P_i, \mu_i}(A) = 1$ and $\sigma_{t_{b_i}, s_0, P_i, \mu_i}(B) = \epsilon$.

Then, for a type t_{A_i} voter, from Equation (2.A1), we have:

$$G(A_i \mid t_{A_i}, s_{a_i}, P_i, \mu_i) - G(B_i \mid t_{A_i}, s_{a_i}, P_i, \mu_i) > 0$$

Likewise, for a type t_{B_i} voter, from Equation (2.A2), we have:

$$G(A_i \mid t_{B_i}, s_{a_i}, P_i, \mu_i) - G(B_i \mid t_{B_i}, s_{a_i}, P_i, \mu_i) > 0$$

Duverger's Law is thus an equilibrium strategy under the Uninformative signal, with its expectational stability derived from the strictness of this equilibrium.

Therefore, Proposition 2.1 is validated.

2.A.3 Proof of Proposition 2.2

Proposition 2.2. *If sincere voting equilibrium exists and is expectationally stable under single-stage intra-positional election with $s_{\omega_i} = \{s_{a_i}, s_{b_i}\}$, then it also exists and remains expectationally stable when a second stage of inter-positional election is introduced. Then, under the Partial informative signal, sincere voting equilibrium exists and is expectationally stable.*

Proof. Considering Proposition 2 and the corresponding proof in Bouton et al. (2017) (page 145, Section A.2.) for the Sincere voting equilibrium and its stability under single-stage intra-positional election, then we know that when $s_{\omega_i} = \{s_{a_i}, s_{b_i}\}$, Sincere voting equilibrium exists and is expectational stable if and only if for $s_{\omega_i} = s_{a_i}$, then:

$$G(A_i \mid t_{A_i}, s_{a_i}, P_i, \mu_i) - G(B_i \mid t_{A_i}, s_{a_i}, P_i, \mu_i) \geq 0 \tag{2.A3}$$

and

$$G(A_i \mid t_{B_i}, s_{a_i}, P_i, \mu_i) - G(B_i \mid t_{B_i}, s_{a_i}, P_i, \mu_i) \leq 0 \tag{2.A4}$$

with $\mu_i = \beta_i(\omega_i|t_i, s_i)$.

When we introduce a second stage of inter-positional election, where $s_{\omega_i} = s_{a_i}$, whereas $s_{\omega_j} = s_{\omega_k} = s_0$, we reproduce the scenario of Partial uninformative signal.

Under this scenario, the belief is updated, based on the information coming from the two stage-election, and becomes $\mu_i = \beta_i(\omega_i|t_i, s_i) + \eta_j(\omega_j|t_i, s_{\omega_j}) + \eta_k(\omega_k|t_i, s_{\omega_k})$.

Now, if conditions (2.A3) and (2.A4) are satisfied $\forall \omega_i = \{a_i, b_i\}$, then regardless of the state of nature occurring in j and k, we can claim that:

$$G(A_i \mid t_{A_i}, s_{a_i}, P_i, \mu_i) - G(B_i \mid t_{A_i}, s_{a_i}, P_i, \mu_i) \geq 0$$

and

$$G(A_i \mid t_{B_i}, s_{a_i}, P_i, \mu_i) - G(B_i \mid t_{B_i}, s_{a_i}, P_i, \mu_i) \leq 0$$

Therefore, Proposition 2.2 is validated: a Sincere voting equilibrium exists and is expectationally stable under the Partial informative signal.

2.A.4 Proof of Proposition 2.3

Proposition 2.3. *If Sincere voting equilibrium exists under Partial informative signal, then it also exists under Uninformative signal.*

Proof. A Sincere voting equilibrium exists under the Partial informative signal if and only if:

$$G(A_i \mid t_{A_i}, s_{a_i}, P_i, \mu_i) - G(B_i \mid t_{A_i}, s_{a_i}, P_i, \mu_i) \geq 0 \geq G(A_i \mid t_{B_i}, s_{a_i}, P_i, \mu_i) - G(B_i \mid t_{B_i}, s_{a_i}, P_i, \mu_i) \tag{2.A5}$$

Under the Uninformative signal, we know that:

$$G(A_i \mid t_i, s_0, P_i, \mu_i) - G(B_i \mid t_i, s_0, P_i, \mu_i) \equiv \mu(a_i, \omega_j, \omega_k \mid t_i, s_{a_i})\big[G(A_i \mid t_i, s_{a_i}, P_i, \mu_i) - G(B_i \mid t_i, s_{a_i}, P_i, \mu_i)\big]$$
$$+ \mu(b_i, \omega_j, \omega_k \mid t_i, s_{b_i})\big[G(A_i \mid t_i, s_{b_i}, P_i, \mu_i) - G(B_i \mid t_i, s_{b_i}, P_i, \mu_i)\big]$$

Then, for $s_{\omega_i} = s_{\omega_j} = s_{\omega_k} = s_0$, if condition (2.A5) is satisfied $\forall \omega \in \Omega$, we have that:

$$G(A_i \mid t_{A_i}, s_0, P_i, \mu_i) - G(B_i \mid t_{A_i}, s_0, P_i, \mu_i) \geq 0 \geq G(A_i \mid t_{B_i}, s_0, P_i, \mu_i) - G(B_i \mid t_{B_i}, s_0, P_i, \mu_i) \quad (2.A6)$$

Therefore, Sincere voting is an equilibrium strategy under the Uninformative signal and, following Lemma 2.1, is expectationally stable.

Thus, Proposition 2.3 is validated.

2.A.5 Proof of Proposition 2.4

Proposition 2.4. *As long as the information decreases, the degree of ambiguity increases. Then, a sincere voting equilibrium exists and is the most likely to be selected.*

Proof. Let s_ω be the degree of informativeness of all public signals, i.e., $s_\omega = s_{\omega_i} + s_{\omega_j} + s_{\omega_k}$, then:

- For a type t_{A_i} voter

$$\lim_{(s_{\omega_i}) \to 0} \big[G(A_i \mid t_{A_i}, s_\omega, P_i, \mu_i) - G(B_i \mid t_{A_i}, s_\omega, P_i, \mu_i)\big] \geq 0$$

- For a type t_{B_i} voter

$$\lim_{(s_{\omega_i}) \to 0} \big[G(A_i \mid t_{B_i}, s_\omega, P_i, \mu_i) - G(B_i \mid t_{B_i}, s_\omega, P_i, \mu_i)\big] \leq 0$$

Therefore, Proposition 2.4 is validated.

2.B Appendix 2.B - Additional analyses

2.B.1 Distribution of participants per treatment and country

Table 2.B1: Distribution of participants per treatment and country

Treatment	Country	n° Sessions	n°Groups	n°Participants
NPA	Japan	2	5	30
	Italy	3	6	36
PA	Japan	2	4	24
	Italy	2	5	30
NPA+OA	Japan	2	5	30
	Italy	3	6	36
PA+OA	Japan	2	6	36
	Italy	3	6	36

2.B.2 NPA treatment: Aggregate and individual behavior

When analyzing subjects' overall propensity to vote for each alternative across 60 rounds, irrespective of the detectability of a strategy, we find that under no preference ambiguity, the majority of votes are cast for the selected jar. Voting for the jar accounts for 88.30% of cases across all rounds. This action is chosen in 95.72% of cases within the Japanese subsample (with homogeneity across groups)[31] and in 80.88% of cases in the Italian ones (but with heterogeneity across groups).[32] This frequency is still compatible with a higher sincere voting attitude of about 69% in both subsamples. There is no evident preference for any alternative other than the jar. Furthermore, since approximately two-thirds of participants received a ball that matched the color of the selected jar (65.46%), this correlation partly explains the elevated level of sincere voting. However, when the jar's color does not match the color of the ball assigned to the voter, the propensity for sincere voting drops significantly. In the Japanese subsample, the overall frequency of votes for the jar decreases to 88.60%, and the frequency of sincere voting declines to 10.72%. Similarly, in the Italian subsample, the frequency of voting for the jar decreases by approximately 16 percentage points, and the frequency of sincere voting is halved. A direct comparison of voting behavior when the ball color matches the jar or not reveals a statistically significant difference (Wilcoxon-Mann-Whitney test, $z = 3.142$, $p < 0.001$). This result highlights that participants are significantly more likely to vote for the jar when the ball color matches, as the alignment simplifies decision-making, whereas mismatches reduce sincere voting by introducing complexity.

Given the seven aforementioned strategies, in Table 2.B2 we analyse voters' behavior by disaggregating the strategies identified in Table 2.3 by independent groups. We observe that *% of identified strategies* reaches almost 100% in the majority of groups. Diversification of these strategies is minimal

[31] The frequencies are 94.72%, 97.50%, 95.83%, 93.05%, 98.33% and 96.38% from group 1 to group 6.

[32] The frequencies are 61.39%, 57.78%, 93.61%, 85%, 91.39% and 96.11% from group 1 to group 6.

in Italy and non-existent in Japan. These findings bolster the emergence of a prevalent type of equilibria under the certainty of the preference distribution of the group of voters, i.e., Duverger's Law Equilibria (Bouton et al., 2017), wherein participants strategically vote *Jar* or *Red*.

Table 2.B2: Frequencies of identified strategies in each matching group of NPA treatment

	Group	Strategy							% of identified strategies
		Blue	Red	Gray	Sincere	Opposite Sincere	Jar	Opposite Jar	
Italy	1	0.00	**80.64**	0.00	18.21	0.00	1.15	0.00	96.11
	2	0.00	**73.72**	0.00	20.82	0.68	4.78	0.68	81.39
	3	0.00	0.30	0.00	5.44	0.00	**94.26**	0.00	91.94
	4	0.00	0.00	0.00	30.03	0.64	**69.33**	0.00	86.94
	5	0.00	0.00	0.00	5.40	0.00	**94.60**	0.00	87.50
	6	0.00	0.00	0.00	18.77	0.00	**81.23**	0.00	99.17
Japan	1	0.00	0.00	0.00	16.67	0.00	**83.33**	0.00	100
	2	0.00	0.00	0.00	3.34	0.00	**96.66**	0.00	99.72
	3	0.28	0.00	0.00	6.53	0.00	**93.18**	0.00	97.78
	4	0.00	0.00	0.00	24.09	0.00	**75.91**	0.00	99.16
	5	0.00	0.00	0.00	0.28	0.00	**99.72**	0.00	97.78
	6	0.28	0.57	0.00	1.99	0.00	**97.16**	0.00	97.78

Note: In bold is the modal strategy for each group.

Duverger's Law alignment under NPA treatment is further supported by the analysis of individual behavior across 60 rounds in each group. Specifically, in the six Italian groups, 11.11% of participants vote for *Jar* in every round, while approximately 33.33% use this strategy in at least 90% of the rounds. Interestingly, 11.11% choose *Sincere* as their modal strategy. In contrast, the six Japanese groups exhibit a stronger tendency toward Duverger's Law equilibrium of voting for *Jar*, as already shown aggregately in Table 2.B2. In particular, 58.33% of Japanese participants consistently vote for *Jar* in all 60 rounds, and 22.22% adopt this strategy in at least 90% of the rounds. Only 8.33% use this strategy in fewer than 30 rounds, highlighting their greater alignment with strategic behavior compared to Italian participants.

2.B.3 PA treatment: Aggregate and individual behavior

Regardless of the identified strategies, we observe that in the 60 choices made under the preference ambiguity condition, overall voters cast a ballot for the color associated with that of their ball, i.e., voting sincerely, about 70% of the time. When comparing Italian and Japanese subsamples, we find no differences in the shown frequency (69.56% and 71.53%, respectively).

Subsequently, when we filter for the rounds in which voters adopted one of the five possible strategies mentioned above, the tendency to vote sincerely becomes even more pronounced. In Table 2.B3, we disaggregate the identified strategies shown in Table 2.3 by independent groups. We observe that sincere voting, though not unique, is the most frequently played strategy. The modal choice is to vote *Sincere* in 5 of 9 groups (3 Italian and 2 Japanese). *Blue* is the modal strategy for group 5 of Italy and groups 1 and 2 of Japan, while *Red* is the modal strategy only for group 2 of Italy. *Gray* and *Opposite Sincere*, as expected, are never modal. These results confirm the findings of Bouton et al. (2017), highlighting the coexistence of both types of equilibrium: Sincere voting and Duverger's Law.

The coexistence of these two types of equilibria becomes evident when analyzing individual voting

Table 2.B3: Frequencies of identified strategies in each matching group of PA treatment

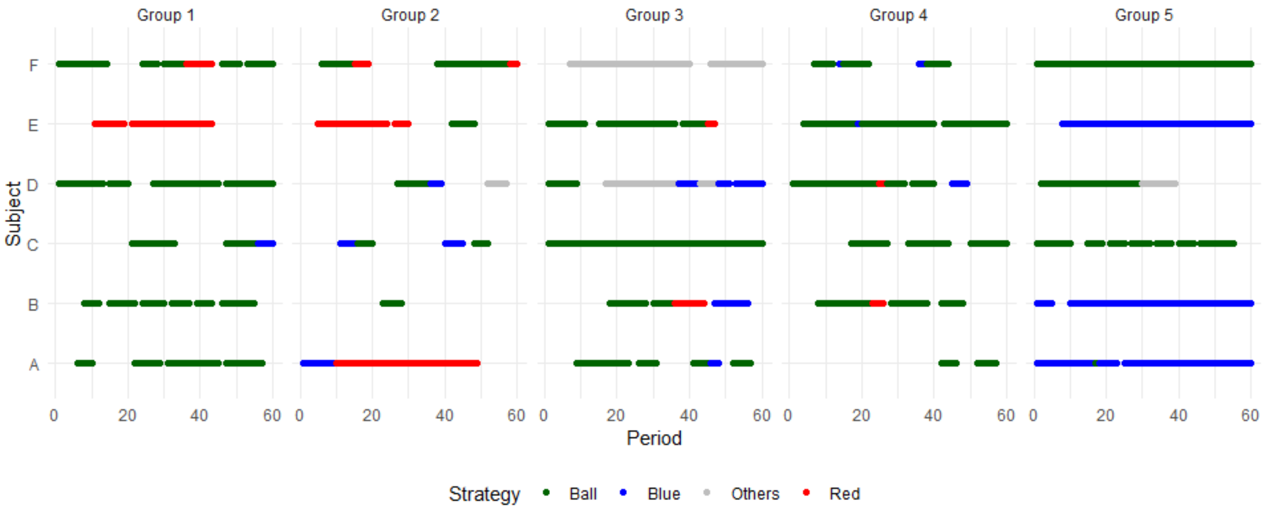
Group		Strategy					% of identified strategies
		Blue	Red	Gray	Sincere	Opposite Sincere	
Italy	1	2.10	16.81	0.00	**81.09**	0.00	66.11
	2	14.63	**44.51**	0.00	37.19	3.65	45.55
	3	11.27	4.36	0.00	**57.45**	26.91	76.38
	4	4.39	2.93	0.00	**92.68**	0.00	56.94
	5	**53.53**	0.00	0.00	43.27	3.20	86.67
Japan	1	**90.36**	0.00	0.00	9.64	0.00	92.22
	2	**60.51**	0.00	0.00	39.49	0.00	97.78
	3	44.11	1.68	0.00	**50.51**	3.70	82.50
	4	9.48	0.00	0.00	**90.52**	0.00	90.83

Note: In bold is the modal strategy for each group.

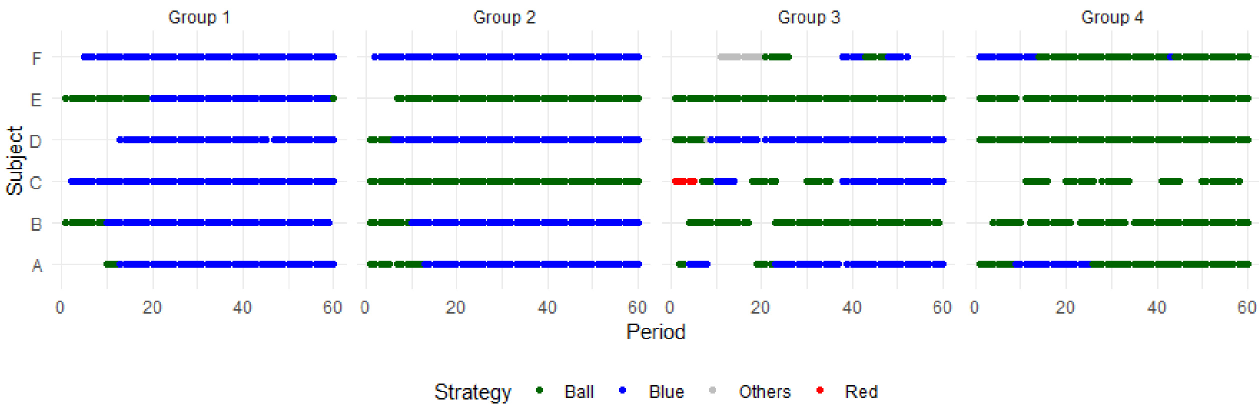
choices across 60 rounds. In Figure 2.B1, we notice that for the *Sincere* strategy, only 5.56% of Italian participants and 12.50% of Japanese participants adopt it consistently in all rounds. However, 25% of participants in both subsamples chose this strategy in at least half of the rounds. In contrast, the *Blue* strategy shows notable differences. It is consistently played by 8.33% of Japanese participants in all 60 rounds and by 41.66% in at least half of the rounds. In the Italian groups, only 8.33% of participants adopt this strategy for at least 20 rounds. The *Red* strategy is less prominent. It is played for at least 20 rounds by 8.33% of Italian participants, while only one Japanese participant uses it, and even then, for no more than 10 rounds. Finally, the *Opposite Sincere* strategy is adopted by only 2.78% of Italian participants, with no significant uptake among the Japanese participants.

Figure 2.B1: Individual behavior in groups in treatment PA

(a) Individual behavior in Italian groups



(b) Individual behavior in Japanese groups



2.B.4 NPA+OA treatment: Aggregate and individual behavior

The strong convergence toward Duverger's Law equilibrium, by voting for the selected jar, observed at the aggregate level in Section 2.5.2 can be further elucidated by disaggregating the data first by groups and then analyzing individual behavior within each group.

When disaggregating the data by groups, as shown in Table 2.B4, the modal strategy is consistently *Jar* across all groups. This strategy accounts for no less than four-fifths of the overall identified strategies, with the sole exception being group 3 of the Italian subsample. Even in this case, no alternative strategy appears to be played with higher frequency, reinforcing the notion that coordinating on the color indicated by the public signal (*Jar*) is the most effective approach to maximize the expected utility of winning. Thus, under outcome ambiguity but no preference ambiguity, the equilibrium predicted by Duverger's Law remains the only viable option. Moreover, as observed in the aggregate results (Table 2.4), Italian groups tend to take more rounds to settle on a strategy, reflected in a lower percentage of *Identified strategies*. In contrast, Japanese groups consistently demonstrate a more strategic approach, with *Identified strategies* persisting for more than 50 rounds. This underscores a more rational and conservative coordination behavior among Japanese participants compared to their Italian counterparts.

Table 2.B4: Frequencies of identified strategies in each matching group in NPA+OA treatment

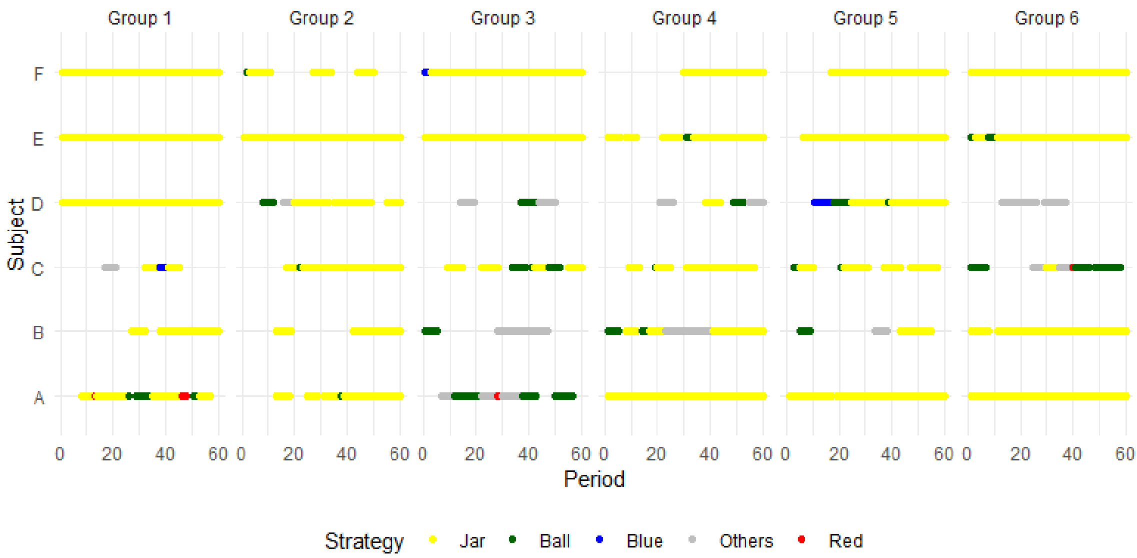
Group		Strategy							% of identified strategies
		Blue	Red	Gray	Sincere	Opposite Sincere	Jar	Opposite Jar	
Italy	1	1.09	1.46	0.00	3.28	1.82	**92.33**	0.00	76.11
	2	0.00	0.00	0.00	3.35	1.67	**94.98**	0.00	66.39
	3	0.81	0.00	0.00	19.35	6.85	**58.06**	14.11	68.89
	4	0.00	0.00	0.00	6.56	7.72	**82.24**	3.47	71.94
	5	2.62	0.00	0.00	5.99	0.00	**89.51**	1.87	74.17
	6	0.00	0.34	0.00	9.73	5.73	**79.19**	5.37	82.78
Japan	1	0.00	0.00	0.00	2.04	0.00	**97.96**	0.00	95.28
	2	0.00	0.00	0.00	2.92	0.97	**96.10**	0.00	85.56
	3	0.00	0.00	0.00	20.35	0.00	**79.65**	0.00	95.56
	4	0.00	0.00	0.00	0.84	0.00	**99.16**	0.00	99.44
	5	0.00	0.00	0.00	6.84	0.00	**93.15**	0.00	93.33

Note: In bold is the modal strategy for each group.

These findings hold true when we analyze voting choices at the individual level. As shown in Figure 2.B2, 19.44% of Italian participants and 43.33% of Japanese participants consistently employ the *Jar* strategy across all 60 rounds. Furthermore, 25% of Italians and 20% of Japanese use this strategy in at least 50 rounds. Surprisingly, 11.11% of Italian participants never adopt the *Jar* strategy. This behavioral disparity could be associated with a significantly lower overall tendency to adopt any strategy type within the Italian subsample (73.38%) compared to the Japanese subsample (93.83%).

Figure 2.B2: Individual behavior in groups in treatment NPA+OA

(a) Individual behavior in Italian groups



(b) Individual behavior in Japanese groups

2.B.5 PA+OA treatment: Aggregate and individual behavior

Further disaggregating the data from Table 2.6, first by groups and then by individual voters, reveals a convergence toward a sincere voting strategy as the level of ambiguity increases.

When disaggregating by groups, as shown in Table 2.B5, we observe that the *Sincere* strategy emerges as the modal choice across all groups, being employed in at least three-fourths of the overall identified strategies. The exceptions to this trend are group 3 of Italians and group 3 of Japanese, where a notable frequency of voting for Duverger's Law alternatives such as *Blue* or *Red* is observed. These deviations align with the assumptions of Hypothesis 2, which posits that the outcome ambiguity amplifies the effect of the preference ambiguity, encouraging a shift toward sincere voting. However, this behavior underscores that a sincere voting strategy, while predominant, does not constitute a universally unique equilibrium condition if the preference distribution is unknown. Additionally, as observed in all other cases involving at least one type of ambiguity, Italian groups take more time to settle on a strategy than their Japanese counterparts. This difference is further amplified by the simultaneity of both types of ambiguity – preference and outcome. This finding provides additional evidence supporting the intuition of a greater capacity for coordination and rationalization among participants in Japan compared to those in Italy.

Table 2.B5: Frequencies of identified strategies in each matching group in PA+OA treatment

Group		Strategy					% of identified strategies
		Blue	Red	Gray	Sincere	Opposite Sincere	
Italy	1	5.32	4.73	0.00	**75.15**	14.79	46.94
	2	7.14	9.4	0.00	**81.58**	1.88	73.89
	3	42.86	2.23	0.00	**54.91**	0.00	62.22
	4	0.00	3.06	0.00	**96.94**	0.00	63.61
	5	15.50	2.50	0.00	**79.50**	2.50	55.56
	6	21.79	6.41	0.00	**71.79**	0.00	65.00
Japan	1	1.78	22.62	0.00	**75.60**	0.00	93.33
	2	0.61	22.08	0.00	**77.30**	0.00	90.55
	3	1.84	25.73	0.00	**66.18**	6.25	75.56
	4	0.00	0.00	0.00	**100**	0.00	97.50
	5	4.78	18.77	0.00	**74.06**	2.39	81.38

Note: In bold is the modal strategy for each group.

Further evidence supporting these findings emerges when we examine voting choices at the individual level. In Figure 2.B3, the *Sincere* strategy is adopted in all 60 rounds by 30% of Japanese participants but only 5.56% of Italian participants. Nonetheless, more than one-fourth of participants in both subsamples employed this strategy for at least half of the rounds.[33]

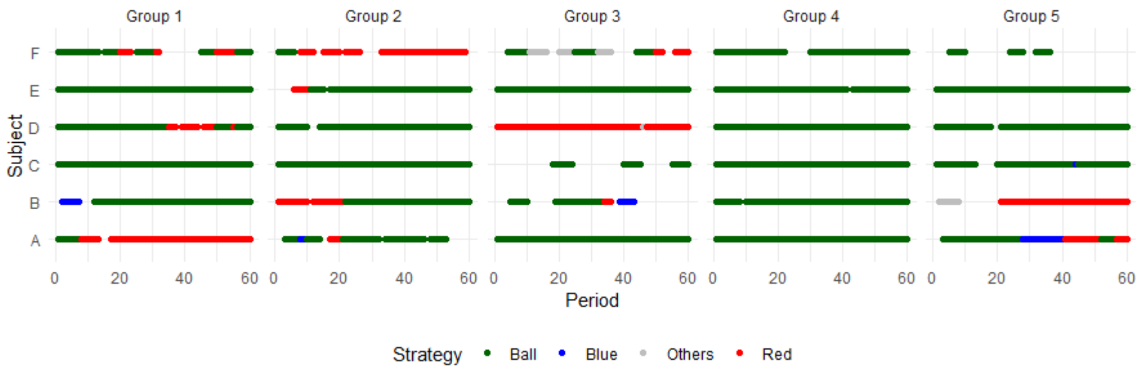
The alternative strategies, *Blue* and *Red*, are marginal compared to *Sincere*. For example, *Blue* is played in all rounds by only 2.77% of Italian voters and no Japanese voter adopt it for more than 10 consecutive rounds. Similarly, *Red* is used for up to 30 rounds by 13% of Japanese participants but for no more than 10 consecutive rounds by Italian voters.

[33] In the Italian subsample, fewer individuals consistently chose the *Sincere* strategy for the majority of rounds, reflecting a lower overall inclination to adopt any strategy consistently across all 60 rounds compared to the Japanese (61.20% vs. 87.66%). This difference is statistically significant (Wilcoxon-Mann-Whitney test, $z = 2.739$, $p = 0.004$), indicating a country-specific divergence in strategic behavior.

Figure 2.B3: Individual behavior in groups in treatment PA+OA

(a) Individual behavior in Italian groups

(b) Individual behavior in Japanese groups



2.B.6 Summary statistics of socio-demographic characteristics

Table 2.B6: Summary Statistics

	Full Sample		Japan	Italy	Difference
	Mean	Std. Dev.	Mean	Mean	
Age	21.178	2.052	20.192	22.036	1.844***
Female	0.360	0.481	0.342	0.377	0.035
Year of Education	2.748	1.474	2.242	3.188	0.947***
Economics	0.736	0.441	0.500	0.942	0.442***
Religion	1.655	0.804	1.358	1.913	0.555***
Politics	2.702	0.734	2.533	2.848	0.31***
Risk aversion	2.973	0.956	2.517	3.384	0.867***
Trust	2.302	1.022	2.150	2.420	0.270**

Note: *Age* is a continuous variable ranging from 18 to 60 years. *Female* is a dummy variable equal to 1 if the respondent is female. *Year of Education* is a discrete variable ranging from 1 (one year of education) to 9 (nine years of education). *Economics* is a dummy variable equal to 1 if the respondent is an Economics student. *Religion* and *Politics* are discrete variables ranging from 1 (not at all religious/not at all politically engaged) to 4 (extremely religious/extremely politically engaged). *Risk aversion* and *Trust* are discrete variables ranging from 1 (not at all risk-averse/do not trust people at all) to 5 (extremely risk-averse/extremely trusting). Tests used: Chi-square for categorical and Mann-Whitney for ordinal scales. ***$p < 0.001$, **$p < 0.01$, *$p < 0.05$

2.C Appendix 2.C - Instructions

2.C.1 Instructions for NPA and PA treatments

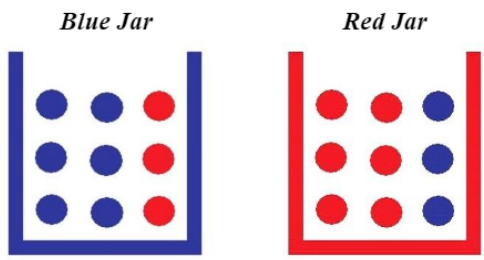
Welcome and thank you for taking part in this experiment. Please remain quiet and switch off your mobile phone. It is important that you do not talk to other participants during the entire experiment. Please read these instructions very carefully; the better you understand the instructions the more money you will be able to earn. If you have further questions after reading the instructions, please raise your hand. We will then approach you in order to answer your questions personally. Please do not ask aloud.

This experiment consists of 60 rounds. The rules are the same for all participants and for all rounds. At the beginning of the experiment, you will be randomly assigned to a group of 6 (including yourself). You will belong to the same group throughout the whole experiment. You will only interact with the participants in your group. Your earnings will depend partly on your decisions, partly on the decisions of the other participants in your group and partly on chance.

The Jar

There are two jars: the ***blue jar*** and the ***red jar***.

The ***blue jar*** contains ***6 blue balls*** and ***3 red balls***. The ***red jar*** contains ***3 blue balls*** and ***6 red balls***.



At the beginning of each round, one of the two jars will be randomly selected for your group. The color of the jar may thus change from one round to the next. In each round, each jar is equally likely to be selected, i.e., each jar is selected with a probability of 50%.

[*NPA treatment*] You will be told which jar has been chosen before making your decision.

[*PA treatment*] You will not be told which jar has been chosen before making your decision.

The Ball

After a jar is selected for your group, every participant in your group (including yourself) is going to see the color of ***one ball*** randomly drawn from that jar. Since you are 6 in your group, the computer performs this random draw 6 times, separately for each member. Each ball is equally likely to be drawn, and each draw is made with replacement. That is, independently of the balls received by the other members of the group, you and every other member of your group:

- have a chance of two thirds of receiving a blue ball if the selected jar is blue;

- have a chance of two thirds of receiving a red ball if the selected jar is red.

Importantly, ***you will only see the color of your own ball***, and not the color of the ball received by the other members of your group.

Your Decision

Once you have seen the color of one of the balls, you can make your decision. **You will have to vote for one of these three colors:** Blue, Red, or Gray. You can vote for one of the colors by clicking on it. After making your decision, please press the 'OK' key to confirm.

Group Decision

Once all participants have made their decision, the votes of all 6 participants will be added up. On top of that, the computer will add 4 votes for Gray. The group decision will depend on the total number of votes that each color receives:

- **If one color has strictly more votes than other colors,** this color will be the group decision.
- **If there is a tie between two colors with the most votes** (i.e., Blue and Gray, or Red and Gray), one of the two colors with the most votes will be selected randomly. Among the two colors with the most votes, each color will have the same probability of being chosen to be the group decision.

Payoff in Each Round

Your payoff depends on the ***color of your ball*** and on the ***group decision***. Your payoff is indicated in the following table:

		Group Decision		
		Blue	Red	Gray
Your Ball	Blue	200	110	20
	Red	110	200	20

The row (indicated on the left part of the table) specifies the color of your ball. The columns (indicated on the top part of the table) specify the group decision, i.e. which color got elected.

- If your ball is Blue and the group decision is Blue, you get 200 eurocents (resp., 400 yen).
- If your ball is Blue and the group decision is Red, you get 110 eurocents (resp., 220 yen).
- If your ball is Blue and the group decision is Gray, you get 20 eurocents (resp., 40 yen).
- If your ball is Red and the group decision is Blue, you get 110 eurocents (resp., 220 yen).
- If your ball is Red and the group decision is Red, you get 200 eurocents (resp., 400 yen).
- If your ball is Red and the group decision is Gray, you get 20 eurocents (resp., 40 yen).

To summarise, if the color of the group decision matches the color of your ball, your payoff is 400 yen (resp., 200 cents). If group decision is either Blue or Red, but does not match the color of your selected ball, your payoff is 220 yen (resp., 110 cents). Finally, if the color of the group decision is Gray, your payoff is 40 yen (resp., 20 cents) independently of the color of your ball.

Information at the End of Each Round

Once you and all the other participants have made and confirmed your choices, the round will be over. At the end of each round, you will receive the following information:

- Total number of votes for Blue
- Total number of votes for Red
- Total number of votes for Gray (including the 4 votes added by the computer)
- The *group decision* (which color got elected in your group: Blue, Red or Gray)
- The color of the selected jar (Blue or Red)
- Your ball (Blue or Red)
- Your payoff

Final Earnings

At the end of the experiment, the computer will randomly select 6 rounds and you will earn the payoffs you obtained in these rounds. Each of the 60 rounds has the same chance of being selected.

Control Questions

Before the experiment, you will have to answer some control questions in the computer terminal. Click on the OK button after you have answered each question. Once you and all the other participants have answered all the questions, the experiment will start.

2.C.2 Instructions for NPA+OA and PA+OA treatments

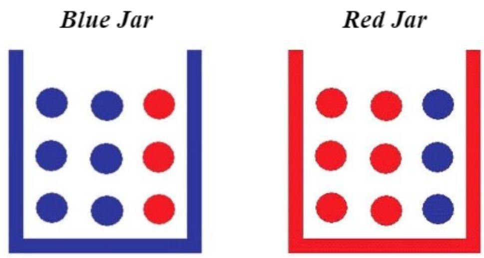
Welcome and thank you for taking part in this experiment. Please remain quiet and switch off your mobile phone. It is important that you do not talk to other participants during the entire experiment. Please read these instructions very carefully; the better you understand the instructions the more money you will be able to earn. If you have further questions after reading the instructions, please raise your hand. We will then approach you in order to answer your questions personally. Please do not ask aloud.

This experiment consists of 60 rounds. The rules are the same for all participants and for all rounds. At the beginning of the experiment, you will be randomly assigned to a group of 6 (including yourself). You will belong to the same group throughout the whole experiment. You will only interact with the participants in your group. Your earnings will depend partly on your decisions, partly on the decisions of the other participants in your group and partly on chance.

The Jar

There are two jars: the ***blue jar*** and the ***red jar***.

The ***blue jar*** contains ***6 blue balls*** and ***3 red balls***. The ***red jar*** contains ***3 blue balls*** and ***6 red balls***.



At the beginning of each round, one of the two jars will be randomly selected for your group. The color of the jar may thus change from one round to the next. In each round, each jar is equally likely to be selected, i.e., each jar is selected with a probability of 50%.

[*NPA+OA treatment*] You will be told which jar has been chosen before making your decision.

[*PA+OA treatment*] You will not be told which jar has been chosen before making your decision.

The Ball

After a jar is selected for your group, every participant in your group (including yourself) is going to see the color of ***one ball*** randomly drawn from that jar. Since you are 6 in your group, the computer performs this random draw 6 times, separately for each member. Each ball is equally likely to be drawn, and each draw is made with replacement. That is, independently of the balls received by the other members of the group, you and every other member of your group:

- have a chance of two thirds of receiving a blue ball if the selected jar is blue;
- have a chance of two thirds of receiving a red ball if the selected jar is red.

Importantly, ***you will only see the color of your own ball***, and not the color of the ball received by the other members of your group.

Your Decision

Once you have seen the color of one of the balls, you can make your decision. **You will have to vote for one of these three colors:** Blue, Red, or Gray. You can vote for one of the colors by clicking on it. After making your decision, please press the 'OK' key to confirm.

Group Decision

Once all participants have made their decision, the votes of all 6 participants will be added up. On top of that, the computer will add 4 votes for Gray. The group decision will depend on the total number of votes that each color receives:

- **If one color has strictly more votes than other colors,** this color will be the group decision.
- **If there is a tie between two colors with the most votes** (i.e., Blue and Gray, or Red and Gray), one of the two colors with the most votes will be selected randomly. Among the two colors with the most votes, each color will have the same probability of being chosen to be the group decision.

Payoff in Each Round

Your payoff depends on ***the color of your ball***, on the ***group decision***, and on a ***second draw***. The second draw consists in the following. Given the group decision, and whatever this decision, the computer inserts a ball with the color chosen by the group in an urn, together with a Green ball and a Black ball. Then, one of these three balls is randomly drawn:

- with probability 1/3, the drawn ball is the one with the color chosen by the group;
- with probability 1/3, the drawn ball is the Green one;
- with probability 1/3, the drawn ball is the Black one.

If the drawn ball is one with the color chosen by the group, then the group decision is applied. In the other two cases, the group decision is not applied, in the sense that the payoff of the 6 participants in the group does not depend on the group decision.

Depending upon this second drawn, your payoff is indicated in the following table:

		Group Decision Applied (probability = 1/3)			Group Decision NOT Applied	
		Blue	Red	Gray	Green (probability = 1/3)	Black (probability = 1/3)
Your Ball	Blue	200	110	20	5	15
	Red	110	200	20	15	5

The row (indicated on the left part of the table) specifies the color of your ball. The columns (indicated on the top part of the table) specify the group decision, i.e., which color got elected.

- If your ball is Blue and the outcome of the second draw is Blue, you get 200 eurocents (resp., 400 yen).
- If your ball is Blue and the outcome of the second draw is Red, you get 110 eurocents (resp., 220 yen).
- If your ball is Blue and the outcome of the second draw is Gray, you get 20 eurocents (resp., 40 yen).
- If your ball is Blue and the outcome of the second draw is Green, you get 5 eurocents (resp., 10 yen).
- If your ball is Blue and the outcome of the second draw is Black, you get 15 eurocents (resp., 30 yen).
- If your ball is Red and the outcome of the second draw is Blue, you get 110 eurocents (resp., 220 yen).
- If your ball is Red and the outcome of the second draw is Red, you get 200 eurocents (resp., 400 yen).
- If your ball is Red and the outcome of the second draw is Gray, you get 20 eurocents (resp., 40 yen).
- If your ball is Red and the outcome of the second draw is Green, you get 15 eurocents (resp., 30 yen).
- If your ball is Red and the outcome of the second draw is Black, you get 5 eurocents (resp., 10 yen).

To summarize:

- if the selected ball in the second draw is Green or Black, your payoff does not depend on your group decision, and is either 5 cents or 15 cents according to the color of your ball.
- if the selected ball in the second draw is the one with the color chosen by the group, then:

  - if the color of the group decision matches the color of your ball, your payoff is 400 yen (resp., 200 cents);

  - if group decision is either Blue or Red, but does not match the color of your selected ball, your payoff is 220 yen (resp., 110 cents);

  - if the color of the group decision is Gray, your payoff is 40 yen (resp., 20 cents) independently of the color of your ball.

Information at the End of Each Round

Once you and all the other participants have made and confirmed your choices, the round will be over. At the end of each round, you will receive the following information:

- Total number of votes for Blue
- Total number of votes for Red
- Total number of votes for Gray (including the 4 votes added by the computer)
- The *group decision* (which color got elected in your group: Blue, Red or Gray)
- The outcome of the *second draw* (Green, Black, or the color elected in your group)
- The color of the selected jar (Blue or Red)
- Your ball (Blue or Red)
- Your payoff

Final Earnings

At the end of the experiment, the computer will randomly select 6 rounds and you will earn the payoffs you obtained in these rounds. Each of the 60 rounds has the same chance of being selected.

Control Questions

Before the experiment, you will have to answer some control questions in the computer terminal. Click on the OK button after you have answered each question. Once you and all the other participants have answered all the questions, the experiment will start.

Chapter 3

Equity or Efficiency: An Experimental Investigation

Keywords: Equity-Efficiency tradeoff, Redistribution, Social preferences, Taxation

JEL codes: C91, D63, D71, H23

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3.1 Introduction

Redistributive policies aiming at increasing societal equity can be justified on several grounds and invoked for different beneficial effects. However, a recurrent cautionary argument points to the cost of these policies in terms of economic efficiency, due to the possibility that they reduce the incentives to work, or save and invest (for introductory accounts of this debate see, e.g., Krugman and Wells, 2024 or Mankiw, 2024).

While the equality-efficiency tradeoff has long been debated by scholars in economics (see, e.g., Sidgwick, 1887; Edgeworth, 1925, for early accounts, and Okun, 1975, for a classical contribution), its current formulation hinges on the Second Fundamental Theorem of Welfare Economics (see, e.g., Mas-Colell et al., 1995), which proves that non-distortionary redistributive policies are based on lump-sum transfers. When these are not available, one has to resort to distortionary taxes, which will cause a deadweight loss. The extent of this loss measures the surplus one should be ready to give up in order to increase equity.

Regarding individual attitudes toward redistribution, the consolidated experimental evidence (see, e.g., Fehr and Schmidt, 1999; Bolton and Ockenfels, 2000; Charness and Rabin, 2002; Bolton and Ockenfels, 2006) shows that individuals are not driven solely by self-interest, but exhibit a wide range of other-regarding preferences, ranging between total selfishness, where one seeks to maximize personal gain, and total altruism, where one is willing to give everything to others purely out of generosity.

Beside this strand of literature, which usually does not focus explicitly on the cost of redistribution, there are studies which have investigated how preferences for redistribution are affected by the tradeoff between equity and efficiency (see, e.g., Andreoni and Miller, 2002; Fisman et al., 2007; Hong et al., 2015). They have shown that, when redistribution is costly, subjects tend to replace an equity-seeking behavior with an efficiency-seeking one, and that this tendency is stronger the larger the cost of redistribution.

This chapter contributes to this line of research by investigating *how subjects respond to the equity-efficiency tradeoff in a novel, theory-driven, experimental design, in which individuals decide how to share a monetary amount between themselves, as proposers, and an anonymous counterpart, as responder, under various conditions of efficiency loss and responder's veto power*. Specifically, we examine whether individuals tend to prioritize equity regardless of efficiency costs or whether their equity concerns diminish as the loss of surplus escalates.

The experimental design is inspired by an example of unproductive taxation illustrated in Mas-Colell et al. (1995, page 823), who, in turn, borrowed it from Atkinson (1973). The example features a variation of the classical Robinson Crusoe model with a second individual, whom we may call Friday, and whose consumption depends only on what is redistributed from Robinson's output. When redistribution is based on distortionary taxation, Robinson's labor supply decision will be affected in such a way that total output will be lower than what is available using lump-sum taxation.

To capture the extent of the efficiency loss, we distinguish three conditions based on the theoretical effects of taxation on Robinson's labor supply and, consequently, the output available for redistribution. In the *Baseline condition*, there is no efficiency loss because we assume that lump-sum taxation is used. When we suppose that, instead, distortionary taxation is used, we consider two conditions, *Low* and *High Efficiency Loss condition*, which differ in the intensity of labor supply, hence output, reduction.

In addition to the efficiency loss, we vary the veto power of responders regarding the proposed distribution of the monetary amount, which corresponds to the theoretical output as measured in the model. To this end, we use three classical games with a dyadic proposer-responder interaction: *Ultimatum Game*, *Impunity Game*, and *Dictator Game*. Using the strategy vector method, each participant, in the role of proposer, states the claimed percentage of what is available and, in the role of a responder, sets a minimum acceptance threshold.[1] This proposer–responder setup mirrors real-world scenarios in which one agent's allocation directly affects another's welfare, and potential vetoes create a tradeoff between equity and efficiency. Having participants assume both roles provides a comprehensive view of behavior, enabling the assessment of consistency between equity-oriented

[1]The strategy vector method captures a complete set of strategies for each possible offer, allowing precise measurement of equity concerns, strategic behavior, and the impact of veto power without confounding effects from repeated sessions or learning.

and efficiency-oriented choices, the effects of efficiency loss, and the veto power. Therefore, each participant decides in all games, in both roles, and in two of the three conditions: either Baseline and Low Efficiency loss or Baseline and High Efficiency loss. Therefore, the Low and the High Efficiency Loss conditions vary between subjects, whereas the other experimental features vary within subjects.

Overall, our design introduces two key innovations. First, by varying the baseline and the efficiency loss conditions within subjects, we can examine directly how individuals respond to the equity-efficiency tradeoff. Moreover, by varying the extent of the efficiency loss between subjects, we can analyze how the severity of the efficiency loss affects the preferences for redistribution. We expect that, regardless of other contextual factors, the occurrence of efficiency loss will lead participants to shift away from fairness preferences and adopt efficiency-oriented behaviors to minimize resource waste; an effect that intensifies as efficiency loss rises.

Second, we enrich our design by analyzing how the same individual responds to a given efficiency loss condition across three sequential game types: Ultimatum game, Impunity game, and Dictator game. To the best of our knowledge, this is the first study to simultaneously examine the effects of increasing efficiency loss while varying game types within a combined within-subject and between-subject framework. By structuring the games with decreasing veto power of the responder, we expect a progressive shift toward efficiency-seeking behaviors as proposers gain greater control. This tendency is contemplated across all efficiency loss conditions, with a more pronounced effect as the efficiency loss increases.

Interestingly, through this analysis of increasing levels of efficiency loss alongside changes in agents' veto power, we are able to construct a persistency index in order to understand how much of the decision-making process of favoring fairness over efficiency, and vice versa, is driven by contextual effects and how is being rooted in an intrinsic behavioral trait that is unaffected by the context.

Furthermore, this unique combination of loss intensities and game types establishes a temporal structure in decision-making that cannot be overlooked. By comparing an immediate exposure to efficiency loss (from the first decision) with a delayed exposure, we expect that individuals who experience a substantial efficiency loss at the beginning of the game will later be more inclined to a fair division of resources compared to those who encounter efficiency loss only after having already made their choices under baseline condition (with no efficiency loss).

The remainder of the chapter is organized as follows. Section 3.2 discusses the relationship between our work and the existing literature. Section 3.3 reports the benchmark model. Section 3.4 describes the experimental design and its implementation. Section 3.5 introduces the behavioral hypotheses and presents the main descriptive analyses supporting them. Section 3.6 reports the regression results. Section 3.7 concludes.

3.2 Related literature

This chapter relates to the vast literature that seeks to understand the distributional preferences between equity and efficiency, and whether and to what extent such differences are related to the dimension of efficiency loss and the type of game experienced.

Several studies have fruitfully investigated, through a variety of approaches – theoretical models, laboratory and field experiments, and survey data – how people manage the tension between advocating for equity and striving to maximize efficiency in redistributive settings (see, e.g., Okun, 1975, Andreoni and Miller, 2002, Fisman et al., 2007, Hong et al., 2015, Ambec et al., 2019, Stantcheva, 2021).

Okun (1975) was among the first to raise this issue, with his emblematic metaphor of a "leaky bucket",[2] capturing the idea that any redistributive policy inevitably involves a tradeoff between equity and efficiency due to implementation costs or other frictions.

From an experimental perspective, a key contribution comes from Andreoni and Miller (2002), who first proposed varying the price of redistribution within a dictator game to isolate the equity-efficiency tradeoff. Applying revealed preference theory, they show that individuals display heterogeneous redistributive preferences: only 22.70% are perfectly selfish, while 14.20% are equity-dominated, and 6.20% are efficiency-dominated. Likewise, Fisman et al. (2007) build on Andreoni and Miller (2002) by introducing a computer-based experimental tool, a graphical point-and-click interface, that enables the collection of more detailed individual-level data. Their findings reinforce the heterogeneity of distributive preferences by distinguishing between the preferences for giving (tradeoffs between one's own payoff and others') and the social preferences (tradeoffs between others' payoffs). Moreover, replicating the experiment of Fisman et al. (2007) comparing Yale Law School students with participants from the American Life Panel (in short, ALP), Fisman et al. (2015b) argue that the equity-efficiency tradeoff is influenced by educational attainment. They find that higher education is associated with a stronger preference for efficiency: 79.8% of Yale students prioritized efficiency, compared to 49.8% of ALP participants. Moreover, the study shows that experimental measures of equity-efficiency preferences can predict career choices: Yale students pursuing nonprofit careers tended to favor equity, while those entering the corporate sector leaned toward efficiency. In related work, Fisman et al. (2017) use the same experimental methodology to estimate the impact of distributional preferences on voting behavior in the US, indicating that those with an equity-seeking stance are more likely to support pro-redistributive policies (as those done by the Democratic party). Consistent findings are reported in a follow-up longitudinal study, where Fisman et al. (2023) examine the intertemporal stability of these distributional preferences by comparing responses from the same pool of subjects three years apart, in 2013 and 2016.[3] They notice that the preferences observed in 2013 serve as a robust predictor of those in 2016, underscoring the enduring nature of individuals' equity-efficiency tradeoff despite external factors. A further investigation of this individual's preference stability in real-world situations using the same experimental methodology is presented in Fisman et al. (2015a), where the authors explore how the economic downturn of the Great Recession has influenced individuals' attitudes and behaviors regarding wealth redistribution, evidencing a shift in people's orientation toward equity during positive economic situations. In contrast, during or after economic crises, especially when recessionary conditions prevail, there is an inclination toward efficient redistribution.

Hong et al. (2015) extend the model of Andreoni and Miller (2002) by examining the equity-efficiency tradeoff from the perspective of an uninvolved social planner allocating resources between two anonymous recipients in a generalized dictator game. Their findings confirm the heterogeneity of preferences and reveal a general decline in sharing as the cost of giving increases, particularly when individuals are most sensitive to changes in cost. Furthermore, individual characteristics, such as

[2] *«Whenever wealth is transferred from the rich to the poor, some of it may "leak" along the way, leading to inefficiencies in the process»* (Okun, 1975).

[3] These years witnessed significant changes in economic, political, and cultural events in the US, providing insight into the enduring nature of individuals' perspectives on the equity-efficiency tradeoff.

gender, age, and socio-political context, significantly influence preferences for equity over efficiency. These results align with Amiel et al. (1999), who argue that equity-seeking behavior among social planners is shaped by socio-cultural context.[4] The connection between individuals' preferences for equity over efficiency and their socio-economic characteristics (such as income, age, and education) is further examined in a survey experiment by Stantcheva (2021), which focuses on the impact of tax policy on distributional preferences. The study finds that these preferences significantly influence political choices, with higher-income and older individuals more inclined to favor efficiency and less redistributive policies, while more educated individuals support policies that promote redistribution.

Furthermore, decision-making power plays a crucial role in wealth redistribution, with efficiency-seeking behaviors being more prominent when no backlash is possible from the other side (Güth et al., 2010), and more equitable offers when the responder's veto power significantly influences the proposer's outcomes (Rodriguez-Lara, 2016). Then, the origin of the income being redistributed is another important factor influencing the equity-efficiency tradeoff. Individuals tend to be more equity-seeking when redistributing earnings that belong to others (Jakiela, 2013). However, when individuals are required to sacrifice their resources, they are more willing to sacrifice their gains for equity than for efficiency (Bolton and Ockenfels, 2006). Moreover, the setting in which redistribution occurs is pivotal. Ambec et al. (2019) demonstrate that participants exhibit more efficiency-seeking behavior in cooperative settings compared to non-cooperative ones, while the equity-efficiency tradeoff becomes less clear in ambiguous situations. Overall, individuals prioritize personal gain over fair redistribution as the stakes rise and the size of potential losses increase (Andreoni, 1995; Charness and Rabin, 2002). However, pure equity-seeking subjects opt for more equitable outcomes, even at personal cost (Shogren, 1997).

Table 3.A1 in Appendix 3.A provides a summary of the experimental structure of the key studies on the equity-efficiency tradeoff discussed in this brief review of the literature and on which we based our study.

3.3 Benchmark Model

We analyze the equity-efficiency tradeoff using a simplified version of a Robinson Crusoe economy featuring an additional needy individual, whom we may call Friday. The model is adapted from Mas-Colell et al. (1995, page 823).

3.3.1 The model

Consider an economy with two individuals, X (Robinson) and Y (Friday), and two commodities leisure, l, and consumption good, c. The initial endowment of leisure is normalized to one, while there is no initial endowment of consumption good. X can work to produce c via a constant returns to scale technology. Y can only consume what is redistributed out of the good produced by X.

Given the constant return to scales in production, the relationship between consumption and time allocation between leisure and work is expressed as $c = 1 - l$, with 1 referring to the total time endowment.[5]

[4]This contrasts with the view of Traub et al. (2009), who suggest that uninvolved planners are inherently more equity-driven than involved ones, often displaying randomized preferences.

[5]Since the total amount of time, which can be allocated either to working or to enjoying leisure, is normalized to 1,

In what follows, we consider the following three quantities: the amount of leisure time enjoyed by X, denoted as l^X, and the amount of the consumption good to X and Y, denoted as c^X and c^Y, respectively.

In this economy, the first-best (Pareto optimal) problem consists in maximizing Y's utility subject to a given level of X's utility $\bar{u}^X$, the feasibility of total consumption, and the constraint on the amount of time devoted to leisure:

$$\begin{aligned} \max_{l^X, c^X, c^Y} \quad & u^Y(c^Y) \\ \text{s.t.} \quad & u^X(l^X, c^X) \geq \bar{u}^X \\ & c^X + c^Y \leq 1 - l^X \\ & 0 \leq l^X \leq 1 \end{aligned} \tag{3.1}$$

We assume that $u^X(\cdot)$ and $u^Y(\cdot)$ are strictly increasing in the amount of consumption good; this implies, in particular, that the first and second constraint in the above problem are binding at a solution. Furthermore, in get a closed form solution, we assume that u^X is quasi-linear with respect to c, i.e.,

$$u^X(l^X, c^X) = v^X(l^X) + c^X,$$

and that $v^X(\cdot)$ is quadratic, i.e.,

$$v^X(l^X) = l^X - \frac{a}{2}(l^X)^2,$$

with $a \geq 1$. Given these simplifying assumptions, from the second constraint one can solve for c^X and substitute it in the first constraint to get:

$$l^X - \frac{a}{2}(l^X)^2 + (1 - l^X - c^Y) = \bar{u}^X,$$

which, in turn, can be solved for c^Y to get:

$$c^Y = 1 - \bar{u}^X - \frac{a}{2}(l^X)^2.$$

Finally, this expression can be substituted in $u^Y(\cdot)$ to get that (3.1) is equivalent to:

$$\begin{aligned} \max_{l^X} \quad & u^Y\left(1 - \bar{u}^X - \frac{a}{2}(l^X)^2\right) \\ \text{s.t.} \quad & 0 \leq l^X \leq 1 \end{aligned}$$

Given monotonicity and the fact that of $u^Y(\cdot)$ decreases with l^X, the (first-best) amount of leisure is $l^X_{\mathtt{fb}} = 0$.

Now, suppose that X has to decide the amount of work and consumption to maximize his utility; suppose also that part of the consumption good he produces is seized via a lump-sum tax T, with $T \in [0, 1]$, so that it can be redistributed to Y via $c^Y = T$. In this case, the maximization problem of

one has that $1 - l$ is the labor input and, because of the constant returns to scale technology, $c = 1 - l$ is the output of consumption good.

X is written as follows:

$$\begin{aligned} \max_{l^X, c^X} \quad & u^X(l^X, c^X) \\ \text{s.t.} \quad & c^X + l^X \leq 1 - T \\ & 0 \leq l^X \leq 1 \end{aligned} \tag{3.2}$$

Since we maintain the assumption on $u^X(\cdot)$ and $v^X(\cdot)$, and since the first constraint is binding at a solution, one can use it to get $c^X = 1 - l^X - T$, which can be substituted into the objective function to get that (3.2) is equivalent to:

$$\begin{aligned} \max_{l^X} \quad & 1 - \frac{a}{2}(l^X)^2 - T \\ \text{s.t.} \quad & 0 \leq l^X \leq 1 \end{aligned}$$

The solution, therefore, is $l^X_T = 0$, hence $c^X_T = 1 - T$. In this case, one has $l^X_T = l^X_{\mathtt{fb}}$, so that the lump-sum taxation does not distort X's labor supply and the total output is, therefore, equal to one.

Let $\pi_T = 1$ denote the *size of the pie* available for redistribution under the lump-sum tax T; in this case, one has that

$$\begin{aligned} c^X_T &= \pi_T - T \\ c^Y_T &= T \end{aligned} \tag{3.3}$$

Now, suppose that, instead of lump-sum taxation, X is subject to a proportional tax t, with $t \in [0, 1]$, on the output he produces, so that part of it can redistributed to Y via $c^Y = t(1 - l^X)$. In this case, the maximization problem of X is written as follows:

$$\begin{aligned} \max_{l^X, c^X} \quad & u^X(l^X, c^X) \\ \text{s.t.} \quad & c^X \leq (1 - t)(1 - l^X) \\ & 0 \leq l^X \leq 1 \end{aligned} \tag{3.4}$$

From the first constraint, one gets $c^X = (1-t) - (1-t)l^X$, which can be substituted into the objective function to get that (3.4) is equivalent to:

$$\begin{aligned} \max_{l^X, c^X} \quad & l^X - \frac{a}{2}(l^X)^2 + (1 - t) - (1 - t)l^X \\ \text{s.t.} \quad & 0 \leq l^X \leq 1 \end{aligned}$$

After simplifying the objective function, one gets:

$$\begin{aligned} \max_{l^X, c^X} \quad & tl^X - \frac{a}{2}(l^X)^2 + (1 - t) \\ \text{s.t.} \quad & 0 \leq l^X \leq 1 \end{aligned}$$

The (interior) solution is, which is found by solving the equation $t - al^X = 0$, is equal to:[6]

[6] This solution is admissible since $a \geqslant 1$.

$$l_t^X = \frac{t}{a} \tag{3.5}$$

Since $l_t^X > 0 = l_T^X$, labor supply is distorted and the amount of consumption good produced, and available for redistribution, is lower than the (first-best) amount which is produced with lump-sum taxation.

To get some intuition about this results, observe that, as t increases, an *income effect* and a *substitution effect* occur. Specifically, when t rises, X's (real) income decreases because part of the lump-sum tax. Since leisure is a normal good, this implies that X lowers his consumption of leisure. At the same time, as t increases, leisure becomes relatively cheaper compared to consumption. This implies that X substitutes c^X with l^X. Due to the quasi-linearity of u^X, the latter (substitution) effect outweighs the former (income) effect. As a result, when t increases, so does the demand for leisure, which results in a decline of labor supply; this, in turn, implies that the output available for redistribution, i.e., $1 - l_t^X$, decreases.

Let $\pi_t = 1 - l_t^X \in [0, 1]$ denote the *size of the pie* available for redistribution under the proportional tax rate t; in this case, one has that

$$\begin{aligned} c_t^X &= (1-t)\pi_t \\ c_t^Y &= t\pi_t \end{aligned} \tag{3.6}$$

Therefore, it is apparent from (3.6) that the tax rate t determines *simultaneously* the pie size π_t and its distribution via the share $(1-t)$ to X and the share t to Y. This means that, in this case, it is not possible to disentangle the extent of the redistribution from the amount to be redistributed, differently from what happens with lump-sum taxation. This feature is the key to the equity-efficiency tradeoff implied by this model; to better see this point, one can rewrite the pie size as follows:

$$\pi_t = 1 - \frac{t}{a} = \frac{a-t}{a} = \frac{a-1}{a} + \frac{1-t}{a} \tag{3.7}$$

It follows from (3.7) that π_t *increases* with $(1-t)$, i.e., with the share of the pie which accrues to X; equivalently, π_t *decreases* with t, i.e., with the share of the pie which accrues to Y. This result summarizes the equity-efficiency tradeoff stemming from the model: with proportional taxation, the pie size, via X's labor supply, and its distribution are jointly determined by the tax rate. When t decreases, both the pie size and X's share increase, and the opposite occurs when t increases.

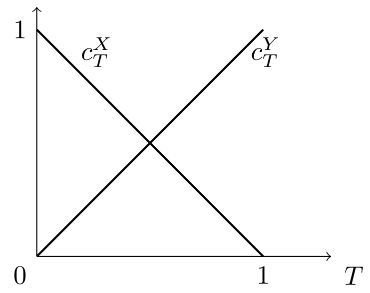
3.3.2 A graphical illustration of the pie size and its distribution

To illustrate the possible combinations of the pie size and its distribution (c^X, c^Y), we consider three scenarios upon which the experimental design will be based.

The *Baseline* case. Assume lump-sum taxation. Since the tax rate T does not distort the labor-leisure decision, π_T is equal to one for any $T \in [0, 1]$, and one has $c_T^X = 1 - T$ and $c_T^Y = T$. The possible distribution constellations are illustrated in Figure 3.1.

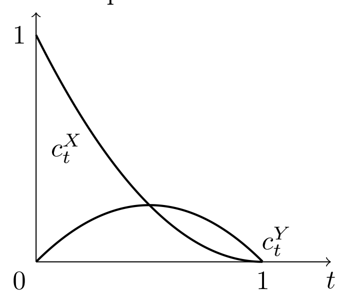
The *High Efficiency Loss* case. Assume proportional taxation and let $a = 1$, so that one has $l_t^X = t$ and $\pi_t = 1 - t$. This implies that $c_t^X = (1-t)^2$ and $c_t^Y = t(1-t)$. Therefore, in this case there is a rather severe equity-efficiency tradeoff: as t increases, c_t^X decreases more rapidly than c_t^Y

Figure 3.1: Lump-sum taxation



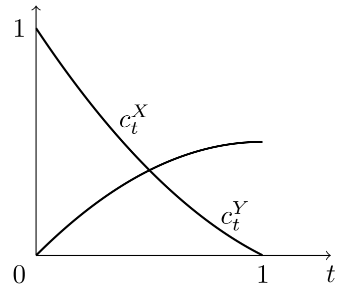
increases; furthermore, for $t > 0.5$, both c_t^X and c_t^Y decrease with t. The distribution constellations for this case are illustrated in Figure 3.2.

Figure 3.2: Proportional taxation and $a = 1$



The *Low Efficiency Loss* case. Assume proportional taxation and let $a = 2$, so that one has $l_t^X = t/2$ and $\pi_t = 1 - t/2$. In this case, labor supply decreases less rapidly with the tax rate t, and so does the size of the pie. Therefore, the equity-efficiency tradeoff is less severe than in the previous case. Specifically, one has that $c_t^X = 1 - 1.5t + 0.5t^2$ and $c_t^Y = t - 0.5t^2 = t(1 - 0.5t)$. The distribution constellations for this case are illustrated in Figure 3.3.

Figure 3.3: Proportional taxation and $a = 2$



To sum up, when there is proportional taxation, the extent of the equity-efficiency tradeoff is affected by the the parameter a, because of its influence on the labor supply: for given t, the higher is a, the larger is the pie size shrinkage, hence the severity of the tradeoff.

3.4 Experimental Design and Procedures

3.4.1 Experimental design

To investigate experimentally distributional preferences subject to the equity-efficiency trade-off, we consider dyadic interactions between a proposer (X) and a responder (Y), where the proposer demands the share d^X, with $d^X \in [0,1]$, of the monetary allotment π, whose amount may, or may not, depend on d^X. Specifically, we consider three experimental conditions: Baseline (henceforth, B), High (henceforth, H), and Low (henceforth, L) efficiency loss. In condition B, we assume $\pi(d^X) = 1$ for every d^X, so that it features no efficiency loss; while in conditions H and L we assume, for $j = L, H$,

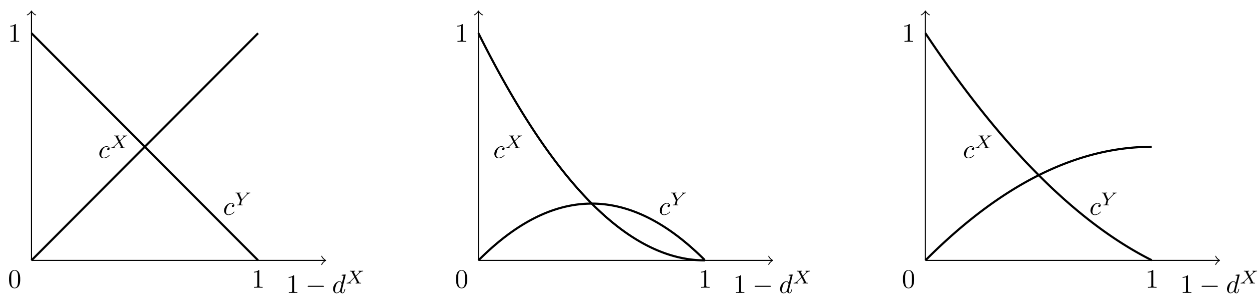
$$\pi(d^X) = \frac{a^j - 1}{a^j} + \frac{d^X}{a^j}, \tag{3.8}$$

with $a^H = 1$ and $a^L = 2$. Given d^X, the distribution of the monetary amounts potentially accruing to the proposer and the responder is

$$\begin{aligned} c^X &= d^X \pi(d^X) \\ c^Y &= (1 - d^X)\pi(d^X) \end{aligned} \tag{3.9}$$

Figures 3.4 illustrates the distribution (c^X, c^Y) in the three conditions.

Figure 3.4: The Experimental Conditions



(a) Condition B **(b) Condition H** **(c) Condition L**

While the monetary amount to be shared and its distribution depend only on d^X, if at all, the actual payoff of the proposer and the responder depend on whether they agree to (c^X, c^Y) or not. Specifically, we implement the dyadic interaction as either an Ultimatum Game (henceforth, UG), an Impunity Game (henceforth, IG), or a Dictator Game (henceforth, DG). To this end, responders state a minimum acceptance threshold d^Y, with $d^Y \in [0,1]$, so that we define $\delta(d^X, d^Y)$ as follows:

$$\delta(d^X, d^Y) = \begin{cases} 1 & \text{if} \quad d^X + d^Y \leq 1 \\ 0 & \text{if} \quad d^X + d^Y > 1. \end{cases}$$

When $\delta(d^X, d^Y) = 1$, there is agreement, since the demands of proposer and responder are compatible; when instead $\delta(d^X, d^Y) = 0$, there is disagreement, since the demands are not compatible. Therefore, given (d^X, d^Y), the payoff by role and by game is summarized in Table 3.1.

Table 3.1: Payoff by role and by game

	UG	IG	DG
Proposer (X)	$\delta(d^X, d^Y)c^X$	c^X	c^X
Responder (Y)	$\delta(d^X, d^Y)c^Y$	$\delta(d^X, d^Y)c^Y$	c^Y

In the experimental implementation of our design, we discretize the choice set by assuming $d^X, d^Y \in \{0\%, 10\%, ..., 100\%\}$. Furthermore, we scale up the initial allotment to 100 tokens, so that, depending on the conditions, the amount (in tokens) to be shared is

$$\pi^B(d^X) = 100, \quad \pi^H(d^X) = 100d^X, \quad \pi^L(d^X) = 50 + 50d^X.$$

Participants are faced with (within subjects) all three games in the fixed sequence UG−IG−DG[7] and in two conditions, i.e., B and only one between H and L. To control for order effects, the efficiency loss (EL) comes either *before* or *after* the baseline. Therefore, the experimental design yields four possible treatment combinations. In the *Low EL - After treatment*, participants play the baseline condition first and the low efficiency-loss condition second (B, L). In the *Low EL - Before treatment*, participants encounter the reverse order by playing the low efficiency loss condition first and the baseline condition second (L, B). Likewise, in the *High EL - After treatment*, participants play the baseline condition first and the high efficiency-loss condition second (B, H). In the *High EL - Before treatment*, they experience the reverse order by playing the high efficiency loss condition first and the baseline condition second (H, B).[8] Table 3.2 summarizes these four treatments of our 2x2 design.

Table 3.2: Treatments

	Low EL	*High EL*
After	(B, L)	(B, H)
Before	(L, B)	(H, B)

Since participants are confronted with each game under two conditions, there are in total six consecutive phases: for $i = 1, 2, 3$, phase i and $i + 3$ correspond to UG, IG, and DG, respectively; furthermore, phases $1 - 3$ correspond to the first condition (either B, H, or L) and phases $4 - 6$ to the second condition in the treatment. Moreover, we use the strategy vector method to elicit (d^X, d^Y) for each participant: in each game, they decide first as proposers and then as responders. Thus, each participant makes twelve decisions.

[7]The sequence reflects decreasing veto power of the responder, who yet retains "voice" in every game. This is consistent with previous studies showing that responder voice influences proposer behavior, even when it does not directly impact redistribution outcomes (see, e.g., Yamamori et al., 2008; Langenbach and Friehe, 2023). In DG, where the payoff of participants depends only on d^X, responders' choices still serve as an expression of their distributional preferences.

[8]Please, remember that each participant only participates in one of these four treatments (between subjects).

3.4.2 Participants and procedures

Experiments were conducted at the CESARE Lab of LUISS Guido Carli University (Rome, Italy), and involved a sample of 148 graduate and undergraduate students from different fields of study (42.57% Economics, 21.62% Law, 20.95% Political Science, 14.86% Other). The sample consisted of 44.59% of male participants and 55.41% of female participants, with an average age of 21.38 years. Participants were recruited using *ORSEE software* (Greiner, 2015).

Each subject participated in only one session, and all sessions were conducted using *z-Tree software* (Fischbacher, 2007). Two sessions were held for each treatment, with the number of participants per session ranging from 16 to 22. Specifically, 72 participated in the sessions with condition L and 76 in those with condition H; clearly, all 148 participated in condition B. Each session lasted approximately 75 minutes and followed identical procedures, as described below.

At the beginning of the experiment, participants received general written instructions that were read aloud to ensure common knowledge. At the beginning of each phase, participants then received specific written (and verbal) instructions,[9] and answered two control questions to check their understanding of the specific features of the phase. There was no feedback throughout the experiment.

At the end of the experiment, participants were paired and informed of their (random) role assignment, which was used only for payment purposes. Furthermore, one of the (equally likely) six phases was randomly selected and, after completing a post-experimental questionnaire, participants were paid based on their own and the paired subject's decision (with 1 token = 0.40 €). The average earning was equal to 21.32 €, including 5 € as a show-up fee.

3.5 Descriptive analyses

In this section, we present the main descriptive analyses of participants' choices as proposers and as responders, pooled across conditions. To this end, we propose three behavioral hypotheses based on existing theoretical and experimental evidence and discuss whether our descriptive data support them.

3.5.1 Behavioral Hypotheses

As detailed in Section 3.2, several studies have shown that individuals face a persistent tradeoff between equity and efficiency when making resource allocation decisions, finding that as potential efficiency losses increase, participants prioritize avoiding the loss of surplus over ensuring an equitable distribution (see, e.g., Andreoni, 1995; Charness and Rabin, 2002). For instance, Andreoni and Miller (2002) demonstrates that, in the Dictator game, participants adjust their allocations in response to the cost of giving. Extending this reasoning to the Impunity and Ultimatum games, we formulate our Hypothesis 1.

Hypothesis 1 *Efficiency-seeking behavior, both as a proposer and as a responder, increases with potential efficiency loss, regardless of game type.*

Under this hypothesis, our goal is to expand the existing evidence on efficiency-seeking behavior to include not only the proposer's perspective, which is well documented in the literature, but also

[9] All instructions were read aloud by the same experimenter to maintain consistency and avoid variability across sessions. See Appendix 3.B for the English translation of the instructions.

the responder's perspective. The latter is often overlooked in previous studies, yet it plays a crucial role, particularly when considering the responder's veto power.

Experimental evidence shows that when responders can reject allocations, proposers are more likely to make equitable offers (Crosetto and Güth, 2021; Güth and Huck, 1997; Güth et al., 1982; List, 2007). Conversely, limited veto power allows proposers to favor efficiency over fairness (Güth et al., 2010; Rodriguez-Lara, 2016). These studies motivate our Hypothesis 2.

Hypothesis 2 *Equity-seeking behavior, both as a proposer and as a responder, increases with the responder's veto power, regardless of the condition.*

We expect to confirm this equity-seeking behavior for all levels of efficiency loss (i.e., baseline, low efficiency loss, and high efficiency loss), as the responder's ability to veto allocations provides a strong incentive for proposers to maintain fairness, even when efficiency considerations might otherwise dominate. When the responders' veto power diminishes, in games like Dictator and Impunity, efficiency-seeking behavior dominates from the proposer side. In contrast, equity-seeking behavior is more likely to persist when the responder retains meaningful veto power, such as in the Ultimatum Game, where both parties' outcomes are interdependent. Therefore, the balance between efficiency and equity considerations is shaped by the degree of agency and influence granted to the responder, as individuals adjust their preferences in response to the perceived power dynamics in the interaction.

Although these exogenous factors influence preferences for equity or efficiency, their endogenous nature also plays a pivotal role, as they are shaped by intrinsic factors such as individual values, beliefs, and social norms. Studies by Fehr and Schmidt (1999), Camerer (2011), and Hong et al. (2015) indicate that individuals prioritize fairness, even when there is a high loss of efficiency or the responder has limited veto power, due to heterogeneity in distributional preferences. This heterogeneity has been correlated with socio-demographic characteristics, including age, gender, education, and political attitudes (Amiel et al., 1999; Jakiela, 2013; Stantcheva, 2021). This leads to formulating our Hypothesis 3.

Hypothesis 3 *Equity-seeking individuals exhibit consistent behavior, regardless of efficiency loss or level of veto power in the game.*

3.5.2 Proposer behavior

Proposers' reactions to the equity-efficiency tradeoff vary significantly across conditions and game types. Table 3.3, which shows the average d^X by condition (per row) and game type (per column), provides an initial summary of these differences:

Table 3.3: Average d^X by condition and game

	UG	IG	DG
B	54.93	84.86	83.58
L	54.17	86.81	85.97
H	58.03	81.59	85.26

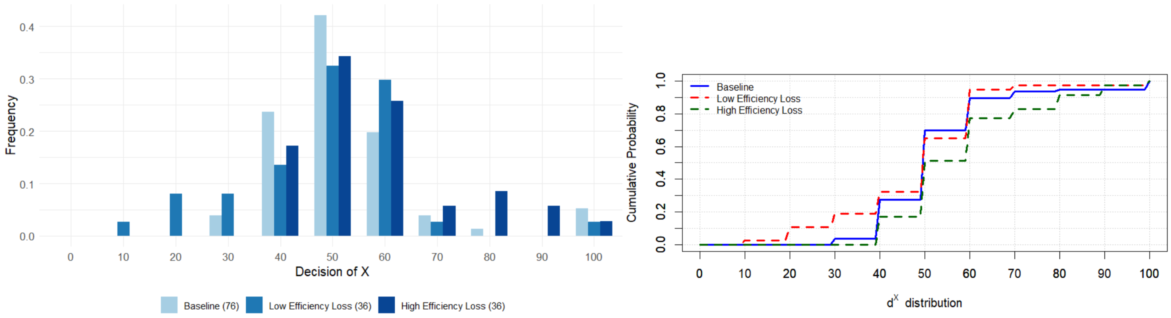
Therefore, in the following paragraphs, we present the main results by game and efficiency loss condition, aggregating the data by treatment order (Before vs. After Efficiency Loss), since no significant order effects were found in proposer responses. Table 3.A2 in Appendix 3.A reports the main results.[10] Furthermore, socio-demographic characteristics are largely homogeneous across the two treatments (see Table 3.A3, Appendix 3.A).

First choice. Before going in depth with our analysis, to capture proposer unconditioned response to the equity-efficiency tradeoff, we isolate the first decision stage, i.e., the choice made in the *Ultimatum Game*, under condition B in the *After Efficiency Loss treatment* and under condition L or H in the *Before Efficiency Loss treatment*.

The average choice is 52.63 in condition B, 48.38 in condition L, and 58.29 in condition H. The difference with condition B is statistically significant when the efficiency loss is high (t = -1.851, p = 0.067), but not when it is low (t = 1.387, p = 0.168). Additionally, there is a significant difference when confronting the two types of efficiency loss (t = -2.606, p = 0.011). Modal demand is 50% under each condition – about two-fifths of their choices are equity-seeking, regardless of the condition, while less than 5% of choices are efficiency-seeking Overall, the (cumulative) distributions show the highest share in the middle interval 50-60, for all conditions.

[10] The only statistically significant order effect is observed when comparing condition L of the Ultimatum Game. However, this effect alone is not enough to admit the existence of an order effect.

Figure 3.5: First choice d^X



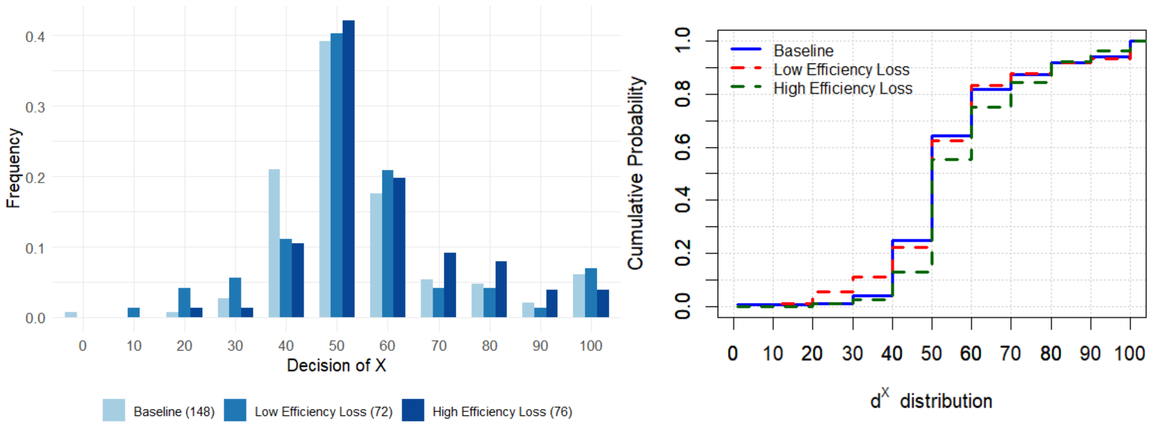
(a) Frequency **(b) Cumulative Distribution**

Note: Frequency and cumulative distribution of d^X first choice. *Baseline* includes 76 subjects, while *Low Efficiency Loss* and *High Efficiency Loss* include 36 and 36 subjects, respectively.

Game type. Using Figures 3.6–3.8, we analyze how these choices vary across conditions for a given game type.

Ultimatum Game: the average choice is 54.93 in condition B, 54.17 in condition L, and 58.03 in condition H. The difference with condition B is statistically significant (t = 1.493, p = 0.070) when the efficiency loss is high, but not when it is low (t = -0.448, p = 0.672). In every condition, the proposers' modal demand is 50% – about two-fifths of their choices are equity-seeking, in that they imply an equal division of the pie regardless of the condition, while 40% and 60% are the next most common choices. Less than 7% of choices are efficiency-seeking (d^X = 100%). Overall, the (cumulative) distributions in conditions B and L are quite similar, while condition H shows more selfish choices.

Figure 3.6: Ultimatum Game d^X

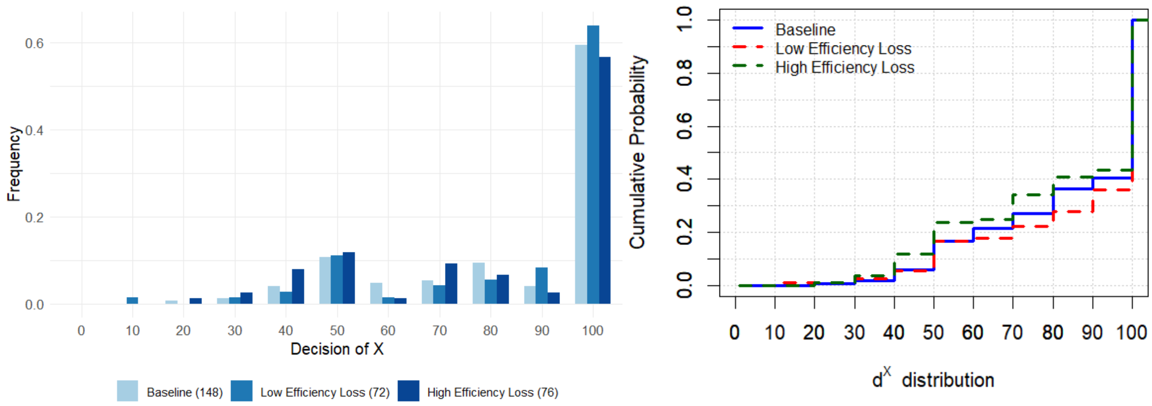


(a) Frequency **(b) Cumulative Distribution**

Note: Frequency and cumulative distribution of d^X choices in UG. *Baseline* includes 148 subjects, while *Low Efficiency Loss* and *High Efficiency Loss* include 72 and 76 subjects, respectively.

Impunity Game: the average choice is 84.86 in condition B, 86.81 in condition L, and 81.59 in condition H. The difference with condition B is not statistically significant compared to both condition L (t = 0.199, p = 0.421) and condition H (t = -0.729, p = 0.766). In every condition, the proposers' modal demand is 100% − about three-fifths of their choices are efficiency-seeking, implying a preservative behavior toward self-interest regardless of the condition. The next common choice in all conditions is 50% − no more than 12% of their choices are equity-seeking. Overall, the (cumulative) distributions show the highest share in the upper interval 90-100 for all conditions.

Figure 3.7: Impunity Game d^X

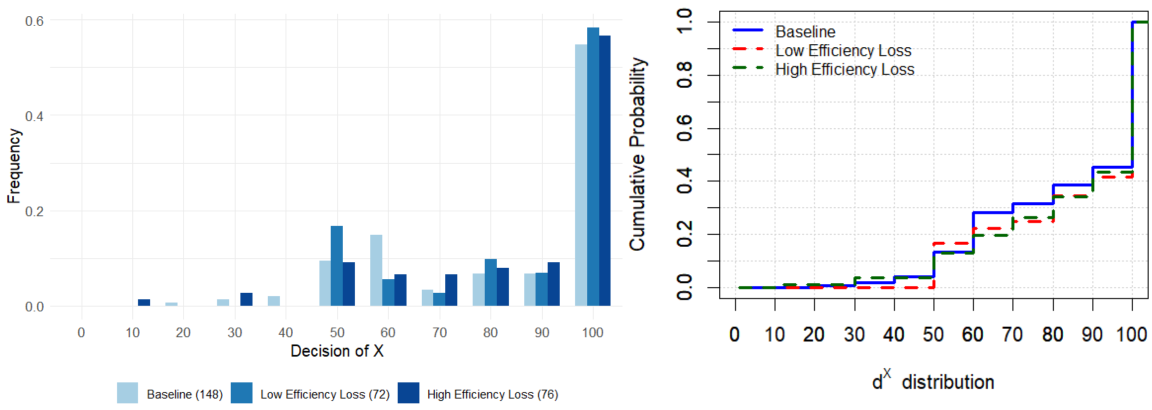


(a) Frequency **(b) Cumulative Distribution**

Note: Frequency and cumulative distribution of d^X choices in IG. *Baseline* includes 148 subjects, while *Low Efficiency Loss* and *High Efficiency Loss* include 72 and 76 subjects, respectively.

Dictator Game: the average choice is 83.58 in condition B, 85.97 in condition L, and 85.26 in condition H. The difference with condition B is slightly statistically significant compared to condition H (t = 1.451 and p = 0.076), but not with condition L (t = 0.456 and p = 0.325). In every condition, the proposers' modal demand is 100% − about three-fifths of their choices are efficiency-seeking, implying a preservative behavior toward self-interest regardless of the condition. The next common choices are 60 in condition B (14.86%) and 50 in condition L (16.67%), indicating a more equity-seeking behavior, while it is 90 in condition H (9.21%), suggesting a more efficiency-seeking behavior. Overall, the (cumulative) distributions absorb more than half of the observations in the upper interval 90-100 under all conditions.

Figure 3.8: Dictator Game d^X



(a) Frequency **(b) Cumulative Distribution**

Note: Frequency and cumulative distribution of d^X choices in DG. *Baseline* includes 148 subjects, while *Low Efficiency Loss* and *High Efficiency Loss* include 72 and 76 subjects, respectively.

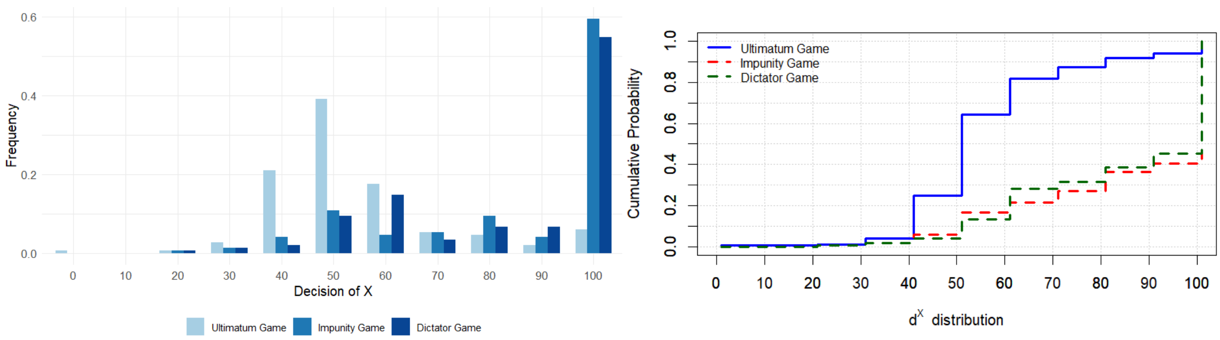
Result 1*: Efficiency-seeking behavior increases as the equity-efficiency trade-off worsens. However, there are differences between game types. In particular, increasing efficiency loss leads to only minimal shifts towards efficiency-seeking behavior in UG, while the shift is more pronounced in IG and DG.*

Overall, Result 1 partially supports Hypothesis 1.

Efficiency loss intensity. Now, using Figures 3.9-3.11, we explore the equity-efficiency tradeoff by keeping the level of efficiency loss constant while varying the game type.

Condition B: the average choice is 54.93 in UG, 84.86 in IG, and 83.58 in DG. The difference is statistically significant for UG compared to both IG (t = 14.423, p < 0.001) and DG (t = 13.503, p < 0.001), but not when we compare IG and DG (t = -0.798, p = 0.787). The distributions in the three games diverge significantly. In UG, 77.70% is concentrated in the 40-60 range, with a modal choice of 50%. In contrast, in IG and DG, more than 50% of the choices are clustered at 100%. Overall, the (cumulative) distributions show that while UG accumulates mass more evenly across the central deciles (30-60), both IG and DG exhibit relatively flat accumulation up to the 80–90 interval, followed by a sharp increase in the final decile.

Figure 3.9: Baseline (B) d^X

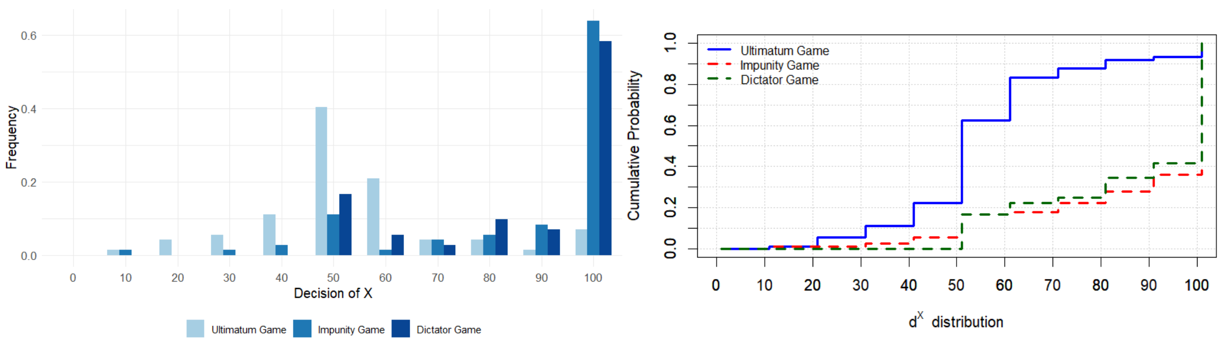


(a) Frequency **(b) Cumulative Distribution**

Note: Frequency and cumulative distribution of d^X choices in condition Baseline (B) with 148 subjects.

<u>Condition L</u>: the average choice is 54.17 in UG, 86.81 in IG, and 85.97 in DG. The difference is statistically significant for UG compared to both IG (t = 10.630, p < 0.001) and DG (t = 10.123, p < 0.001), but not when we compare IG and DG (t = -0.371, p = 0.644). The divergence between the two types of distribution (UG vs. IG and DG) persists – about two-fifths of the choices are the modal choice of 50% in UG, while about three-fifths of the choices are at the modal choice of 100% in IG and DG. Overall, the (cumulative) distributions in IG and DG are quite similar, while UG shows more equity-seeking choices.

Figure 3.10: Low Efficiency Loss (L) d^X

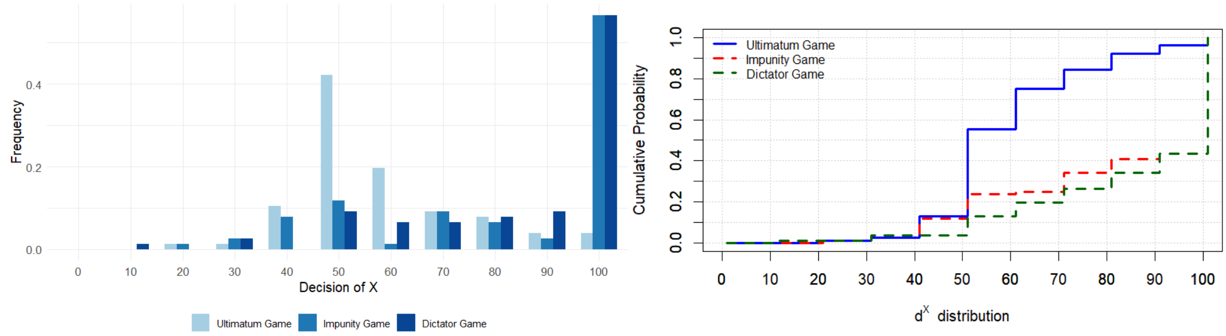


(a) Frequency **(b) Cumulative Distribution**

Note: Frequency and cumulative distribution of d^X choices in condition Low Efficiency Loss (L) with 72 subjects.

Condition H: the average choice is 58.03 in UG, 81.59 in IG, and 85.26 in DG. The difference is confirmed statistically significant for UG compared to both IG (t = 7.452, $p < 0.001$) and DG (t = 9.149, $p < 0.001$). In addition, it is also significant between IG and DG (t = 1.733, p = 0.044). The divergence between the two types of distribution (UG vs. IG and DG) persists, with the same frequencies in the two modes of 50% in UG and 100% in IG and DG. Overall, the (cumulative) distributions in IG and DG are quite similar, while UG shows more equity-seeking choices.

Figure 3.11: High Efficiency Loss (H) d^X



(a) Frequency **(b) Cumulative Distribution**

Note: Frequency and cumulative distribution of d^X−choices in condition High Efficiency Loss (H) with 76 subjects.

Result 2*: For a given condition, the behavior of proposers responds to the veto power of responders. As a result, the share of the pie demanded by the proposers is lower in UG than in IG and DG.*

Overall, Result 2 partially supports Hypothesis 2.

Persistency Index. To assess whether participants' choices as proposers in the baseline and the efficiency loss conditions are consistent, we compute the *persistency index* for proposers, $P(d^X)$. For each game, let $C_i(d^X)$ equal 1 if participant i chooses d^X in both type of conditions and 0 otherwise; furthermore, let $N_B(d^X)$ denote the number of participants who choose d^X in condition B. Then, the persistency index is equal to

$$P(d^X) = \frac{\sum_{i=1}^{N} C_i(d^X)}{N_B(d^X)}, \tag{3.10}$$

We consider the case $P(50)$, i.e., perfectly equity-seeking behavior, as the focal point for our equity-efficiency tradeoff analysis. Table 3.4 shows that the highest persistence of perfectly equity-seeking behavior occurs in UG, possibly due to the responder's veto power being encouraged. Interestingly, similar persistence also occurs in DG, despite the absence of the responder's veto power. This may be motivated by a rather stable preference for equity among these subjects.

Result 3*: Regardless of efficiency loss and veto power, perfectly equity-seeking proposers consistently favor an equal split between parties.*

Overall, Result 3 supports Hypothesis 3.

In addition to proposers who demonstrate persistence in their behavior across conditions, we investigate the responses of those who adjust their choices when efficiency loss occurs. We mainly focus

Table 3.4: Persistency Index d^X

	UG	IG	DG
P(50)	0.55	0.38	0.57

on subjects choosing the fair division of $d^X = 50$ under condition B.[11] In Table 3.5, we observe that in all three games, proposers generally maintain or even increase their preferences when faced with both low and high efficiency loss. In UG, more than half of the proposers consistently uphold their preference for a fair division, regardless of the intensity of the efficiency loss, which aligns with our previous findings from the persistency index. In DG, no participants reduce their preferences. However, behavior varies between the low and high efficiency loss conditions. Under low efficiency loss, proposers show no significant motivation to adjust their preferences toward a more efficient division, with about three-quarters maintaining their original choices. In contrast, when the efficiency loss is high, a more efficiency-seeking behavior emerges, as proposers who increase their demand for a larger share are more than half, likely due to the more substantial reduction in the overall pie size.

Table 3.5: Adjusted d^X from baseline to efficiency loss | $d^X = 50$ in condition B

		UG	IG	DG
No Change	*Low*	0.54	0.25	0.75
	High	0.56	0.50	0.50
Increase	*Low*	0.29	0.50	0.25
	High	0.38	0.38	0.50
Decrease	*Low*	0.17	0.25	0.00
	High	0.06	0.12	0.00

Note: Adjusted preferences in response to (low or high) efficiency loss. *No change* refers to proposers who maintain their equity-seeking behavior; *Increase* and *Decrease* capture a shift toward a higher or lower d^X, respectively.

[11]The opposite extreme of $d^X = 100$ is not considered as the only rational behavior, for a proposer who chooses 100 in condition B, is to maintain this choice under the efficiency loss.

3.5.3 Responder behavior

Responders' reactions to the equity-efficiency tradeoff, as those of proposers, vary significantly across conditions and game types. Table 3.6, which shows the average d^Y by condition (per row) and game type (per column), provides an initial summary of these differences:

Table 3.6: Average d^Y by condition and by game

	UG	IG	DG
B	29.80	18.45	40.47
L	31.53	19.03	37.92
H	31.18	25.53	42.89

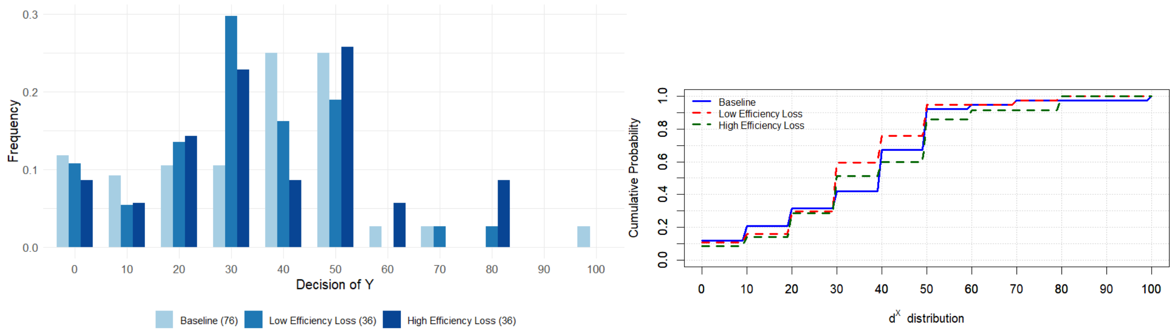
In the following paragraphs, we present the main results by game and efficiency loss condition, with data aggregated by treatment order (Before vs. After Efficiency Loss). No systematic order effects were observed in responder responses. Table 3.A4 in Appendix 3.A reports the results.[12] Furthermore, we recall that socio-demographic characteristics are also largely homogeneous across treatments (see Table 3.A3, Appendix 3.A).

First choice. As with the proposer, to capture responder unconditioned response to the equity-efficiency tradeoff, we isolate the first decision stage, i.e., the choice made in the *Ultimatum Game*, under condition B in the *After Efficiency Loss treatment* and under condition L or H in the *Before Efficiency Loss treatment*.

The average choice is 34.74 in condition B, 32.16 in condition L, and 36.86 in condition H. The difference with condition B is not statistically significant when the efficiency loss is both high (t = -0.485, p = 0.628) and low (t = 0.627, p = 0.532). Furthermore, there is a significant difference when confronting the two types of efficiency loss (t = -0.999, p = 0.321). Modal threshold is fixed at 30% under condition L, at 50% under condition H, while it is between 40% and 50% under condition B − about two-fourth of their choices are equity-seeking. Only around 15% of the choices are efficiency-seeking. Overall, the (cumulative) distributions reach over 90% in the middle interval 50-60 in all conditions.

[12] Statistically significant order effects are limited to condition B of the Ultimatum and Impunity Games, and condition H of the Ultimatum Game. These findings do not indicate a consistent order effect.

Figure 3.12: First choice d^Y



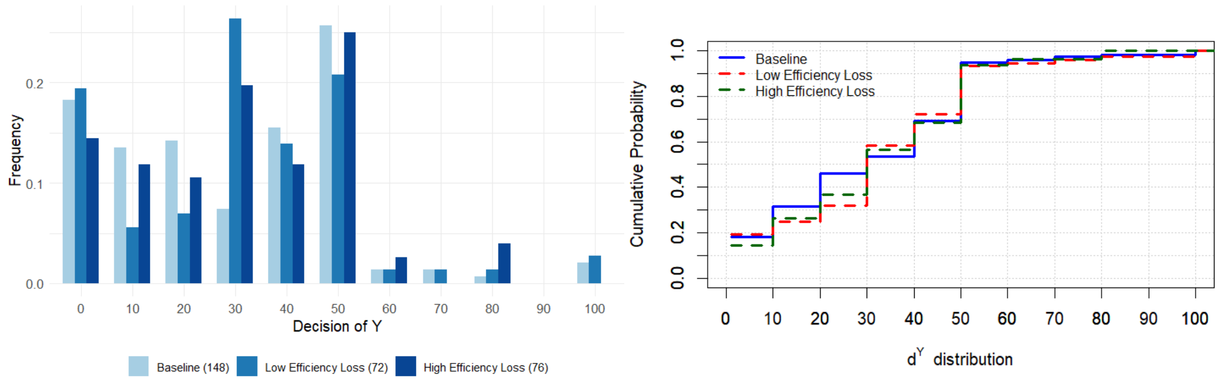
(a) Frequency **(b) Cumulative Distribution**

Note: Frequency and cumulative distribution of d^Y first choice. *Baseline* includes 76 subjects, while *Low Efficiency Loss* and *High Efficiency Loss* include 36 and 36 subjects, respectively.

Game type. Using Figures 3.13–3.15, we analyze how these choices vary across conditions for a given game type.

Ultimatum Game: the average choice is 29.80 in condition B, 31.53 in condition L, and 31.18 in condition H. The difference with condition B is not statistically significant compared to both condition L (t = 0.884, p = 0.190) and condition H (t = 0.205, p = 0.419). The responders' modal demand is 50 under conditions B and H, while it is 30 under condition L – about two-fourth of their choices are equity-seeking. Only around 15% of the choices are efficiency-seeking. Overall, the (cumulative) distributions reach over 90% of the choices at 50% in all conditions.

Figure 3.13: Ultimatum Game d^Y



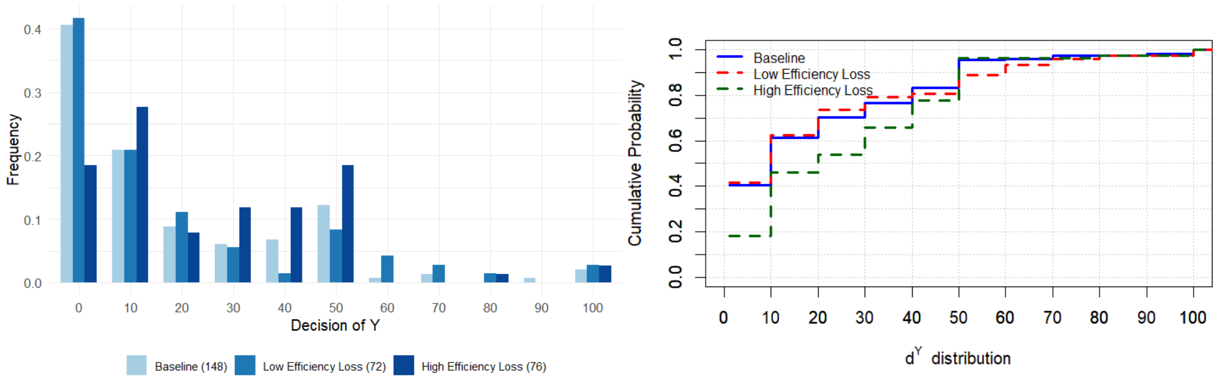
(a) Frequency **(b) Cumulative Distribution**

Note: Frequency and cumulative distribution of d^Y choices in UG. *Baseline* includes 148 subjects, while *Low Efficiency Loss* and *High Efficiency Loss* include 72 and 76 subjects, respectively.

Impunity Game: the average choice is 18.45 in condition B, 19.03 in condition L, and 25.53 in condition H. The difference with condition B is statistically significant compared to condition H (t = 2.163, p = 0.017), but not to condition L (t = 1.011, p = 0.158). The responders' modal demand is 0% in conditions B and L, while it is 10% in condition H, revealing an efficiency-seeking behavior. Only around 15% of the choices are equity-seeking. Overall, the (cumulative) distribution reaches over 70%

of the choices at 50% in all conditions.

Figure 3.14: Impunity Game d^Y

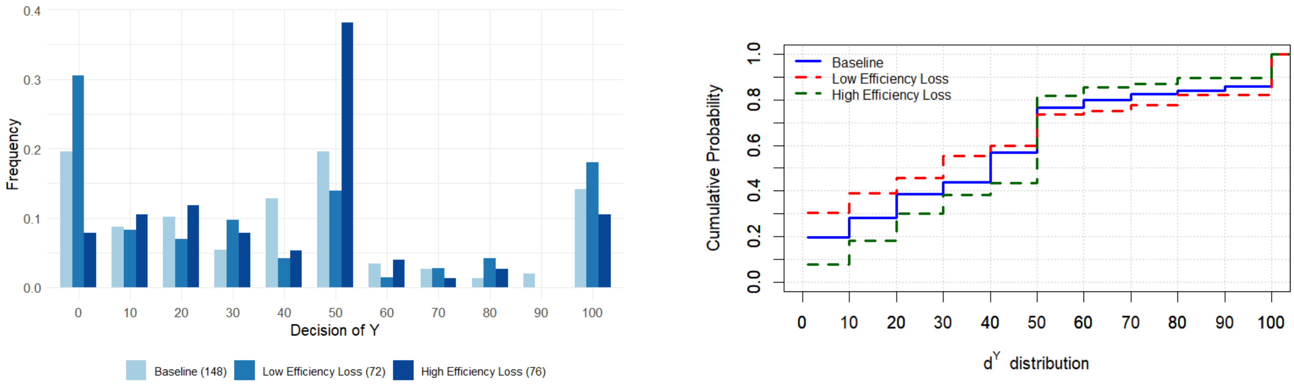


(a) Frequency **(b) Cumulative Distribution**

Note: Frequency and cumulative distribution of d^Y choices in IG. *Baseline* includes 148 subjects, while *Low Efficiency Loss* and *High Efficiency Loss* include 72 and 76 subjects, respectively.

<u>Dictator Game</u>: the average choice is 40.47 in condition B, 37.92 in condition L, and 42.89 in condition H. The difference with condition B is not statistically significant compared to both condition L (t = -0.400, p = 0.655) and condition H (t = 0.539, p = 0.296). The responders' modal demand is 0% in condition L and 50% in conditions B and H – about two-fifths and one-fourth of the choices are efficiency-seeking, respectively. Overall, the (cumulative) distributions show a similar pattern for conditions B and L, while in condition H, there is more equity-seeking behavior.

Figure 3.15: Dictator Game d^Y



(a) Frequency **(b) Cumulative Distribution**

Note: Frequency and cumulative distribution of d^Y choices in DG. *Baseline* includes 148 subjects, while *Low Efficiency Loss* and *High Efficiency Loss* include 72 and 76 subjects, respectively.

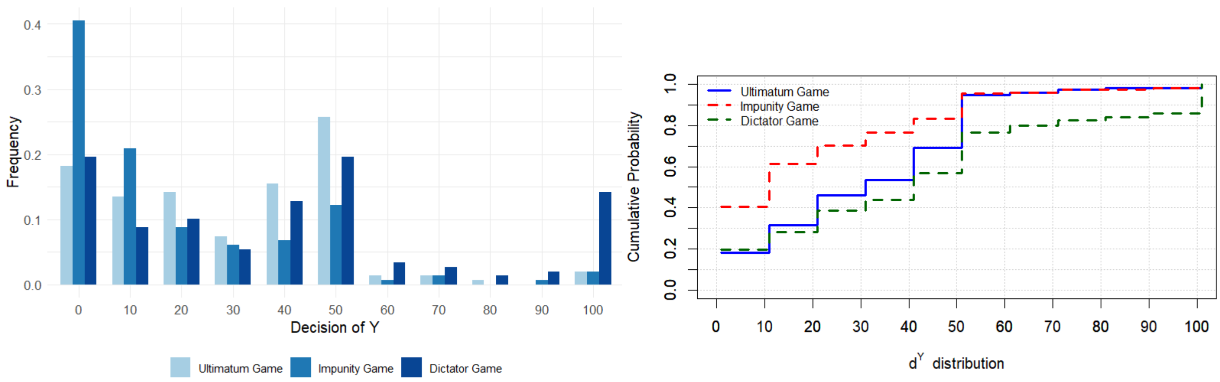
Result 4: *Efficiency-seeking behavior increases as the equity-efficiency tradeoff worsens. However, there are differences between game types. In particular, increasing efficiency loss leads to only minimal shifts toward efficiency-seeking behavior in UG, whereas the shift is more pronounced in IG and DG.*

Overall, Result 4 partially supports Hypothesis 1.

Efficiency loss intensity. Now, in Figures 3.16-3.18, we explore the equity-efficiency tradeoff by keeping the level of efficiency loss constant while varying the game type.

Condition B: the average choice is 29.80 in UG, 18.45 in IG, and 40.47 in DG. The difference is statistically significant when comparing DG with both UG (t = 3.692, $p < 0.001$) and IG (t = 7.562, $p < 0.001$), while it is not significant between UG and IG (t = -5.99, p = 1). The distributions in the three games diverge significantly: in UG 25% of the choices have a modal demand at 50%, while in IG 40% of the choices have a modal demand at 0%. DG reveals a split response pattern, with two peaks at 0% and 50%, suggesting a tension between equity and efficiency concerns. Overall, the (cumulative) distributions reveal more equity-seeking choices in UG and DG compared to IG.

Figure 3.16: Baseline (B) d^Y

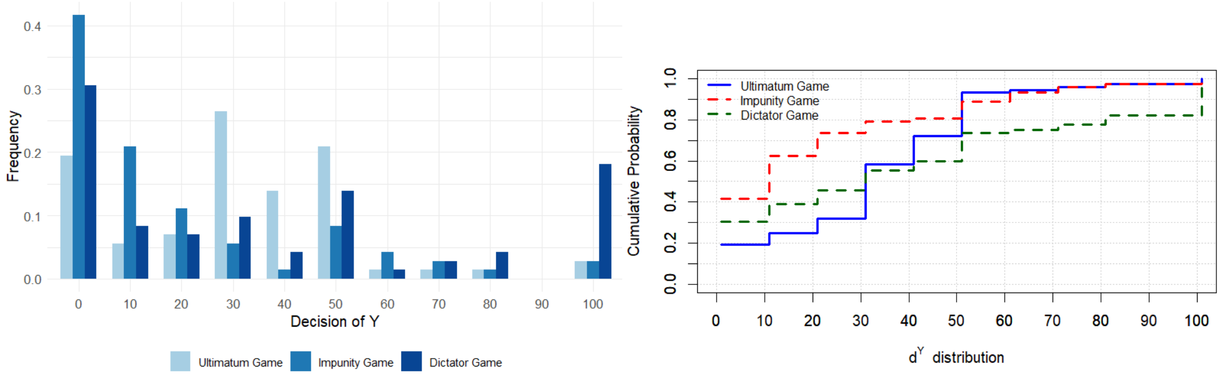


(a) Frequency **(b) Cumulative Distribution**

Note: Frequency and cumulative distribution of d^Y choices in condition Baseline (B) with 148 subjects.

Condition L: the average choice is 31.53 in UG, 19.03 in IG, and 37.92 in DG. The difference is statistically significant when comparing IG with both UG (t = 3.862, $p < 0.001$) and DG (t = 4.100, $p < 0.001$), but not between UG and DG (t = 1.433, p = 0.078). The responders' modal demand is 30% in UG, for about one-fourth of choices, and 0% in both IG and DG, for more than two-fifths and one-fourth, respectively. Overall, the (cumulative) distributions differ significantly among the three games.

Figure 3.17: Low Efficiency Loss (L) d^Y

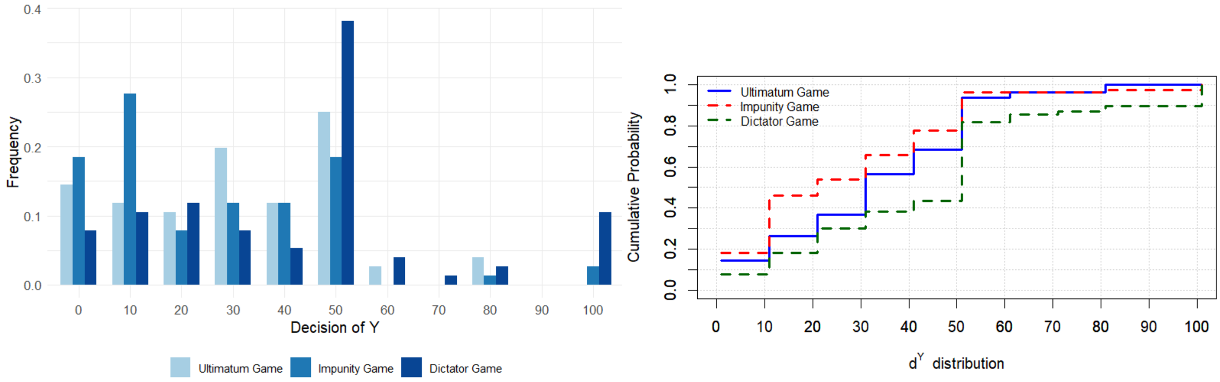


(a) Frequency **(b) Cumulative Distribution**

Note: Frequency and cumulative distribution of d^Y choices in condition Low Efficiency Loss (L) with 72 subjects.

<u>Condition H</u>: the average choice is 31.18 in UG, 25.53 in IG, and 42.89 in DG. The difference is statistically significant when comparing DG with both UG (t = 3.460, p < 0.001) and IG(t = 5.086, p < 0.001), but not between UG and IG (t = -2.167, p = 0.983). The responders' modal demand is 10% in IG, with about one-fourth of choices that are efficiency-seeking, and 50% in UG and DG, with about one-fourth and two-fifths of choices that are equity-seeking, respectively. Overall, the (cumulative) distributions differ significantly among the three games.

Figure 3.18: High Efficiency Loss (H) d^Y



(a) Frequency **(b) Cumulative Distribution**

Note: Frequency and cumulative distribution of d^Y choices in condition High Efficiency Loss (H) with 76 subjects.

Result 5: *For a given condition, responders adjust their choices based on their veto power: under UG, equity-seeking behavior is higher than in IG and DG.*

Overall, Result 5 partially supports Hypothesis 2.

Persistency Index. To assess whether participants' choices as responders in the baseline and the efficiency loss conditions are consistent, we apply the persistency index. As for the proposer, we consider the cases $P(50)$, i.e., perfectly equity-seeking behaviors, as the focal point for our equity-efficiency tradeoff analysis. Results from Table 3.7 reveal that the highest persistence occurs in UG, where the responder's power to reject unfair offers gives them greater confidence to preserve equity-seeking behavior. However, the persistency index is also consistent under IG and DG, with approximately the same consistency.

Table 3.7: Persistency Index d^Y

	UG	IG	DG
P(50)	0.55	0.39	0.41

Result 6*: Regardless of efficiency loss and veto power, perfectly equity-seeking responders consistently favor an equal split between parties.*

Overall, Result 6 supports Hypothesis 3.

Another approach to analyzing responder's behavior across the three games is by examining how their preferences change when transitioning from condition B to condition L or condition H.

In Table 3.8, we look at responders who set their minimum threshold at $d^Y = 50$ in the baseline and evaluate how they adjust their preferences when faced with (low or high) efficiency loss in the three games.[13]

Table 3.8: Adjusted d^Y from baseline to efficiency loss | $d^Y = 50$ in condition B

		UG	IG	DG
No Change	*Low*	0.53	0.57	0.27
	High	0.57	0.27	0.47
Increase	*Low*	0.06	0.29	0.18
	High	0.00	0.00	0.16
Decrease	*Low*	0.41	0.14	0.55
	High	0.43	0.73	0.37

Note: Adjusted preferences in response to (low or high) efficiency loss. *No change* refers to proposers who maintain their equity-seeking behavior; *Increase* and *Decrease* capture a shift toward a higher or lower d^Y, respectively.

Overall, we observe that the frequency of responders increasing their minimum threshold is either very low or nonexistent, regardless of the game type. In UG, more than half of the responders prefer a fair division, reflecting perfectly equity-seeking behavior. In contrast, IG shows two distinct patterns depending on the intensity of efficiency loss. When the loss is low, most responders prefer to maintain their choice, insisting on equity-seeking concerns. However, when the loss is high, the responders decrease their minimum threshold, prioritizing efficiency-seeking behavior. In DG, both options "No change" and "Decrease" exhibit relevant frequencies, suggesting that when the responder

[13] We do not consider the other extreme, $d^Y = 0$, as responders who choose this minimum threshold in condition B would logically maintain that choice when efficiency loss occurs, remaining consistent with their initial preference.

lacks the power to influence the outcome, the chosen minimum threshold is more closely related to the expression of their true preference, regardless of the efficiency loss.

3.5.4 (Dis)Agreement scenarios

As detailed in Section 3.4, the strategy vector method requires each participant to act as both a proposer and a responder for each game type and efficiency loss condition, resulting in six decisions as a proposer and six as a responder throughout the experiment. In this section, we investigate the consistency of decision-making, employing a dual analysis that considers both interpersonal and intrapersonal scenarios (Di Cagno et al., 2023).

Interpersonal scenarios. We analyze how often the responder's demand and the proposer's minimum threshold acceptance result in an agreement or disagreement scenario when each individual interacts with every other participant in the two possible role assignments, per game and condition. Simulating all possible interpersonal scenarios, we have 21.756 (=148×147) scenarios under condition B, 5.112 (=72×71) under condition L, and 5.700 (=76×75) under condition H. In Table 3.9, we observe that UG consistently exhibits the highest frequency of agreement in all conditions, while DG shows the lowest agreement frequencies throughout. In contrast, IG displays a more balanced distribution between agreement and disagreement scenarios, with only moderate changes in conditions.

Table 3.9: Interpersonal Scenarios

		UG	IG	DG
Agreement	*Condition B*	0.80	0.57	0.36
	Condition L	0.79	0.55	0.42
	Condition H	0.75	0.45	0.25
Disagreement	*Condition B*	0.20	0.43	0.64
	Condition L	0.21	0.45	0.58
	Condition H	0.25	0.55	0.75

Note: Relative frequency of interpersonal scenarios per game type and condition. *Agreement* refers to instances where d^X and d^Y do not exceed the total available amount; *Disagreement* is otherwise.

Intrapersonal scenarios. We evaluate how often the proposer's demand and the responder's minimum threshold acceptance result in an agreement or disagreement scenario when each individual acts simultaneously in the two roles, for each game and condition. In Table 3.10, we observe that in UG, agreement scenarios are nearly universal in all conditions. In IG, the frequency of agreements is lower than in UG in all conditions. Furthermore, within the game, as the intensity of efficiency loss increases, agreement scenarios slightly decrease. Similarly, in DG, agreement scenarios drop significantly compared to both UG and IG, and within the game when efficiency loss occurs.

Table 3.10: Intrapersonal Scenarios

		UG	IG	DG
Agreement	*Condition B*	0.92	0.70	0.45
	Condition L	0.89	0.64	0.56
	Condition H	0.89	0.54	0.30
Disagreement	*Condition B*	0.08	0.30	0.55
	Condition L	0.11	0.36	0.44
	Condition H	0.11	0.46	0.70

Note: Relative frequency of intrapersonal scenarios per game type and condition. *Agreement* refers to instances where d^X and d^Y do not exceed the total available amount; *Disagreement* is otherwise.

Result 7: *Efficiency loss significantly influences agreements in both interpersonal and intrapersonal scenarios, varying according to the distribution of veto power between the parties.*

(i) *When both parties influence the total outcome (as in UG), agreement scenarios prevail.*

(ii) *When decision-making power is unilateral (as in IG and DG), agreement scenarios decrease, with the reduction being more pronounced as the influence of the other diminishes (lowest in DG compared to IG).*

3.6 Multiple regression analyses

In this section, we perform Seemingly Unrelated Regression (SUR) analyses to identify the main determinants of participants' choices. The analysis explicitly takes into account the sequential (without feedback) structure of the choice tasks. Recall that participants make decisions in six successive phases, in which they are confronted with the three games in the constant sequence (UG, IG, DG), and in two conditions (B and either L or H). Furthermore, since the sequence of games is kept constant, there is a fixed correspondence between phases and games; specifically, phases 1 and 4 correspond to UG, phases 2 and 5 to IG, and phases 3 and 6 to DG.

Given this sequential structure, the SUR estimates account for the interconnectedness of participants' decisions across games and conditions and, by allowing for correlations in the error terms across phases, improve the precision of the estimates. Specifically, the SUR models that we estimate consist of systems of three equations that account for the choices participants make in phases 4 to 6, i.e., in the second condition, they are confronted with (B, L, or H, depending on the treatment) in each game. The dependent variable in each equation is the share of the pie demanded in the corresponding phase; the determinants that we include in the regression are the decisions in the previous phases, the condition, and socio-demographics for gender (male/female) and education level (graduate/undergraduate).[14] To account for the order in which participants are exposed to the different conditions,

[14]Other socio-demographic variables are excluded because participants were randomly assigned to treatments and display largely homogeneous characteristics across groups (see Table 3.A3, Appendix 3.A). Including them would not aid identification and could reduce the precision of the estimates.

we consider separately the treatments (B, L) and (B, H), in which the efficiency loss comes after the baseline, and the treatments (L, B) and (H, B) in which it comes before. Since we consider the participants' choices as proposers and as responders separately, we have a total of four regressions.

Summing up, the system that we estimate can be described by the following general equation

$$d_{it}^{j} = \overline{\beta} + \beta_1 \times \text{Condition}_i + \sum_{\tau=1}^{t-1} \gamma_\tau \times d_{i\tau}^{j} + \beta_2 \times \text{Female}_i + \beta_3 \times \text{Graduate}_i + \varepsilon_{it} \tag{3.11}$$

where d_{it}^{j} and $d_{i\tau}^{j}$ are the demands of participant i, with role $j = X, Y$, in phase $t = 4, 5, 6$ and in the previous phases $\tau < t$, respectively. Condition$_i$ is a categorical variable that takes the value 0 for B, 1 for L, and 2 for H. Female$i$ is a dummy variable equal to 1 for female participants and 0 for male participants. Graduate$_i$ is a dummy variable equal to 1 for graduate students and 0 for undergraduate students. Finally, ε_{ij} is the error term that captures the correlations across phases.

Tables (3.11) and (3.12) report the regression results for the proposers, while Tables (3.13) and (3.14) report those for the responders.

Regarding the effect of the conditions, the regressions confirm the effect of the efficiency loss on the demands of proposers: in this role, participants demand a larger share as the equity-efficiency tradeoff worsens. This effect is confirmed in both the treatments *After* and *Before*; however, in both cases, while quantitatively relevant, it is only moderately statistically significant. A similar result also holds for responders, especially in the ultimatum game, where they have full veto power.[15] Concerning the effect of the sequential structure of the choice task, the estimated coefficients of the choices relative to the same game in the initial condition (d_{τ}^{j} for $j = X, Y$ and $\tau = 1, 2, 3$) are positive in the first, second, and third equations, respectively, for proposers and responders, as well as treatments *After* and *Before*. This implies that participants, both as proposers and as responders, increase their demand when they are confronted with the same game in the subsequent condition (either L or H in the treatments *After*, and B in the treatments *Before*). However, while this effect is highly statistically significant, it is not quantitatively significant. This confirms that the distributive preferences of the participants are rather stable in the sequential pattern of choices. Overall, our regression analyses robustly confirm the main findings of the descriptive analyses.

Result 8*: Although participants react to changes in the efficiency-equity tradeoff and the sequence of decision-making, their distributive preferences remain relatively stable and consistent under conditions, reinforcing the robustness of observed behavioral patterns.*

[15]The negative coefficient on the variable Condition in Tables (3.12) and (3.14) is consistent with the interpretation proposed in the text because, in the treatments *Before*, the variable decreases when going from the first three to the last three phases.

Table 3.11: Determinant of Proposers' Demand | Treatments *After*

	d_4^X (*Ultimatum Game*)	d_5^X (*Impunity Game*)	d_6^X (*Dictator Game*)
d_1^X	0.644***	-0.281*	-0.057
	(0.101)	(0.129)	(0.064)
d_2^X	-0.183*	0.852***	-0.028
	(0.086)	(0.108)	(0.053)
d_3^X	-0.131	-0.115	0.984***
	(0.091)	(0.113)	(0.055)
d_4^X		0.518***	0.112*
		(0.102)	(0.054)
d_5^X			0.738***
			(0.040)
Condition	7.163*	8.240*	5.877**
	(2.916)	(3.667)	(1.808)
Female	3.122	-1.527	2.218
	(2.373)	(2.943)	(1.427)
Graduate	-0.246	-1.253	0.244
	(2.378)	(2.931)	1.421
Constant	44.932***	39.316***	5.568
	(4.831)	(7.524)	(3.977)
Observations	152	152	152
Participants	76	76	76

Table 3.12: Determinant of Proposers' Demand | Treatments *Before*

	d_4^X (*Ultimatum Game*)	d_5^X (*Impunity Game*)	d_6^X (*Dictator Game*)
d_1^X	0.804***	-0.218	-0.111
	(0.111)	(0.116)	(0.089)
d_2^X	-0.115	0.896***	-0.040
	(0.088)	(0.092)	(0.070)
d_3^X	-0.260**	-0.292**	0.852***
	(0.088)	(0.094)	(0.074)
d_4^X		0.466***	-0.008
		(0.088)	(0.073)
d_5^X			0.675***
			(0.065)
Condition	-7.869*	-7.177*	-3.066
	(3.533)	(3.703)	(2.849)
Female	-1.932	-4.770	-3.829
	(2.739)	(2.823)	(2.167)
Graduate	0.597	-5.221	-3.752
	(2.701)	(2.782)	(2.139)
Constant	57.047***	62.861***	31.190***
	(2.536)	(5.658)	(5.931)
Observations	144	144	144
Participants	72	72	72

Note: The treatments *After* are (B, L) and (B, H). The treatments *Before* are (L, B) and (H, B). Each column reports the estimate of the corresponding equation (3.11) and it is associated to a different phase, hence to a different game. ***p<0.001, **p<0.01, *p<0.05

Table 3.13: Determinant of Responders' Demand | Treatments *After*

	d_4^Y (*Ultimatum Game*)	d_5^Y (*Impunity Game*)	d_6^Y (*Dictator Game*)
d_1^Y	0.832***	-0.004	-0.066
	(0.104)	(0.090)	(0.121)
d_2^Y	-0.022	1.005***	-0.016
	(0.090)	(0.077)	(0.104)
d_3^Y	-0.059	-0.003	0.981***
	(0.061)	(0.052)	(0.070)
d_4^Y		0.584***	0.245*
		(0.071)	(0.116)
d_5^Y			0.516***
			(0.112)
Condition	9.726***	3.161	10.067***
	(2.407)	(2.178)	(2.960)
Female	-4.126	2.246	-5.806
	(2.847)	(2.461)	(3.328)
Graduate	-3.567	-0.647	-1.212
	(2.855)	(2.463)	(3.322)
Constant	14.872***	-0.579	7.704
	(4.168)	(3.730)	(5.031)
Observations	152	152	152
Participants	76	76	76

Table 3.14: Determinant of Responders' Demand | Treatments *Before*

	d_4^Y (*Ultimatum Game*)	d_5^Y (*Impunity Game*)	d_6^Y (*Dictator Game*)
d_1^Y	0.885***	-0.013	-0.151
	(0.098)	(0.074)	(0.133)
d_2^Y	0.017	0.996***	0.020
	(0.088)	(0.066)	(0.119)
d_3^Y	-0.049	-0.006	0.946***
	(0.060)	(0.045)	(0.081)
d_4^Y		0.488***	0.049
		(0.064)	(0.138)
d_5^Y			0.460**
			(0.154)
Condition	-10.254***	-0.636	-12.080**
	(2.849)	(2.232)	(4.021)
Female	2.763	-0.689	-1.832
	(2.972)	(2.233)	(4.022)
Graduate	-0.313	2.325	1.820
	(2.987)	(2.237)	(4.044)
Constant	21.180***	1.416	27.560***
	(2.711)	(2.441)	(4.402)
Observations	144	144	144
Participants	72	72	72

Note: The treatments *After* are (B, L) and (B, H). The treatments *Before* are (L, B) and (H, B). Each column reports the estimate of the corresponding equation (3.11) and it is associated to a different phase, hence to a different game. ***p<0.001, **p<0.01, *p<0.05

3.7 Conclusion

This chapter contributes to the research on the equity-efficiency tradeoff by examining how individuals navigate the tension between fair division and efficiency maximization when faced with the risk of efficiency loss across three game types (UG, IG, DG) and two loss conditions (L or H).

We find that efficiency-seeking behavior increases as the equity-efficiency tradeoff worsens for both proposers and responders. However, the magnitude of this shift strongly depends on the game type. Specifically, in UG, subjects show only a modest shift toward efficiency, maintaining a preference for equity. In contrast, in IG and DG, the shift toward efficiency is much more pronounced, particularly for proposers.

Then, disentangling the choices for responders' veto power under each condition (B, L, and H), we find that both proposers' and responders' choices are dependent on it. Proposers tend to demand a smaller share of the pie as the responder's veto power increases, regardless of the efficiency loss condition. Similarly, responders adjust their demands upward as their veto power increases, showing more equity-seeking behavior in UG.

Additionally, regardless of the efficiency loss condition and level of veto power, we find that the equity-seeking behavior of both proposers and responders remains persistent in each game. Thus, participants who opt for an equal split of the pie in condition B tend to maintain this preference even when faced with condition L or condition H, and vice versa. This stability suggests that equity-seeking behavior reflects a robust individual preference rather than a reaction to changes in incentives or strategic context.

Furthermore, using a SUR model, we account for the relation between subjects' preferences toward equity or efficiency and the sequential structure of the choice task. As in the descriptive analysis, we confirmed that proposers and responders are more efficiency-seeking as long as the efficiency loss intensifies in each game, regardless of the sequential structure. Interestingly, we find that, in both roles, subjects increase the demand when faced with the same game for the second time (i.e., in the subsequent condition). Although this effect is highly statistically significant, it is not quantitatively significant. This confirms that the distributive preferences of the participants are rather stable across the sequential pattern of choices.

These findings offer valuable insights into the design of real-world redistributive policies. Our experimental evidence shows that, although individuals consistently prioritize equity, efficiency-seeking behavior becomes prominent only under strong strategic incentives. Therefore, redistributive policies are more likely to gain legitimacy and compliance when framed around fairness. In practice, measures such as progressive taxation or need-based transfers can promote equity without provoking opposition, reflecting the strong preference for fairness that underpins public acceptance of redistribution.

One example is Brazil's conditional cash transfer (CCT) program, Bolsa Família, which provides financial support in exchange for verifiable actions, such as ensuring children attend school or receive vaccinations. By making redistribution contingent on criteria that are socially recognized as fair, these programs have successfully combined efficiency, in the form of long-term human capital investment, with broad social acceptance. Similarly, minimum income schemes in several European countries, such as the Italian Reddito di Cittadinanza and the Spanish Ingreso Mínimo Vital, demonstrate how redistribution framed around equity principles (i.e., supporting the households most in need) can simultaneously alleviate poverty, reduce inequality, and maintain political legitimacy.

In sum, our findings, linked to real-world tax policies, show that equitable measures can simultaneously advance social and economic goals. This suggests that policymakers can design redistributive mechanisms that promote equity as a guiding principle while limiting efficiency losses, thus fostering social trust and ensuring political feasibility.

3.A Appendix 3.A - Additional tables and figures

Table 3.A1: Summary: Experimental designs

Author	Obs	Pool	Design	Game	Task	Treatment
Güth and Huck (1997)	124	Students	Classroom Experiment	Ultimatum Impunity Dictator	Proposer's token allocation, Responder's acceptance treshold	T1: Random variation of endowment; T2:Pre-expeimental questionnaire
Andreoni and Miller (2002)	176	Economics students	Paper & Pencil Experiment	Dictator	Token allocation between self and anonymous other	T1:Exogenous token price; T2:Self-selection of token price
Bolton and Ockenfels (2006)	288	Management and Economics students	Classroom Experiment	Voting	Decision between two redistributive policies	T1:Fair division vs. Pareto gain; T2:Fair division vs. Majorty game; T3:Fair division vs. Minority gain
Fisman et al. (2007)	199	Students and Staff	Laboratory Experiment	Dictator	Token allocation between self and anonymous other	T1:Two-person budget set; T2:Three-person budget set; T3:Step-shaped set
Güth et al. (2010)	332	Economics students	Paper & Pencil Experiment	Generosity	Decision on how much keep for themselves	T1:Y-games; T2:Z-games
Jakiela (2013)	144	Students	Laboratory Experiment	Dictator	Token allocation between self and anonymous other	T1:Giving treatment; T2:Taking treatment
Fisman et al. (2015a)	289	Students and Staff	Laboratory Experiment	-	Answer questions about income tax and estate tax	T1: income-tax survey; T2: estate-tax survey
Fisman et al. (2015b)	517	Law Students; American Life Panel	Laboratory & Online Experiment	Dictator	Token allocation between self and anonymous other	T1:Students set; T2:ALP set
Hong et al. (2015)	144	Students	Laboratory Experiment	Dictator	Token allocation between two unknown subjects	DG with random variation of price of giving and initial available endowment
Ambec et al. (2019)	180	Students	Laboratory Experiment	Dictator Trust	Token allocation between self and anonymous other	T1:Baseline; T2: Veil treatment; T3:Fee treatment; T4:Info treatment
Fisman et al. (2017)	1002	American Life Panel	Online Experiment	Dictator	Token allocation between self and anonymous other	T1: DG in 2013; T2: DG in 2016
Fisman et al. (2023)	687	American Life Panel	Online Experiment	Dictator	Token allocation between self and anonymous other	T1: Gain Boom; T2: Gain Recession; T3: Loss Recession

Table 3.A2: Average d^x | Order

	Before	After	p-value
Ultimatum Game			
B	57.95%	52.63%	0.065
L	48.38%	60.29%	0.006**
H	57.80%	59.44%	0.668
Impunity Game			
B	83.95%	86.03%	0.558
L	90.27%	83.14%	0.170
H	81.67%	81.95%	0.960
Dictator Game			
B	84.93%	81.84%	0.381
L	90.00%	81.71%	0.073
H	85.83%	85.12%	0.885

Note: Average d^X per game type. *Before* refers to sessions where efficiency loss is in the first three phases of each game; *After* refers to sessions in which efficiency loss occurs in the latter three phases. Two-sample t-test. ***p<0.001, **p<0.01, *p< 0.05

Table 3.A3: Summary Statistics of socio-demographics | Order

	Full Sample		Before	After	Difference
	Mean	Std. Dev.	Mean	Mean	
Age	21.381	1.869	21.389	21.373	0.016
Female	0.558	0.497	0.611	0.507	0.104**
Nationality	0.979	0.141	0.986	0.973	0.013
Graduate	0.429	0.495	0.389	0.467	0.078*
Economics	0.429	0.495	0.431	0.427	0.004

Note: *Age* is a continuous variable ranging from 18 to 30 years. *Female* is a dummy variable equal to 1 if female. *Nationality* is a categorical dummy variable equal to 1 if Italian. *Graduate* is a categorical dummy variable equal to 1 if graduate students, 0 if undergraduates. *Economics* is a categorical dummy variable equal to 1 if an Economics student. Tests used: Chi-square for categorical and t-test for continuous variables. ***$p < 0.001$, **$p < 0.01$, *$p < 0.05$

Table 3.A4: Average d^Y | Order

	Before	After	p-value
Ultimatum Game			
B	24.25%	34.74%	0.004**
L	32.16%	30.86%	0.809
H	35.83%	26.34%	0.045**
Impunity Game			
B	13.84%	22.63%	0.020**
L	16.22%	22.00%	0.338
H	29.17%	21.71%	0.153
Dictator Game			
B	37.12%	43.82%	0.215
L	39.46%	36.29%	0.720
H	44.17%	40.73%	0.593

Note: Average d^Y per game type. *Before* refers to sessions where efficiency loss is introduced during the first three phases of each game; *After* refers to sessions in which efficiency loss occurs in the latter three phases. Two-sample t-test. ***p<0.001, **p<0.01, *p< 0.05

3.B Appendix 3.B - Instructions

General Instruction

Welcome to this experiment. During the experiment, you and the other participants will be asked to make several decisions. Please read the instructions carefully, as your decisions and those of the other participants will determine your earnings.

Earnings in this experiment are measured in tokens. At the end of the experiment, tokens will be converted into euros at the rate of 1 token = €0.40. In addition to your earnings, you will receive a participation fee of €5.

From this point on, communication between participants is strictly prohibited. If you have any questions about the instructions, please raise your hand, and one of the experimenters will assist you privately.

Experiment Description.

This experiment consists of six phases (Phase 1, Phase 2, Phase 3, Phase 4, Phase 5, and Phase 6). In each phase, you and another participant, who will be anonymously and randomly paired with you, will decide how to divide an amount of tokens between yourselves.

In this experiment, you may assume two roles: Role X or Role Y. Each participant will make decisions in both roles. Therefore, you will need to decide how to act in both Role X and Role Y. Specifically, you must decide what percentage of the available tokens you want to keep for yourself in each role (the available percentages are as follows: 0%, 10%, 20%, and so on, up to 100%). To confirm your choice, you must press the designated button on the screen. Until you confirm your choice, you can modify it by selecting a different percentage.

At the end of the experiment, you will be randomly assigned, with a 50% probability, to either Role X or Role Y and paired randomly with another participant in the opposite role. Finally, for each pair, one of the six phases will be randomly selected, with an equal probability of 1/6, for payment. Your earnings will depend on the role you are randomly assigned to and the decisions made by both you and the participant in the opposite role, to whom you are randomly paired, during the selected phase, as explained in detail in the instructions for each phase.

Specifically, based on the decisions made by each pair of participants, two scenarios can occur in each phase, called Scenario A and Scenario B. Scenario A occurs if the sum of the percentages requested for themselves by the pair of participants, one in Role X and the other in Role Y, does not exceed 100%. Scenario B occurs if the sum of the percentages requested for themselves by the pair of participants, one in Role X and the other in Role Y, exceeds 100%.

At the end of the experiment, and before receiving payment, you will be asked to complete a short questionnaire. After completing the questionnaire, please remain seated until you are called by one of the experimenters for payment.

Low-After Efficiency Loss treatment[16]

Phase 1 - Phase 2 - Phase 3

In this phase, a total of one hundred (100) tokens are available.

Earnings in this phase are determined as follows:

- **If Scenario A occurs:**
  - The earnings of the participant in Role X are equal to the available tokens multiplied by the percentage they chose to keep for themselves.
  - The earnings of the participant in Role Y are equal to the available tokens minus the earnings of the participant in Role X.
- **If Scenario B occurs:**

  [**Phase 1**]

  - The earnings of the participant in Role X are zero.
  - The earnings of the participant in Role Y are zero.

  The possible earnings (in tokens) for this phase are summarized in the following table.

Percentage Role X chooses for self		0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
	Available tokens	100	100	100	100	100	100	100	100	100	100	100
Scenario A	Earnings in the Role X	0	10	20	30	40	50	60	70	80	90	100
	Earnings in the Role Y	100	90	80	70	60	50	40	30	20	10	0
Scenario B	Earnings in the Role X	0	0	0	0	0	0	0	0	0	0	0
	Earnings in the Role Y	0	0	0	0	0	0	0	0	0	0	0

  [**Phase 2**]

  - The earnings of the participant in Role X are equal to the available tokens multiplied by the percentage they chose to keep for themselves.
  - The earnings of the participant in Role Y are zero.

  The possible earnings (in tokens) for this phase are summarized in the following table.

[16] We report the instructions for the Low-After Efficiency Loss treatment only, as the instructions for the Low-Before Efficiency Loss treatment are identical except for the order of the phases for the baseline and low efficiency loss conditions. Specifically, in the Low-Before Efficiency Loss treatment, Phases 4, 5, and 6 from the Low-After Efficiency Loss treatment become Phases 1, 2, and 3. Conversely, Phases 1, 2, and 3 from the Low-After Efficiency Loss treatment become Phases 4, 5, and 6 in the Low-Before Efficiency Loss treatment.

Percentage Role X chooses for self		0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
	Avaiable tokens	100	100	100	100	100	100	100	100	100	100	100
Scenario A	Earnings in the Role X	0	10	20	30	40	50	60	70	80	90	100
	Earnings in the Role Y	100	90	80	70	60	50	40	30	20	10	0
Scenario B	Earnings in the Role X	0	10	20	30	40	50	60	70	80	90	100
	Earnings in the Role Y	0	0	0	0	0	0	0	0	0	0	0

[Phase 3]

- The earnings of the participant in Role X are equal to the available tokens multiplied by the percentage they chose to keep for themselves.
- The earnings of the participant in Role Y are equal to the available tokens minus those earned by the participant in role X.

The possible earnings (in tokens) for this phase are summarized in the following table.

Percentage Role X chooses for self		0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
	Avaiable tokens	100	100	100	100	100	100	100	100	100	100	100
Scenario A	Earnings in the Role X	0	10	20	30	40	50	60	70	80	90	100
	Earnings in the Role Y	100	90	80	70	60	50	40	30	20	10	0
Scenario B	Earnings in the Role X	0	10	20	30	40	50	60	70	80	90	100
	Earnings in the Role Y	100	90	80	70	60	50	40	30	20	10	0

The phase will begin shortly, and you will make your decisions for both Role X and Role Y. Before making your choices, you must answer two control questions, which will appear on the screen. For your convenience, these questions are also provided below.

Control Questions

Question 1: Suppose a participant demands 80% in Role X, and another participant demands 50% in Role Y. If these two participants are selected and matched, with the first in Role X and the second in Role Y:

1. What scenario would occur? **A** **B**
2. What would be the earnings of the participant in Role X? __________
3. What would be the earnings of the participant in Role Y? __________

Question 2: Suppose a participant demands 60% in Role X, and another participant demands 20% in Role Y. If these two participants are selected and matched, with the first in Role X and the second in Role Y:

1. What scenario would occur? **A** **B**
2. What would be the earnings of the participant in Role X? __________

3. What would be the earnings of the participant in Role Y? __________

Phase 4 - Phase 5 - Phase 6

At this phase, a maximum of one hundred (100) tokens are available. The actual number of tokens available depends on the choice of the participant in role X, as described in the following table:

Percentage Role X chooses for self		0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
	Available tokens	50	55	60	65	70	75	80	85	90	95	100

The earnings in this phase are determined as follows:

- **If Scenario A occurs:**
  - The earnings of the participant in Role X are equal to the available tokens multiplied by the percentage they chose to keep for themselves.
  - The earnings of the participant in Role Y are equal to the available tokens minus the tokens earned by the participant in Role X.
- **If Scenario B occurs:**

  [**Phase 4**]

  - The earnings of the participant in Role X are zero.
  - The earnings of the participant in Role Y are zero.

  The possible earnings (in tokens) for this phase are summarized in the following table.

Percentage Role X chhoses for self		0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
	Available tokens	50	55	60	65	70	75	80	85	90	95	100
Scenario A	Earnings in the Role X	0	5.5	12	19.5	28	37.5	48	59.5	72	85.5	100
	Earnings in the Role Y	50	49.5	48	45.5	42	37.5	32	25.5	18	9.5	0
Scenario B	Earnings in the Role X	0	0	0	0	0	0	0	0	0	0	0
	Earnings in the Role Y	0	0	0	0	0	0	0	0	0	0	0

  [**Phase 5**]

  - The earnings of the participant in Role X are equal to the available tokens multiplied by the percentage they chose to keep for themselves.
  - The earnings of the participant in Role Y are zero.

  The possible earnings (in tokens) for this phase are summarized in the following table.

Percentage Role X chooses for self		0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
	Available tokens	50	55	60	65	70	75	80	85	90	95	100
Scenario A	Earnings in the Role X	0	5.5	12	19.5	28	37.5	48	59.5	72	85.5	100
	Earnings in the Role Y	50	49.5	48	45.5	42	37.5	32	25.5	18	9.5	0
Scenario B	Earnings in the Role X	0	5.5	12	19.5	28	37.5	48	59.5	72	85.5	100
	Earnings in the Role Y	0	0	0	0	0	0	0	0	0	0	0

[**Phase 6**]

- The earnings of the participant in Role X are equal to the available tokens multiplied by the percentage they chose to keep for themselves.
- The earnings of the participant in Role Y are equal to the available tokens minus those earned by the participant in role X.

The possible earnings (in tokens) for this phase are summarized in the following table.

Percentage Role X chooses for self		0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
	Available tokens	50	55	60	65	70	75	80	85	90	95	100
Scenario A	Earnings in the Role X	0	5.5	12	19.5	28	37.5	48	59.5	72	85.5	100
	Earnings in the Role Y	50	49.5	48	45.5	42	37.5	32	25.5	18	9.5	0
Scenario B	Earnings in the Role X	0	5.5	12	19.5	28	37.5	48	59.5	72	85.5	100
	Earnings in the Role Y	50	49.5	48	45.5	42	37.5	32	25.5	18	9.5	0

The phase will begin shortly, and you will make your decisions for both Role X and Role Y. Before making your choices, you must answer two control questions, which will appear on the screen. For your convenience, these questions are also provided below.

Control Questions

Question 1 Suppose one participant demands 60% for themselves in Role X, and another participant demands 20% for themselves in Role Y. If these two participants were selected and matched, with the first in Role X and the second in Role Y, answer the following questions:

1. How many tokens would actually be available? __________
2. Which scenario would occur? **A** **B**
3. What would be the earnings of the participant in Role X?__________
4. What would be the earnings of the participant in Role Y?__________

Question 2 Suppose one participant demands 80% for themselves in Role X, and another participant demands 50% for themselves in Role Y. If these two participants were selected and matched, with the first in Role X and the second in Role Y, answer the following questions:

1. How many tokens would actually be available? __________

2. Which scenario would occur? **A** **B**

3. What would be the earnings of the participant in Role X?__________

4. What would be the earnings of the participant in Role Y?__________

High-After Efficiency Loss treatment[17]

Phase 1 - Phase 2 - Phase 3

In this phase, a total of one hundred (100) tokens are available.

Earnings in this phase are determined as follows:

- **If Scenario A occurs:**
  - The earnings of the participant in Role X are equal to the available tokens multiplied by the percentage they chose to keep for themselves.
  - The earnings of the participant in Role Y are equal to the available tokens minus the earnings of the participant in Role X.
- **If Scenario B occurs:**

  [**Phase 1**]
  - The earnings of the participant in Role X are zero.
  - The earnings of the participant in Role Y are zero.

  The possible earnings (in tokens) for this phase are summarized in the following table.

Percentage Role X chooses for self		0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
	Available tokens	100	100	100	100	100	100	100	100	100	100	100
Scenario A	Earnings in the Role X	0	10	20	30	40	50	60	70	80	90	100
	Earnings in the Role Y	100	90	80	70	60	50	40	30	20	10	0
Scenario B	Earnings in the Role X	0	0	0	0	0	0	0	0	0	0	0
	Earnings in the Role Y	0	0	0	0	0	0	0	0	0	0	0

  [**Phase 2**]
  - The earnings of the participant in Role X are equal to the available tokens multiplied by the percentage they chose to keep for themselves.
  - The earnings of the participant in Role Y are zero.

  The possible earnings (in tokens) for this phase are summarized in the following table.

[17] We report the instructions for the High-After Efficiency Loss treatment only, as the instructions for the High-Before Efficiency Loss treatment are identical except for the order of the phases for the baseline and low efficiency loss conditions. Specifically, in the High-Before Efficiency Loss treatment, Phases 4, 5, and 6 from the High-After Efficiency Loss treatment become Phases 1, 2, and 3. Conversely, Phases 1, 2, and 3 from the High-After Efficiency Loss treatment become Phases 4, 5, and 6 in the High-Before Efficiency Loss treatment.

Percentage Role X chooses for self		0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
	Avaiable tokens	100	100	100	100	100	100	100	100	100	100	100
Scenario A	Earnings in the Role X	0	10	20	30	40	50	60	70	80	90	100
	Earnings in the Role Y	100	90	80	70	60	50	40	30	20	10	0
Scenario B	Earnings in the Role X	0	10	20	30	40	50	60	70	80	90	100
	Earnings in the Role Y	0	0	0	0	0	0	0	0	0	0	0

[Phase 3]

- The earnings of the participant in Role X are equal to the available tokens multiplied by the percentage they chose to keep for themselves.
- The earnings of the participant in Role Y are equal to the available tokens minus those earned by the participant in role X.

The possible earnings (in tokens) for this phase are summarized in the following table.

Percentage Role X chooses for self		0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
	Avaiable tokens	100	100	100	100	100	100	100	100	100	100	100
Scenario A	Earnings in the Role X	0	10	20	30	40	50	60	70	80	90	100
	Earnings in the Role Y	100	90	80	70	60	50	40	30	20	10	0
Scenario B	Earnings in the Role X	0	10	20	30	40	50	60	70	80	90	100
	Earnings in the Role Y	100	90	80	70	60	50	40	30	20	10	0

The phase will begin shortly, and you will make your decisions for both Role X and Role Y. Before making your choices, you must answer two control questions, which will appear on the screen. For your convenience, these questions are also provided below.

Control Questions

Question 1: Suppose a participant demands 80% in Role X, and another participant demands 50% in Role Y. If these two participants are selected and matched, with the first in Role X and the second in Role Y:

1. What scenario would occur? **A** **B**
2. What would be the earnings of the participant in Role X? __________
3. What would be the earnings of the participant in Role Y? __________

Question 2: Suppose a participant demands 60% in Role X, and another participant demands 20% in Role Y. If these two participants are selected and matched, with the first in Role X and the second in Role Y:

1. What scenario would occur? **A** **B**
2. What would be the earnings of the participant in Role X? __________

3. What would be the earnings of the participant in Role Y? __________

Phase 4 - Phase 5 - Phase 6

At this phase, a maximum of one hundred (100) tokens are available. The actual number of tokens available depends on the choice of the participant in role X, as described in the following table:

Percentage Role X chooses for self		0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
	Available tokens	0	10	20	30	40	50	60	70	80	90	100

The earnings in this phase are determined as follows:

- **If Scenario A occurs:**
  - The earnings of the participant in Role X are equal to the available tokens multiplied by the percentage they chose to keep for themselves.
  - The earnings of the participant in Role Y are equal to the available tokens minus the tokens earned by the participant in Role X.
- **If Scenario B occurs:**

  [**Phase 4**]

  - The earnings of the participant in Role X are zero.
  - The earnings of the participant in Role Y are zero.

  The possible earnings (in tokens) for this phase are summarized in the following table.

Percentage Role X chooses for self		0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
	Available tokens	0	10	20	30	40	50	60	70	80	90	100
Scenario A	Earnings in the Role X	0	1	4	9	16	25	36	49	64	81	100
	Earnings in the Role Y	0	9	16	21	24	25	24	21	16	9	0
Scenario B	Earnings in the Role X	0	0	0	0	0	0	0	0	0	0	0
	Earnings in the Role Y	0	0	0	0	0	0	0	0	0	0	0

  [**Phase 5**]

  - The earnings of the participant in Role X are equal to the available tokens multiplied by the percentage they chose to keep for themselves.
  - The earnings of the participant in Role Y are zero.

  The possible earnings (in tokens) for this phase are summarized in the following table.

Percentage Role X chooses for self		0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
	Available tokens	0	10	20	30	40	50	60	70	80	90	100
Scenario A	Earnings in the Role X	0	1	4	9	16	25	36	49	64	81	100
	Earnings in the Role Y	0	9	16	21	24	25	24	21	16	9	0
Scenario B	Earnings in the Role X	0	1	4	9	16	25	36	49	64	81	100
	Earnings in the Role Y	0	0	0	0	0	0	0	0	0	0	0

[**Phase 6**]

- The earnings of the participant in Role X are equal to the available tokens multiplied by the percentage they chose to keep for themselves.
- The earnings of the participant in Role Y are equal to the available tokens minus those earned by the participant in role X.

The possible earnings (in tokens) for this phase are summarized in the following table.

Percentage Role X chooses for self		0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
	Available tokens	0	10	20	30	40	50	60	70	80	90	100
Scenario A	Earnings in the Role X	0	1	4	9	16	25	36	49	64	81	100
	Earnings in the Role Y	0	9	16	21	24	25	24	21	16	9	0
Scenario B	Earnings in the Role X	0	1	4	9	16	25	36	49	64	81	100
	Earnings in the Role Y	0	9	16	21	24	25	24	21	16	9	0

The phase will begin shortly, and you will make your decisions for both Role X and Role Y. Before making your choices, you must answer two control questions, which will appear on the screen. For your convenience, these questions are also provided below.

Control Questions

Question 1 Suppose one participant demands 60% for themselves in Role X, and another participant demands 20% for themselves in Role Y. If these two participants were selected and matched, with the first in Role X and the second in Role Y, answer the following questions:

1. How many tokens would actually be available? __________
2. Which scenario would occur? **A** **B**
3. What would be the earnings of the participant in Role X?__________
4. What would be the earnings of the participant in Role Y?__________

Question 2 Suppose one participant demands 80% for themselves in Role X, and another participant demands 50% for themselves in Role Y. If these two participants were selected and matched, with the first in Role X and the second in Role Y, answer the following questions:

1. How many tokens would actually be available? __________

2. Which scenario would occur? **A** **B**

3. What would be the earnings of the participant in Role X?__________

4. What would be the earnings of the participant in Role Y?__________

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