Choice and Welfare Under Social Constraints*

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Abstract

Economists often rely on people's choices to infer their preferences. However, inferring preferences from choices becomes problematic when people face unobserved constraints. In this paper, I study how to (cautiously) infer preferences from choices when the choices of the members of a social group are subject to a constraint that we only imperfectly know. When this happens, heterogeneity in the group's choices, along with more information about the constraint, helps recover the preferences of group members, whereas homogeneity in choices hinders it. I further argue that standard approaches to choice-based welfare analysis can lead to misleading inferences about welfare when there are unobserved social constraints.

JEL: D01, D60, D70

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"Every society and every social group ... embodies the appetites and natural desires of the individual man; but it implies, also, that wishes, in becoming organized, are necessarily disciplined and controlled in the interest of the group as a whole." Park (1921)

"An act of choice for this social animal is, in a fundamental sense, always a social act." Sen (1973)

1 Introduction

Applied work in different fields of Economics — including Political Economy, Health Economics, Household Economics, and Education Economics — often uses people's choices to infer their preferences. The underlying assumption is that if people are free to choose, they will select the option they like the most among those that are available. We can then recover preferences from choices, which we can use to make out-of-sample predictions and conduct welfare analysis (see Bernheim (2009) and Varian (2012)).

However, people often face constraints that we only imperfectly know. Among these constraints, social constraints are ubiquitous. The rules and norms of the social groups we belong to influence our behavior and also our expectations about how other group members will — or should — behave.[1] By avoiding choices that will upset a group's rules and norms, we often sacrifice personal welfare to conform.

Motivated by these considerations, I propose a family of models of choice where the members of a group maximize their preferences subject to a constraint that can depend on the preferences of other members. The models in this family differ by the information that an analyst, who only observes choices, has about the constraint. I use these models to construct a framework for cautiously inferring preferences from choices conditional on the analyst's knowledge of the constraint.

To illustrate the relevance of this framework, think of a politician who must vote either in favor or against a bill. Although the politician can personally oppose the bill, his party might have decided that all members should support it, leading the

[1] In a scene of the sitcom *Curb Your Enthusiasm*, Larry, the main character, is at a birthday party. After seeing an acquaintance eating a large share of one of the party's appetizers, he says: *"I think you are going over your allotment a little bit ... We have unwritten laws in the society."*

politician to vote in favor of it (cf. Epstein (1983) and Lawrence, Maltzman, and Smith (2006)). Or think of a Supreme Court judge who must decide on a case brought to the court. Although she might sympathize with one side of the case, the judicial merit can force her to go against her (personal) sympathies (cf. Ducat and Dudley (1987) and Brace, Langer, and Hall (2000)).[2] Or think of a household member buying orange juice in a supermarket. Although the member might prefer soda to orange juice, other household members might hate soda, and the member bought orange juice as a compromise (cf. Xu (2007) and Munro (2018)). Or think of high-school students applying to colleges through a centralized school admission process. Some families can decide not to rank their favorite school at the top of their stated preferences because they consider it too competitive and, hence, not feasible (cf. Fack, Grenet, and He (2019) and Hakimov and Kübler (2021)). In all these examples, inferring preferences from choices can be misleading.

The framework for welfare analysis I propose aims to identify and hopefully remedy some of these misleading inferences. More precisely, in Section 2, I define the notion of a *group feasibility restriction*, which maps the group's preference profile to a constraint in each menu. For instance, in the politician's example, if the party votes to decide how members should vote in a bill, the group feasibility restriction will be majority voting. I then use group feasibility restrictions to define a family of models of choice under constraints (Definition 1) when group members face the same constraint.[3] I showcase the relevance and flexibility of this family of models in Examples 1 to 6. In Example 7, I generalize the family of models in Definition 1 to the case where constraints are nested. I later revisit this case to show that the tools used to analyze the case of homogeneous constraints also apply to it (Example 11). I end Section 2 by proposing a notion of revealed preference for these models as a function of choices and the information the outside analyst has about the group feasibility restriction (Definition 2).

In Section 3, I deal with the case in which the analyst has no information about the group feasibility restriction, identifying the restrictions it imposes on the choices of the group members (Corollary 1). I build on this exercise to characterize the group

[2]For a recent example, the US Supreme Court unanimously sided with Donald Trump by ruling that states cannot bar candidates for federal office from the ballot, despite some judges not being Trump enthusiasts.

[3]See Section 2 for a discussion of the assumption that all group members face the same constraint.

members' revealed preferences when the outside analyst has no information about the group feasibility restriction (Corollary 2). This characterization provides the paper's central intuition: when group members face the same (unobserved) constraint, heterogeneity in their choices contributes to the identification of preferences. In contrast, choices that are too similar hinder preference recovery because a (cautious) analyst often cannot distinguish choices due to the constraint from choices due to the similarity of preferences.[4]

I use this insight to argue that the model's inferred preferences can starkly disagree with those inferred by the Bernheim and Rangel (2009) approach (Proposition 1). This disagreement becomes a shortcoming of the Bernheim and Rangel (2009) approach when the constraints are "physical" or "attentional." In general, however, the two approaches should be seen as complementary as their disagreement signals a conflict between personal and social preferences, where personal preferences are those a person would have when unencumbered by social constraints, and social preferences are those that internalize the social constraint (Examples 8, 9, and 10). The distinction between personal and social preferences can be useful to a planner when allocating alternatives among group members, especially in situations where the choice itself imposes the social cost.[5]

In Section 4, I revisit Examples 1 to 6 to illustrate how to use whatever information the analyst has about the group feasibility restriction to recover more of the members' preferences. The main takeaway of this part is that if the analyst knows more about the constraint, she can use this knowledge to learn about alternatives that, although feasible in a menu, are not chosen by any group member, which can expand the range of inferences about preferences she can make.

[4] This intuition is the basis of our natural suspicion of quasi-unanimous decisions in some contexts (e.g., election results in pseudo-democratic countries).

[5] To illustrate this distinction and how it can be useful to a planner, assume Alice and Bob are eating cookies, but now there is only one more cookie in the tray. Alice does not want the extra cookie, whereas Bob is craving for it. However, Bob refrains from taking the cookie because it is the last one and he wants to be polite. Therefore, an analyst might infer that they both prefer no cookie to one more cookie. These are their (revealed) social preferences, since they internalize the social constraint. However, if a planner knew their personal preferences, the planner would give Bob the cookie. Moreover, the planner could infer their personal preferences by adding one more cookie to the tray, in which case Bob would eat a cookie, whereas Alice would not.

1.1 Related Literature

This paper bridges three strands of the choice theory literature: choice under constraints (e.g., Masatlioglu et al. (2012), Cherepanov et al. (2013), and Lleras et al. (2017)), choice under social influence (e.g., Cuhadaroglu (2017) and Borah and Kops (2018)), and choice-based welfare analysis (e.g., Bernheim and Rangel (2009), Horan and Sprumont (2016), and Nishimura (2018)).

Most papers in the literature on choice under constraints deal with cognitive or procedural, rather than social, constraints. Although some of these papers employ a similar approach to obtain their results to the one I use here (particularly Masatlioglu, Nakajima, and Ozbay (2012), Cherepanov, Feddersen, and Sandroni (2013), and Lleras et al. (2017)), this paper advances the literature on several fronts. Conceptually, this paper's approach introduces a more flexible way of modeling the analyst's uncertainty about the constraint, and hence, most papers on constrained choices are particular cases of the family of models introduced here. Moreover, since the framework deals with group choices, it allows one to study the case of an unobserved arbitrary constraint, whereas this case imposes no restrictions on the choices of *one* person.

Second, most papers in this literature deal with choice functions and/or make stringent assumptions about the collection of menus the analyst observes (e.g., the analyst observes choices from all finite menus or, at least, from pairs of alternatives). In contrast, this paper deals with choice *correspondences* defined over an *arbitrary* collection of menus, making its results more useful for applied researchers, who can seldom choose from which menus to observe choices.

Third, the argument I use in the proofs of the results not only sheds light on the proofs of other results in the literature but also provides a recipe to derive characterizations of models of constrained choice that admit a minimum constraint. For instance, Example 13, when specialized to the cases where $n = 1$, yields a characterization of the observable restrictions and welfare implications of the order rationalization model of Cherepanov, Feddersen, and Sandroni (2013) and the limited consideration model of Lleras et al. (2017) for choice correspondences defined over an arbitrary collection of menus. Moreover, the minimum constraint used in Example 13 identifies the set of alternatives that the decision-maker *must* consider in both models.

The second strand—choice under social influence—examines the revealed preference implications of models of group choice. To the best of my knowledge, the first paper in this literature was Cuhadaroglu (2017), which studies a model where group members first eliminate dominated alternatives according to their preferences and then use the preferences of other group members to refine their choices. Borah and Kops (2018) propose a model of choice where each member of a social network maximizes her preferences subject to a constraint that depends on the choices of her neighbors in the network. The key distinction between my work and these papers is that they study a particular model of constrained choice, allowing for heterogeneity in the constraints, whereas I study a general family of models, imposing that the constraints are homogeneous. Moreover, although these other papers discuss welfare, they primarily focus on deriving the models' observable implications. In contrast, this paper focuses on welfare.

The third strand is the literature on choice-based welfare analysis. This strand roughly splits into two branches. On one branch, there are model-free approaches that attempt to infer welfare preferences based on normative assumptions on choices but without committing to a specific model of decision-making (see, among others, Green and Hojman (2007), Bernheim and Rangel (2009), Horan and Sprumont (2016), Nishimura (2018), and Caliari (2023)). The second strand conducts choice-based welfare analysis based on a model of choices, or, at least, a model of "mistakes" (see Rubinstein and Salant (2012) and Manzini and Mariotti (2014) for a discussion of some of these models). This paper strikes a compromise between these two branches as it commits to a specific choice procedure—namely, preference maximization under a constraint—but allows the analyst to be uncertain about the actual constraint. Moreover, although some papers that use the model-based approach show that their models' welfare inferences can disagree with those of the Bernheim and Rangel (2009) approach, they do so through examples. It is unclear how "typical" such examples are (e.g., Masatlioglu et al. (2012)). In contrast, Proposition 1 is a general result of the incompatibility of this paper's approach to that of Bernheim and Rangel (2009).

Conceptually, this paper also contributes to the literature that studies how social factors influence people's behavior (Becker (1974); Akerlof (1980); Bernheim (1994); Fehr and Schmidt (1999); Bolton and Ockenfels (2000)). Most of these papers modify preferences to incorporate these social factors, whereas this paper introduces them as constraints, a route suggested by Sen (1997). Whereas the papers in this literature focus on how social factors influence the predictions of a standard model in a domain, this paper focuses on the revealed preference implications of social factors when modeled as social constraints.

2 A Family of Models of Choice Under Social Constraints

Let X be a nonempty set of alternatives, and $\mathcal{M}$ a collection of nonempty subsets of X. An element $S \in \mathcal{M}$ is a *menu.* A *choice correspondence* on $(X, \mathcal{M})$ is a correspondence $c : \mathcal{M} \rightrightarrows X$ such that $\emptyset \neq c(S) \subseteq S$, for all $S \in \mathcal{M}$. $\mathcal{C}(X, \mathcal{M})$ denotes the space of all choice correspondences on $(X, \mathcal{M})$.

Given a binary relation R on X, $R^{>}$ denotes its *strict part* (i.e., $xR^{>}y$ iff xRy and not yRx), and $R^{=}$ its *symmetric part* (i.e., xRy and yRx). Moreover, $\mathrm{tran}(R)$ denotes its transitive closure. Given two binary relations R and R', R *extends* R' if $R' \subseteq R$ and $R'^{>} \subseteq R^{>}$. A binary relation R is *Suzumura-consistent* if $x \,\mathrm{tran}(R)\, y$ implies not $yR^{>}x$. It is well known that Suzumura-consistency characterizes when a binary relation admits a complete and transitive extension. A binary relation $\succsim$ on X is a *preference relation* if it is complete and transitive. $\mathcal{R}_X$ denotes the space of all preference relations on X.

Fix an arbitrary $n \in \mathbb{N}$ to be interpreted as the group size. Group members are indexed by $i \in \{1, \dots, n\}$. For each member $i \in \{1, \dots, n\}$, the choice correspondence c_i on $(X, \mathcal{M})$ represents member i's choices. The n-tuple $(c_i)_{i=1}^n$ is the group's *choice profile* on $(X, \mathcal{M})$. Each member $i \in \{1, \dots, n\}$ has a preference relation $\succsim_i$ on X. The n-tuple $(\succsim_i)_{i=1}^n$ is the group's *preference profile* on X.

Group members face the same constraint from each menu, where the constraint can depend on the preference profile. This constraint is represented by a map $F : \mathcal{R}_X^n \to \mathcal{C}(X, \mathcal{M})$, which we call a *group feasibility restriction.*[6] That is, a group feasibility restriction F maps a preference profile $(\succsim_i)_{i=1}^n$ to a constraint $F[\succsim_1, \dots, \succsim_n]$, where $F[\succsim_1, \dots, \succsim_n](S)$ represents the set of feasible alternatives on menu $S \in \mathcal{M}$ when the group's preference profile is $(\succsim_i)_{i=1}^n$.

An analyst knows that group members maximize their preferences subject to a constraint that can depend on the group's preference profile. By maximizing a pref-

[6]The social choice literature refers to such maps as Social Choice Rules.

erence $\succsim$ on a menu S, we mean that choices in S are given by the set

$$\max(S, \succsim) := \{x \in S : x \succsim y, \text{ for all } y \in S\}.$$

The analyst wishes to infer members' preferences given their choices and her information about the group feasibility restriction F. Her information about F is represented by a collection $\mathcal{F}$ of group feasibility restrictions that she conjectures the group might face. The larger this collection, the less she knows about the constraint.

At one extreme, when $\mathcal{F} = \mathcal{C}(X, \mathcal{M})^{\mathcal{R}_X^n}$, she knows very little about the group feasibility restriction. At the other extreme, when $\mathcal{F} = \{F\}$, she knows the group feasibility restriction — although she still might not know the constraint members face since it can depend on the group's preference profile, which is unknown to her. For an intermediary case, the analyst might only know that the group feasibility restriction F satisfies properties $P_1, P_2, \ldots, P_n$. In this case, $\mathcal{F}$ would be the collection of group feasibility restrictions that satisfy these properties. The following definition formalizes this discussion.

Definition 1 (*Collective $\mathcal{F}$-Rationality*)**.** Given a collection $\mathcal{F}$ of group feasibility restrictions, a choice profile $(c_i)_{i=1}^n$ **is collectively $\mathcal{F}$-rational** if there exists $(\succsim)_{i=1}^n \in \mathcal{R}_X^n$ and $F \in \mathcal{F}$ such that, for all $i \in \{1, \ldots, n\}$,

$$c_i(S) := \max(F[\succsim_1, \ldots, \succsim_n](S), \succsim_i).$$

When $\mathcal{F} = \mathcal{C}(X, \mathcal{M})^{\mathcal{R}_X^n}$, $(c_i)_{i=1}^n$ is **collectively rational**. When $\mathcal{F} = \{F\}$, for some $F \in \mathcal{C}(X, \mathcal{M})^{\mathcal{R}_X^n}$, $(c_i)_{i=1}^n$ is **collectively F-rational**.

2.1 Examples

The following examples illustrate how flexible the family of models in Definition 1 is.

Example 1 (*Preference-independent restrictions*)**.** Some social constraints are independent of the preferences of the group members. This is often the case for the customs, codes of conduct, and rules of a group. If the analyst knows the constraint $\varphi \in \mathcal{C}(X, \mathcal{M})$ the group faces, we can define F_φ as $F_\varphi[\succsim_1, \ldots, \succsim_n] := \varphi$, for every preference profile $(\succsim_i)_{i=1}^n$. Then, $(c_i)_{i=1}^n$ is collectively F_φ-rational, if and only if, there exists a profile $(\succsim_i)_{i=1}^n$ such that $c_i(\cdot) = \max(\varphi(\cdot), \succsim_i)$ for each $i \in \{1, \ldots, n\}$.

More generally, the analyst might only have a vague idea about the customs, codes of conduct and morality, and rules of a group. In this case, we can, with a slight abuse of notation, define $\mathcal{F}_J \coloneqq \{\varphi_j\}_{j\in J}$ for some arbitrary set J with $\varphi_j \in \mathcal{C}(X, \mathcal{M})$ for each $j \in J$. Then, $(c_i)_{i=1}^n$ is collectively $\mathcal{F}_J$-rational if, and only if, there exists a profile $(\succsim_i)_{i=1}^n$ and a constraint $\varphi \in \mathcal{F}_J$ such that $c_i(\cdot) = \max(\varphi(\cdot), \succsim_i)$ for each $i \in \{1, \ldots, n\}$.

Example 2 (*Moral Constraints*)**.** Whether an action is morally acceptable can depend on what other actions are available. In particular, if an action is morally reproachable given the other feasible actions, the action remains unacceptable if more actions become available. For instance, if stealing food is unacceptable when the only option left is to starve, it should remain unacceptable when the person can either starve or pay for the food. Suppose the analyst knows that the moral constraint φ group members face satisfies this property. That is, given menus S and T with $S \subseteq T$, if $x \notin \varphi(S)$ and $x \in T$, then $x \notin \varphi(T)$, which is the counter-positive of the α axiom (see Sen (1971) and, especially, Cherepanov et al. (2013)). Define the collection of group feasibility restrictions $\mathcal{F}_\alpha$ as

$$\mathcal{F}_\alpha \coloneqq \left\{F \in \mathcal{C}(X, \mathcal{M})^{\mathcal{R}_X^n} : F[\succsim_1, \ldots, \succsim_n] \text{ satisfies } \alpha, \text{for all } (\succsim_i)_{i=1}^n\right\}.$$

Then, $(c_i)_{i=1}^n$ is collectively F_φ-rational, if and only if, there exists a constraint φ that satisfies α and a profile $(\succsim_i)_{i=1}^n$ such that $c_i(\cdot) = \max(\varphi(\cdot), \succsim_i)$ for each $i \in \{1, \ldots, n\}$.

Example 3 (*Social Attention*)**.** Masatlioglu, Nakajima, and Ozbay (2012) propose a model in which a person maximizes her preferences over the alternatives she pays attention to on a menu. The set of alternatives that the person pays attention to on a menu satisfies the property that if the person does not pay attention to x, removing it from the menu does not change the set of alternatives to which the person pays attention. Formally, assume that if $S \in \mathcal{M}$ and $x \in S$, then $S\backslash\{x\} \in \mathcal{M}$. We say that $\varphi \in \mathcal{C}(X, \mathcal{M})$ is an *attention filter* if, for every $S \in \mathcal{M}$ and $x \in S$, $\varphi(S\backslash\{x\}) = \varphi(S)$ whenever $x \notin \varphi(S)$. Such attention constraints can depend on the groups to which a person belongs. For instance, the members of a rich household might ignore cheap brands when purchasing products. So, suppose the analyst conjectures that the choices of a group are subject to an attention filter. Define the collection of group feasibility restrictions $\mathcal{F}_{\text{att}}$ as

$$\mathcal{F}_{\text{att}} \coloneqq \{F \in \mathcal{F} : F[\succsim_1, \ldots, \succsim_n] \text{ is an attention filter for all } (\succsim_i)_{i=1}^n\}.$$

Then, $(c_i)_{i=1}^n$ is collectively F_{att}-rational, if and only if, there exists an attention filter φ and a profile $(\succsim_i)_{i=1}^n$ such that $c_i(\cdot) = \max(\varphi(\cdot), \succsim_i)$ for each $i \in \{1, \ldots, n\}$.

In the previous examples, the constraint was independent of the group's preference profile. The following examples illustrate cases where it is not independent.

Example 4 (*Preference externalities*)**.** In markets for products with high fixed costs, firms will only offer a product if there are enough consumers to purchase it. This is termed a *preference externality* because the set of alternatives available to a consumer depends on the preferences of other consumers (see Waldfogel (1999) and Anderson and Waldfogel (2015)). Let a menu S be the set of products firms can supply if they anticipate enough demand. The analyst is aware of this list of potential products but does not know consumers' preferences and, therefore, what products firms actually supply. Assume there is also a default product $d \in X$, which belongs to every menu $S \in \mathcal{M}$ and is always supplied. For each menu $S \in \mathcal{M}$, firms will only supply an alternative $x \in S\backslash\{d\}$ if at least $k \in \{1, \ldots, n\}$ consumers would choose it from the menu. Given a preference profile $(\succsim_i)_{i=1}^n$, let

$$N[\succsim_1, \cdots, \succsim_n](x, S) \coloneqq |\{i \in \{1, \ldots, n\} : x \in \max(S, \succsim_i)\}|$$

be the number of consumers that would buy product x in menu S. Define the group feasibility restriction F_k as

$$F_k[\succsim_1, \ldots, \succsim_n](S) \coloneqq \{x \in S : x = d \text{ or } N[\succsim_1, \cdots, \succsim_n](x, S) \geqslant k\}.$$

Then, $(c_i)_{i=1}^n$ is collectively F_k-rational if, and only if, there exists a profile $(\succsim_i)_{i=1}^n$ such that, for each $i \in \{1, \ldots, n\}$,

$$c_i(S) = \max\left(\{x \in S : x = d \text{ or } N[\succsim_1, \cdots, \succsim_n](x, S) \geqslant k\}, \succsim_i\right).$$

Example 5 (*What Would Others Think?*)**.** Group members often refrain from choosing an alternative that will be frowned upon by other group members. For instance, group members might not choose an alternative from a menu if another member judges it as the worst alternative, except when one group member dislikes each alternative. In that case, they choose whatever they prefer because either they will upset someone or choose their least preferred alternatives on a menu. Formally, define the group feasibility restriction F_{Others} as

$$F_{\text{Others}}[\succsim_1, \ldots, \succsim_n](S) \coloneqq \begin{cases} S \setminus \left(\bigcup_{i=1}^{n} \text{MIN}(S, \succ_i) \right) & , \text{ if } \bigcup_{i=1}^{n} \text{MIN}(S, \succ_i) \subset S \\ S & , \text{ otherwise} \end{cases},$$

where

$$\text{MIN}(S, \succ_i) = \{ x \in S : \exists y \in S \text{ s. t. } (y \succ_i x) \text{ and } \forall z \in S \neg (x \succ_i z) \}.$$

Then, $(c_i)_{i=1}^{n}$ is collectively F_{Others}-rational if, and only if, there exists a profile $(\succsim_i)_{i=1}^{n}$ such that, for each $i \in \{1, \ldots, n\}$,

$$c_i(S) = \begin{cases} \max \left(S \setminus \bigcup_{i=1}^{n} \text{MIN}(\succ_i, S), \succsim_i \right) & , \text{ if } \bigcup_{i=1}^{n} \text{MIN}(S, \succ_i) \subset S \\ \max(S, \succsim_i) & , \text{otherwise} \end{cases}.$$

Example 6 (*Hierarchical Consensus*)**.** A group with a hierarchy decides what alternatives are feasible by the following sequential procedure (cf., Manzini and Mariotti (2007) and Piccione and Rubinstein (2007)). Given a list of alternatives, those at the top of the hierarchy select their most preferred alternatives in the list. When they have more than one preferred alternative, they delegate the decision between these alternatives to the next level of the hierarchy. The next level then either selects an alternative or, when it has more than one preferred alternative, delegates the decision to the next level, and so forth. Group members are then free to choose between the alternatives that survive this process. Formally, suppose the group's hierarchy is such that group member 1 is at the top and group member n is at the bottom. Given a preference profile $(\succsim_i)_{i=1}^{n}$, define the group feasibility restriction F_H as

$$F_H[\succsim_1, \ldots, \succsim_n](S) \coloneqq \max(\cdots(\max(\max(S, \succsim_1), \succsim_2)) \cdots, \succsim_n).$$

In words, member 1 first maximizes her preferences over S, then member 2 maximizes her preferences over $\max(S, \succsim_1)$, and so forth. Then, $(c_i)_{i=1}^{n}$ is collectively F_H-rational if, and only if, there exists a profile $(\succsim_i)_{i=1}^n$ such that, for each $i \in \{1, \ldots, n\}$,

$$c_i(\cdot) = \max\left(\max(\cdots(\max(\max(S, \succsim_1), \succsim_2))\cdots, \succsim_n), \succsim_i\right).$$

Remark 1. The group feasibility restriction can be the outcome of an underlying game that determines what is feasible. For instance, group members can play a voting game in which each decides how to vote, given the group's preference profile. Only alternatives with a sufficient number of votes are feasible. When voting is non-strategic, this can be modeled as in Example 4, but the example can be modified to incorporate strategic voting. Alternatively, in Example 4, the firms in the product market can decide whether to offer their product based on the consumers' preference profile *and* the decision of other firms. The set of feasible products is then the outcome of the resulting game.

Remark 2. The group feasibility restriction can also be a social choice rule, aggregating the group's preference profile into a set of alternatives that are deemed acceptable. For instance, F can return the maximal elements of some aggregated group preference, e.g., the Pareto relation or the Borda Rule. Alternatively, F could represent majority voting, for example, when people vote in a referendum on whether to ban a product. Or F could be the serial dictatorship rule, as in Example 6.

2.2 The Homogeneous Constraint Assumption

A crucial implicit assumption in Definition 1 is that each group member faces the *same* group feasibility restriction, i.e., that constraints are *homogeneous*. This assumption is admittedly strong and underlies the results presented in this paper. If constraints in Definition 1 were member-specific, the resulting model could explain any choice profile. This would hold even if group members shared the same preference. Therefore, one needs to restrict the heterogeneity in constraints somehow, but there is no "canonical" way of doing so. The case of homogeneous constraint is then a natural and valuable starting point for understanding the implications of constraints for choice-based welfare analysis.

It is natural because many social constraints are indeed homogeneous, as the examples above show.[7] It is valuable because the tools and methods developed to

[7] Constraints being homogeneous does not mean they are equally binding to each group member.

analyze this case can help to analyze cases where the constraints are heterogeneous. For instance, if there is heterogeneity of constraints within a group across observable characteristics (e.g., income), we can apply the results of the homogeneous case to the corresponding subgroups. In particular, if obedience to social constraints is highly correlated with observable characteristics, we can use the framework I propose to infer the preferences of members who obey the constraints while using the standard revealed preference results to infer the preferences of members who do not.

A more interesting case is that of a group whose members incur a cost if they violate the constraint in a menu, and these costs are not correlated to observable characteristics. If some members face a higher cost than others of violating the constraint in every menu, it is as if group members maximize their preferences subject to nested constraints so that group members with a higher cost face a more stringent constraint. In this spirit, consider the following generalization of Definition 1, which I will later analyze using the tools and methods developed to deal with the case of a homogeneous constraint.

Example 7 (*Nested Constraints*)**.** Some group members are often less constrained than others. For instance, the richer a group member, the less constrained the member is when choosing a restaurant to eat. Alternatively, group members might differ in their cost of violating the social constraint. One way to model these cases is to assume that group members face nested constraints. Formally, assume that each group member $i \in \{1, \ldots, n\}$ faces a group feasibility restriction $F_i \in \mathcal{F}_i$, where for every preference profile $(\succsim_i)_{i=1}^n$ and menu $S \in \mathcal{M}$,

$$F_1[\succsim_1, \ldots, \succsim_n](S) \subseteq \cdots \subseteq F_n[\succsim_1, \ldots, \succsim_n](S).$$

The analyst's knowledge about the feasibility restrictions corresponds to the subset $\mathcal{F}$ of profiles in $\prod_{i=1}^n \mathcal{F}_i$ that satisfy this nestedness condition. Therefore, a choice profile $(c_i)_{i=1}^n$ is collectively $\mathcal{F}$-rational when there is a $(F_i)_{i=1}^n \in \mathcal{F}$ and a preference profile $(\succsim_i)_{i=1}^n$ such that for every $i \in \{1, \ldots, n\}$ and $S \in \mathcal{M}$,

$$c_i(S) = \max(F_i[\succsim_1, \ldots, \succsim_n](S), \succsim_i).$$

If a group member's most preferred alternatives in a menu are always (socially) feasible, the group member is not effectively restricted in the menu (as in Example 6).

2.3 Revealed Preferences and Preference Identification

The analyst is cautious when inferring preferences. Therefore, given a collectively $\mathcal{F}$-rational profile of choices, the analyst will only infer that group member i prefers x to y if this holds for member i's preferences in any preference profile that collectively $\mathcal{F}$-rationalizes choices. Formally:

Definition 2 (*$\mathcal{F}$-preference*)**.** Given a collection of group feasibility restrictions $\mathcal{F}$ and a choice profile $(c_i)_{i=1}^n$ that is $\mathcal{F}$-collectively rational, $x \succ_{\mathcal{F},c_i} y$ if $x \succ_i y$ for every $(\succsim_i)_{i=1}^n$ that collectively F-rationalizes $(c_i)_{i=1}^n$ for some $F \in \mathcal{F}$. We say that $x \sim_{\mathcal{F},c_i} y$ if $x \sim_i y$ for every $(\succsim_i)_{i=1}^n$ that collectively F-rationalizes $(c_i)_{i=1}^n$ for some $F \in \mathcal{F}$. Finally, define $\succsim_{\mathcal{F},c_i} := \succ_{\mathcal{F},c_i} \cup \sim_{\mathcal{F},c_i}$. When $\mathcal{F} = \mathcal{C}(X,\mathcal{M})^{\mathcal{R}_X^n}$, we write $x \succsim_{c_i} y$, and when $\mathcal{F} = \{F\}$ for some $F \in \mathcal{C}(X,\mathcal{M})^{\mathcal{R}_X^n}$, we write $x \succsim_{F,c_i} y$.

Remark 3. $\succsim_{\mathcal{F},c_i}$ should be interpreted as group member i's preferences when unencumbered by social constraints. Therefore, even when the choices c_i of member i are compatible with unconstrained preference maximization, the preferences one would infer by not taking constraints into account can be different from those in $\succsim_{\mathcal{F},c_i}$ (see Examples 8, 9, and 17).

Let $\mathcal{F}$ and $\mathcal{F}'$ be two collections of group feasibility restrictions with $\mathcal{F} \subseteq \mathcal{F}'$. If a choice profile is collectively $\mathcal{F}$-rational, it is collectively $\mathcal{F}'$-rational. Therefore, the less the analyst knows about the constraint, the larger the set of choice profiles the analyst can rationalize. However, the less the analyst knows about the constraint, the harder it is to disentangle which choices are due to preferences and which are due to constraints. The following claim, which follows readily from Definition 2, formalizes this intuition.

Claim 1. Let $\mathcal{F}, \mathcal{F}'$ be two collections of group feasibility restrictions. If $\mathcal{F} \subseteq \mathcal{F}'$ and $(c_i)_{i=1}^n$ is collectively $\mathcal{F}$-rational, then $\succsim_{\mathcal{F},c_i}$ extends $\succsim_{\mathcal{F}',c_i}$, for each $i \in \{1,\dots,n\}$.

Claim 1 implies that if a choice profile $(c_i)_{i=1}^n$ is collectively $\mathcal{F}$-rational, $\succsim_{\mathcal{F},c_i}$ extends $\succsim_{c_i}$ for every $i \in \{1,\dots,n\}$, where recall that $\succsim_{c_i}$ is member i's revealed preference when the analyst has no information about the constraint. Therefore, whatever the analyst can infer about preferences without any information about the group feasibility restriction would remain valid if the analyst learned more about the group feasibility restriction. Therefore, we begin by analyzing the case in which the analyst has no information about the constraint.

3 The No Information Benchmark

Assume that the analyst has no information about the group feasibility restriction, i.e., she is interested in whether the choice profile $(c_i)_{i=1}^n$ is collectively rational. The following claim shows that this case imposes the same restrictions on $(c_i)_{i=1}^n$ as those imposed by a model in which group members maximize their preferences subject to a constraint that is independent of the preference profile.

Claim 2. A choice profile $(c_i)_{i=1}^n$ is collectively rational if, and only if, there is a $\varphi \in \mathcal{C}(X, \mathcal{M})$ and a preference profile $(\succsim_i)_{i=1}^n$ such that, for each $i \in \{1, \ldots, n\}$, $c_i(\cdot) = \max(\varphi(\cdot), \succsim_i)$.

Therefore, when the analyst has no information about the group feasibility restriction, she can assume that the constraint is independent of the preference profile when testing whether a choice profile is collectively rational.

3.1 Observable Consequences

By Claim 2, to characterize when a choice profile $(c_i)_{i=1}^n$ is collectively rational, we must determine when we can find a preference profile $(\succsim)_{i=1}^n$ and a constraint φ such that group members maximize their preferences subject to φ.

I split the characterization into two steps. In the first step, I fix an $i \in \{1, \ldots, n\}$ and a constraint φ and show how to construct, when possible, a preference relation $\succsim_i$ such that $c_i(\cdot) = \max(\varphi(\cdot), \succsim_i)$. In the second step, I define the appropriate constraint φ to test whether $(c_i)_{i=1}^n$ is collectively rational.

3.1.1 First Step

Fix an $i \in \{1, \ldots, n\}$ and a feasibility constraint $\varphi \in \mathcal{C}(X, \mathcal{M})$. The choice correspondence c_i is *φ-rational* if there is a preference relation $\succsim_i$ such that $c_i(S) = \max(\varphi(S), \succsim_i)$ for every $S \in \mathcal{M}$.[8] Define the following binary relations:

- $x \, P_{\varphi, c_i} \, y$ if there is a $S \in \mathcal{M}$ such that $x \in c_i(S)$ and $y \in \varphi(S) \backslash c_i(S)$;
- $x \, I_{c_i} \, y$ if there is a $S \in \mathcal{M}$ such that $\{x, y\} \subseteq c_i(S)$;

[8]Bossert and Suzumura (2009) provide an axiomatization of φ-rationality, but the one I propose here will be more convenient for characterizing what one can infer about preferences.

- $R_{\varphi,c_i} \coloneqq P_{\varphi,c_i} \cup I_{c_i}$.

If we want to interpret R_{φ,c_i} as c_i's revealed preference given φ, P_{φ,c_i} as its strict part, and I_{c_i} as its symmetric part, the following property must be satisfied.

Definition 3. Given $c_i \in \mathcal{C}(X,\mathcal{M})$, c_i is *φ-consistent* if $c_i(\cdot) \subseteq \varphi(\cdot)$ and, for every $x, y \in X$, if $x \operatorname{tran}(R_{\varphi,c_i})\, y$, then $y\, P_{\varphi,c_i}\, x$ does not hold.

Suppose the group feasibility restriction is constant and equals φ (as in Example 1). If $(c_i)_{i=1}^n$ is collectively φ-rational, the notion of revealed preferences Definition 2 specializes to x is *φ-preferred to y for c_i* if either $x \succ_i y$, for every $\succsim_i$ that φ-rationalizes c_i, or $x \sim_i y$, for every $\succsim_i$ that φ-rationalizes c_i. We then write $x \succsim_{\varphi,c_i} y$.

The following lemma will be instrumental in deriving the results presented in this paper.

Lemma 1. *Let φ, φ' be feasibility constraints. Then, for every $i \in \{1, \dots, n\}$,*

(i) ***(Rationality)*** *c_i is φ-rational if, and only if, c_i is φ-consistent;*

(ii) ***(Welfare)*** *If c_i is φ-rational, $x \succsim_{\varphi,c_i} y$ if, and only if, $x \operatorname{tran}(R_{\varphi,c_i})\, y$;*

(iii) ***(Expansion of welfare inferences)*** *Suppose $c_i(\cdot) \subseteq \varphi(\cdot) \subseteq \varphi'(\cdot)$. Then if c_i is φ'-consistent, then c_i is φ-consistent, and $\succsim_{\varphi',c_i}$ extends $\succsim_{\varphi,c_i}$.*

Proof. Fix $i \in \{1, \dots, n\}$. To prove (i), suppose there exists a preference relation $\succsim_i$ such that, for every $S \in \mathcal{M}$, $c_i(S) = \max(\varphi(S), \succsim_i)$. Now, assume that $x \operatorname{tran}(R_{\varphi,c_i})\, y$. Then, by the transitivity of $\succsim_i$, $x \succsim_i y$ and, hence, for every $S \in \mathcal{M}$ with $x \in \varphi(S)$ and $y \in c_i(S)$, we must have $x \in c_i(S)$. Thus, we cannot have $y\, P_{\varphi,c_i}\, x$, establishing φ-consistency. To prove the converse, suppose that c_i is φ-consistent. Clearly, $R^{>}_{\varphi,c_i} \subseteq P_{\varphi,c_i}$ and, by φ-consistency, $P_{\varphi,c_i} \subseteq R^{>}_{\varphi,c_i}$. Therefore, $P_{\varphi,c_i} = R^{>}_{\varphi,c_i}$. Moreover, $I_{c_i} \subseteq R^{=}_{\varphi,c_i}$ and, by φ-consistency, $I_{c_i} \cap R^{>}_{\varphi,c_i} = I_{c_i} \cap P_{\varphi,c_i} = \emptyset$. It follows that $I_{c_i} = R^{=}_{\varphi,c_i}$. Since $P_{\varphi,c_i} = R^{>}_{\varphi,c_i}$, φ-consistency is now equivalent to Suzumura-consistency. We can thus extend R_{φ,c_i} to a complete preference relation $\succsim_i$ on X. It is easily checked that $c_i(S) = \max(\varphi(S), \succsim_i)$ for every $S \in \mathcal{M}$.

To prove (ii), suppose first that $x \operatorname{tran}(R_{\varphi,c_i})\, y$ and fix any preference relation $\succsim_i$ with $c_i(S) = \max(\varphi(S), \succsim_i)$. Since $x \operatorname{tran}(R_{\varphi,c_i})\, y$, there exists $x_1, \dots, x_k$ such that

$xR_{\varphi,c_i}x_1R_{\varphi,c_i}\cdots R_{\varphi,c_i}x_kR_{\varphi,c_i}y$, where either all $R'_{\varphi,c_i}s$ in the chain equal I_{c_i}, or at least one equals P_{φ,c_i}. In the first case, we have $x \sim_i y$, and in the second case, we have $x \succ_i y$. Since $\succsim_i$ was arbitrary, this shows that $x \succsim_{\varphi,c_i} y$. To prove the converse, suppose that $x\,\mathrm{tran}(R_{\varphi,c_i})\,y$ does not hold. Then, since R_{φ,c_i} is Suzumura-consistent, $R_{\varphi,c_i} \cup \{(y,x)\}$ is also Suzumura-consistent and can be extended to a preference relation $\succsim_i$ on X such that $y \succ_i x$. It is easily checked that $c_i(S) = \max(\varphi(S), \succsim_i)$ for every $S \in \mathcal{M}$. Hence, we cannot have $x \succsim_{\varphi,c_i} y$, completing the proof of (ii).

To prove (iii), assume that $c_i(\cdot) \subseteq \varphi(\cdot) \subseteq \varphi'(\cdot)$. Then, clearly $P_{\varphi,c_i} \subseteq P_{\varphi',c_i}$. Now, suppose that c_i is φ'-consistent and assume, by contradiction, there are $x, y \in X$ such that $x\,\mathrm{tran}(R_{\varphi,c_i})\,y$ and $y\,P_{\varphi,c_i}\,x$. Since $P_{\varphi,c_i} \subseteq P_{\varphi',c_i}$, it follows both that $x\,\mathrm{tran}(R_{\varphi',c_i})\,y$ and that $y\,P_{\varphi',c_i}\,x$, contradicting the φ'-consistency of c_i. Therefore, c_i is φ-consistent, and it is easily checked that $\mathrm{tran}\,(R_{\varphi',c_i})$ extends $\mathrm{tran}\,(R_{\varphi,c_i})$. □

3.1.2 Second Step

Given a constraint φ, part (i) of Lemma 1 characterizes when there exists a preference relation that φ-rationalizes the choices of group member $i \in \{1,\ldots,n\}$. I now show how to define an appropriate constraint φ to test whether $(c_i)_{i=1}^n$ is collectively rational.

Since every group member faces the same constraint, whatever one of them chooses in a menu must be feasible in the menu. Moreover, the more elements we include in the constraint φ, the harder it becomes for c_i to be φ-consistent. These considerations suggest that, given a choice profile $(c_i)_{i=1}^n$, we define the *minimum constraint consistent* with $(c_i)_{i=1}^n$ as[9]

$$\varphi_{\min}(\cdot) \coloneqq \bigcup_{i=1}^{n} c_i(\cdot).$$

We then get to the desired characterization of collective rationality.

Corollary 1. *A profile of choices $(c_i)_{i=1}^n$ is collectively rational if, and only if, c_i is $\varphi_{\min}$-consistent for each $i \in \{1,\ldots,n\}$.*

Proof. If c_i is $\varphi_{\min}$-consistent for every $i \in \{1,\ldots,n\}$, Claim 2 and part (i) of Lemma 1 imply that $(c_i)_{i=1}^n$ is collectively rational. Conversely, if $(c_i)_{i=1}^n$ is collectively rational, then, by Claim 2, we can find a feasibility restriction φ such that c_i is φ-rational for

[9]Since the choice profile will always be apparent from the context, I write $\varphi_{\min}$ instead of $\varphi_{\min}^{(c_i)_{i=1}^n}$.

every $i \in \{1, \ldots, n\}$. Since $\varphi_{\min}(\cdot) \subseteq \varphi(\cdot)$, part (iii) of Lemma 1 implies that c_i is $\varphi_{\min}$-consistent for every $i \in \{1, \ldots, n\}$. $\square$

3.2 Recovering Preferences From Choices

Recall from Definition 2 that $\succsim_{c_i}$ is the revealed preference of member i when the analyst has no information about the group feasibility restriction. The following corollary shows $\succsim_{c_i}$ is precisely the transitive closure of the revealed relation $R_{\varphi_{\min,c_i}}$.

Corollary 2. *Given a collectively rational choice profile $(c_i)_{i=1}^n$, $x, y \in X$ and $k \in \{1, \ldots, n\}$, $x \succsim_{c_k} y$ if, and only if, $x\, tran(R_{\varphi_{min}, c_k})\, y$.*

Proof. Fix a collectively rational choice profile $(c_i)_{i=1}^n$, $x, y \in X$ and $k \in \{1, \ldots, n\}$. Claim 2 implies that $x \succsim_{c_k} y$ if, and only if, $x \succsim_{\varphi, c_k} y$ for every constraint φ such that c_i is φ-consistent for every $i \in \{1, \ldots, n\}$. Moreover, part (iii) of Lemma 1 implies that

$$\bigcap_{\{\varphi : c_i \text{ is } \varphi\text{-consistent for each } i\}} \succsim_{\varphi, c_k} \quad = \quad \succsim_{\varphi_{\min}, c_k}.$$

Therefore, $x \succsim_{c_k} y$ if, and only if, $x \succsim_{\varphi_{\min}, c_k} y$. Applying part (ii) of Lemma 1, we get the desired result. $\square$

Corollary 2 has three implications. The first implication is that given a collectively rational choice profile $(c_i)_{i=1}^n$, the preference profile that collectively rationalizes choices is unique if, and only if, $\text{tran}(R_{\varphi_{\min}, c_i})$ is complete for each $i \in \{1, \ldots, n\}$. The corollary then becomes a uniqueness result.

The second implication is that the smaller the sets $\varphi_{\min}(S)$ are, the more incomplete $R_{\varphi_{\min}, c}$ is and, hence, the more incomplete $\succsim_{c_i}$ is. Therefore, a cautious analyst might not be able to infer much about the preferences of group members when their choices are similar. Intuitively, when group members choose similarly, distinguishing whether they have similar preferences or if their choices are due to a common constraint becomes hard. In this sense, Corollary 2 cautions against inferring preferences from choices when there are unobserved constraints that the analyst has little information about. Whenever the analyst suspects that group members face an unobserved constraint, she should first collect more information on the constraint and use this information to disentangle between preference-based and constrained-based choices (see Section 4 below).

The third implication concerns the framework for welfare analysis proposed by Bernheim and Rangel (2009). Specifically, given a profile of choices $(c_i)_{i=1}^n$ and $i \in \{1, \ldots, n\}$, Bernheim and Rangel (2009) say that x is *unambiguously preferred to* y *for* c_i if, for every $S \in \mathcal{M}$, $y \notin c_i(S)$ whenever $x \in S$. They then write $xP^{\star}_{c_i}y$ and show that when $\mathcal{M}$ contains all finite subsets of X, $P^{\star}_{c_i}$ is the most complete acyclic relation satisfying the property that if $x \in c_i(S)$, then $yP^{\star}_{c_i}x$ does not hold for any $y \in S$.

Bernheim and Rangel (2009) propose that the profile $(P^{\star}_{c_i})_{i=1}^n$ and its associated Pareto relation, namely $P^{\star}_{(c_i)_{i=1}^n} := \bigcap_{i=1}^n P^{\star}_{c_i}$, be used to conduct welfare analysis when observed choices are not consistent with preference maximization. The following proposition shows that their approach can starkly disagree with the one I propose.

Proposition 1. *Given a collectively rational profile of choices* $(c_i)_{i=1}^n$ *and* $x, y \in X$, *if* $x \, P^{\star}_{(c_i)_{i=1}^n} \, y$, *then* $x \, R_{\varphi_{min}, c_i} \, y$ *cannot hold for any* $i \in \{1, \ldots, n\}$.

Proof. Fix a collectively rational profile of choices $(c_i)_{i=1}^n$, and $x, y \in X$ with $x \, P^{\star}_{(c_i)_{i=1}^n} \, y$. By definition, this means that, for every $i \in \{1, \ldots, n\}$ and $S \in \mathcal{M}$, if $x \in S$, then $y \notin c_i(S)$. Thus, if $x \in S$, then $y \notin \varphi_{\min}(S)$, and, hence, $x \, R_{\varphi_{\min}, c_i} \, y$ cannot hold for any $i \in \{1, \ldots, n\}$. □

Proposition 1 says that when x Pareto dominates y in the sense of Bernheim and Rangel (2009), our model implies the analyst cannot *directly* infer how a group member ranks x and y. The analyst might still *indirectly* infer that $x \succsim_{c_i} y$ for some $i \in \{1, \ldots, n\}$. For instance, for a member $i \in \{1, \ldots, n\}$, there might exist a $z \in X$ such that $xR_{\varphi_{\min}, c_i}zR_{\varphi_{\min}, c_i}y$ and, hence, $x\text{tran}(R_{\varphi_{\min}, c_i})y$. Corollary 2 then implies that $x \succsim_{c_i} y$. However, in this case, $xP^{\star}_{(c_i)_{i=1}^n}z$ and $zP^{\star}_{(c_i)_{i=1}^n}y$ cannot hold. Therefore, the more complete $P^{\star}_{(c_i)_{i=1}^n}$ is, the more incomplete $\succsim_{c_i}$ will be.

Proposition 1 thus points to a potential shortcoming of approaches to choice-based welfare analysis that do not incorporate the existence of (unobserved) constraints.[10] This potential shortcoming becomes an actual one when the constraint is "physical," so that some alternatives are not actually available (as in Example 4), or "attentional,"

[10]One of the referees argued that Proposition 1 instead points to a shortcoming of this paper's approach because it implies that the approach cannot identify an unambiguously worse alternative. However, this is only true when the analyst has no information about the constraints that group members face. The analyst can thus potentially identify these unambiguously worse alternatives by collecting more information about the constraint (see Section 4).

	$\{x,y\}$	$\{y,z\}$	$\{x,z\}$	$\{x,y,z\}$
φ	$\{y\}$	$\{y,z\}$	$\{x,z\}$	$\{y,z\}$
c_1	y	y	x	y
c_2	y	z	x	z
c_3	y	y	z	y

Table 1: Constraint and Choices in Example 8.

when the group members are not aware that some alternatives are available (as in Example 3).

When the constraint is "soft," as in the case of socially or morally reprehensible choices, the proposition shows that this paper's approach and the Bernheim and Rangel (2009) approach can disagree. When they do, a misalignment exists between personal preferences, i.e., preferences when unencumbered by social constraints, and social preferences, i.e., preferences that internalize the social constraints. The following examples illustrate this point.

Example 8 (*Relative Acceptability*)**.** Let $X = \{x, y, z\}$, and assume that the group faces a constraint φ in which, for every menu S, if $y \in S$, then $x \notin \varphi(S)$. That is, x is considered to be socially unacceptable when y is also available. Assume that the group has 3 members whose preferences are $x \succ_1 y \succ_1 z$, $x \succ_2 z \succ_2 y$, and $y \succ_3 z \succ_3 x$. Table 1 displays the constraint φ and choice profile $(c_i)_{i=1}^3$. The Bernheim and Rangel (2009) approach would infer that $yP^\star_{c_1}xP^\star_{c_1}z$ and $yP^\star_{c_1}z$, whereas $\succsim_{c_1}$coincides with $\succ_1$. The Bernheim and Rangel (2009) approach would further infer $zP^\star_{c_2}yP^\star_{c_2}x$, but that $zP^\star_{c_2}x$ does not hold, whereas $\succsim_{c_2}$ coincides with $\succ_2$. Finally, both approaches agree on c_3, i.e., $P^\star_{c_3} = \succsim_{c_3} = \succ_3$.[11] Interestingly, y Pareto dominates x in the Bernheim and Rangel (2009) sense, i.e., $yP^\star_{(c_i)_{i=1}^3}x$, but $x \succ_1 y$ and $x \succ_2 y$. One way to interpret the difference between the two approaches is to say that the Bernheim and Rangel (2009) approach recovers (part of) the group members' social preferences, whereas this paper's approach recovers their personal preferences. Therefore, the two approaches are complementary to each other.

Example 9 (*Absolute Acceptability*)**.** Let X and preferences be as in the previous example. However, assume that x is socially unacceptable regardless of the menu,

[11] Although $y \succ_{c_3} x$, this does not contradict Proposition 1 because this is an *indirect* inference from $yR_{\varphi_{\min},c_3}zR_{\varphi_{\min},c_3}x$.

i.e., $x \notin \varphi(S)$ for every $S \in \mathcal{M}$. Table 2 displays the constraint φ and choice profile $(c_i)_{i=1}^3$. Note that now all choices are compatible with maximizing a preference relation. The Bernheim and Rangel (2009) approach would recover the preferences $yP^\star_{c_1}zP^\star_{c_1}x$, $zP^\star_{c_2}yP^\star_{c_2}x$, and $yP^\star_{c_3}zP^\star_{c_3}x$, which one could interpret as the members' social preferences. My approach would only recover a part of the underlying individual preference, namely $y \succ_{c_1} z$, $z \succ_{c_2} y$, $y \succ_{c_3} z$, but cannot recover how members rank x relative to the other alternatives. Again, we can interpret the difference between the two approaches as providing complementary information. If the analyst's goal is to predict behavior, then the preferences recovered by the Bernheim and Rangel (2009) approach would suffice. However, if the analyst had to allocate x, y, and z between the group members, she could assign x to group member 3, who ranks x last in her *personal* preferences. My approach would then caution the analyst that she lacks the necessary information about personal preferences to make an informed decision on an allocation. All she can infer about these personal preferences is that she should *not* allocate y to group member 2, or z to group members 1 and 3.

Example 10 (*The Dictator Game*)**.** This example is inspired by the dictator game experiment described by List (2007). Suppose a sender, the dictator, is asked how much to send to a receiver in two scenarios. In both scenarios, the dictator and the receiver are each endowed with 5 dollars. The dictator must then decide how to allocate an additional 5 dollars between the two. In the first scenario, the dictator can send $s_1 \in M_1 \coloneqq \{\$0, \$1, \dots, \$5\}$. In the second scenario, the dictator can, in addition, take \$1 from the receiver, i.e., $s_2 \in M_2 \coloneqq \{\$-1, \$0, \dots, \$5\}$. Assume the dictator states that $s_1 = \$1$ and $s_2 = \$0$, so that $c_{\text{Dic}}(M_1) = \{\$1\}$ and $c_{\text{Dic}}(M_2) = \{\$0\}$. This behavior is incompatible with preference maximization. Now, the Bernheim and Rangel (2009) approach would then only say that \$0 and \$1 are preferred to $\$2, \dots, \$5$, but would suspend judgment about the ranking of \$0 and \$1. However, suppose we conjecture, as List (2007) does, that the dictator never chooses the most

	$\{x,y\}$	$\{y,z\}$	$\{x,z\}$	$\{x,y,z\}$
φ	$\{y\}$	$\{y,z\}$	$\{z\}$	$\{y,z\}$
c_1	y	y	z	y
c_2	y	z	z	z
c_3	y	y	z	y

Table 2: Constraint and Choices in Example 9.

reprehensible amount in a menu, i.e., $\varphi(S) = S \setminus \min(S, \geqslant)$, where $\geqslant$ is the standard ordering of $\mathbb{R}$. Applying this paper's approach, we would then get that $\$0 \succ_{c_{\text{Dic}}} \$1 \succ_{c_{\text{Dic}}} \{\$2, \$3, \$4, \$5\}$.

The results so far relied on the homogeneous constraint assumption. I now revisit Example 7 to show that a similar argument will lead to the characterization of the observable and welfare implications of the model of nested constraints in Example 7 when all the analyst knows is that the constraints are nested.

Example 11 (*Nested Constraints Revisited*)**.** We are back to the setup of Example 7. Recall that each group member $i \in \{1, \ldots, n\}$ faces a group feasibility restriction $F_i \in \mathcal{F}_i$, where for every preference profile $(\succsim_i)_{i=1}^n$ and menu $S \in \mathcal{M}$,

$$F_1[\succsim_1, \ldots, \succsim_n](S) \subseteq \cdots \subseteq F_n[\succsim_1, \ldots, \succsim_n](S).$$

Assume that all the analyst knows is that group members face nested constraints, with member 1 being the most and member n the least constrained. The analyst's knowledge corresponds to the subset $\mathcal{F}$ of profiles in $\prod_{i=1}^n \mathcal{F}_i$ that satisfy this nestedness condition, where, for each $i \in \{1, \ldots, n\}$, $\mathcal{F}_i$ is the collection of all group feasibility restrictions. Therefore, a choice profile $(c_i)_{i=1}^n$ is collectively $\mathcal{F}$-rational when there is a $(F_i)_{i=1}^n \in \mathcal{F}$ and a preference profile $(\succsim_i)_{i=1}^n$ such that for every $i \in \{1, \ldots, n\}$ and $S \in \mathcal{M}$,

$$c_i(S) = \max(F_i[\succsim_1, \ldots, \succsim_n](S), \succsim_i).$$

The first observation, which is analogous to Claim 2, is that collective $\mathcal{F}$-rationality is observationally indistinguishable from a model in which there is a constraint profile $(\varphi_i)_{i=1}^n$ and a preference profile $(\succsim_i)_{i=1}^n$ such that (i) φ_i is independent of the preference profile for each $i \in \{1, \ldots, n\}$, (ii) $\varphi_1(S) \subseteq \cdots \subseteq \varphi_n(S)$ for each $S \in \mathcal{M}$, and (iii) for every $i \in \{1, \ldots, n\}$ and $S \in \mathcal{M}$, $c_i(S) = \max(\varphi_i(S), \succsim_i)$.

The key observation is that whatever is chosen by group member j must be feasible to group member $i \geqslant j$. Define then, for each $i \in \{1, \ldots, n\}$,

$$\varphi_{i,\min}(\cdot) := \bigcup_{k=1}^{i} c_k(\cdot),$$

and note that $\varphi_{i,\min}(\cdot)$ is the minimum constraint compatible with c_i and collective $\mathcal{F}$-rationality and that $\varphi_{1,\min}(\cdot) \subseteq \cdots \subseteq \varphi_{n,\min}(\cdot)$. Thus, it follows from our previous discussion and Lemma 1 that $(c_i)_{i=1}^n$ is collectively $\mathcal{F}$-rational if, and only if, c_i $\varphi_{i,\min}$-consistent. Moreover, $x \succsim_{\mathcal{F},c_i} y$ if and only if $x \operatorname{tran}(R_{\varphi_{i,\min},c_i})\, y$. This implies that contrary to what one would expect, we cannot, in general, rank the relations $\succsim_{\mathcal{F},c_i}$ in terms of set inclusion. In particular, we cannot necessarily recover more of the preferences of the group members that are less constrained.

Still, heterogeneity in the group's choices again plays a crucial role in recovering preferences. However, what matters now is the heterogeneity of member i's choices *relative* to the choices of members $j < i$, since this determines how large the sets $\varphi_{i,\min}(S)$ are, and hence, by part (iii) of Lemma 1, how complete $\operatorname{tran}(R_{\varphi_{i,\min},c_i})$ is. Finally, and interestingly, Proposition 1 still holds when constraints are nested: if $xP^{\star}_{(c_i)_{i=1}^n}y$, then $x\, R_{\varphi_{i,\min},c_i}\, y$ cannot hold for any $i \in \{1,\ldots,n\}$.

4 Learning About the Group Feasibility Restriction

As we now know, $\succsim_{c_i}$ encodes all the analyst can say about the preference of group member i when she has no information about the group feasibility restriction. By Claim 1, the inferences in $\succsim_{c_i}$ would still hold even if the analyst learned more about the group feasibility restriction.

Nevertheless, $\succsim_{c_i}$ can be too coarse in some applications. In such cases, Claim 1 implies that we can learn more about the members' preferences if the analyst gathers more information about the group feasibility restriction. To illustrate this point, we now revisit Examples 1 to 6.

Example 12 (*Preference-Independent Constraints Revisited*)**.** We return to the setup of Example 1. Recall that $\mathcal{F}_J \coloneqq \{\varphi_j\}_{j\in J}$ for some arbitrary index set J, where $\varphi_j \in \mathcal{C}(X,\mathcal{M})$ for each $j \in J$. When J is a singleton, we are back to Lemma 1. In general, fix a collection $(c_i)_{i=1}^n$ and assume that $\varphi_{\min}(\cdot) \subseteq \varphi(\cdot)$ for some $\varphi \in \mathcal{F}_J$ (if not, $(c_i)_{i=1}^n$ cannot be collectively $\mathcal{F}_J$-rational). Assume also that $\mathcal{F}_J$ is closed under intersections, i.e., for every $J' \subseteq J$, the constraint $\bigcap_{j\in J'} \varphi_j(\cdot) \in \mathcal{F}_J$. Define the constraint

$$\varphi_{\mathcal{F}_J}(\cdot) \coloneqq \bigcap_{\{\varphi\in\mathcal{F}_J:\varphi_{\min}(\cdot)\subseteq\varphi(\cdot)\}} \varphi(\cdot).$$

By assumption, $\varphi_{\mathcal{F}_J} \in \mathcal{F}_J$. Lemma 1 now implies that $(c_i)_{i=1}^n$ is collectively $\mathcal{F}_J$-rational if, and only if, for each $i \in \{1,\ldots,n\}$, c_i is $\varphi_{\mathcal{F}_J}$-consistent. Moreover, if $(c_i)_{i=1}^n$

is collectively $\mathcal{F}_J$-rational, then, for each $i \in \{1, \ldots, n\}$ and $x, y \in X$, $x \succsim_{\mathcal{F}_J, c_i} y$ if, and only if, $x \operatorname{tran}(R_{\varphi_{\mathcal{F}_J}, c_i})\, y$. By Lemma 1, for every $i \in \{1, \ldots, n\}$, $\operatorname{tran}(R_{\varphi_{\mathcal{F}_J}, c_i})$ extends $\operatorname{tran}(R_{\varphi_{\min}, c_i})$. That is, more knowledge of the constraint helps with preference identification.

Example 13 (*Moral Constraints Revisited*)**.** We return to the setup of Example 2. Recall that

$$\mathcal{F}_\alpha \coloneqq \left\{F \in \mathcal{C}(X, \mathcal{M})^{\mathcal{R}_X^n} : F[\succsim_1, \ldots, \succsim_n] \text{ satisfies } \alpha, \text{for all } (\succsim_i)_{i=1}^n\right\}.$$

Given a choice profile $(c_i)_{i=1}^n$ that is collectively $\mathcal{F}_\alpha$-rational, define

$$\varphi_\alpha(S) \coloneqq \left(\bigcup_{\{T \in \mathcal{M} : S \subseteq T\}} \varphi_{\min}(T) \right) \cap S.$$

Clearly, φ_α is the smallest constraint that satisfies α and that contains $\varphi_{\min}$. Lemma 1 now implies that $(c_i)_{i=1}^n$ is collectively $\mathcal{F}_\alpha$-rational if, and only if, for each $i \in \{1, \ldots, n\}$, c_i is φ_α-consistent. Therefore, if $(c_i)_{i=1}^n$ is collectively $\mathcal{F}_\alpha$-rational, then, for each $i \in \{1, \ldots, n\}$ and $x, y \in X$, $x \succsim_{\mathcal{F}_\alpha, c_i} y$ if, and only if, $x \operatorname{tran}(R_{\varphi_\alpha, c_i})\, y$. By Lemma 1, for every $i \in \{1, \ldots, n\}$, $\operatorname{tran}(R_{\varphi_\alpha, c_i})$ extends $\operatorname{tran}(R_{\varphi_{\min}, c_i})$. Hence, knowing the constraint satisfies α helps with preference identification.

Interestingly, when $n = 1$, we arrive at the *order rationalization* model of Cherepanov et al. (2013) and the *limited consideration* model of Lleras et al. (2017). Whereas Cherepanov et al. (2013) and Lleras et al. (2017) only consider choice functions and assume that the analyst observes choices from all nonempty subsets of the finite set of alternatives, the results just derived deliver a characterization of these two models — and their corresponding welfare relation — for choice correspondences defined over an arbitrary collection of menus—even when there are infinite alternatives. Moreover, the alternatives $\varphi_\alpha(S)$ are those that the decision-maker in the two models must always consider in the menu S.

Example 14 (*Social Attention Revisited*)**.** We return to the setup of Example 3. Recall that

$$\mathcal{F}_{\text{att}} \coloneqq \{F \in \mathcal{F} : F[\succsim_1, \ldots, \succsim_n] \text{ is an attention filter for all } (\succsim_i)_{i=1}^n\}.$$

Define, for each $S \in \mathcal{M}$,

$$\varphi_{\mathrm{att}}(S) \coloneqq \{x \in S : \varphi_{\min}(S) \neq \varphi_{\min}(S \backslash \{x\})\}.$$

Clearly, $\varphi_{\min}(\cdot) \subseteq \varphi_{\mathrm{att}}(\cdot)$. Moreover, given a choice profile $(c_i)_{i=1}^n$, a preference profile $(\succsim_i)_{i=1}^n$, and an attention filter φ such that $c_i(\cdot) = \max(\varphi(\cdot), \succsim_i)$, for each $i \in \{1, \ldots, n\}$, we have that $\varphi_{\mathrm{att}}(\cdot) \subseteq \varphi(\cdot)$.[12] It follows that if $(c_i)_{i=1}^n$ is collectively $\mathcal{F}_{\mathrm{att}}$-rational, then, by Lemma 1, c_i is φ_{att}-consistent, and thus $\mathrm{tran}(R_{\varphi_{\mathrm{att}}, c_i})$ extends $\mathrm{tran}(R_{\varphi_{\min}, c_i})$ for each $i \in \{1, \ldots, n\}$. Therefore, even when we cannot characterize $\succsim_{\mathcal{F}_{\mathrm{att}}, c_i}$ in terms of the model's primitives, we can still infer more about preferences when we use the information that the constraint is an attention filter.

Example 15 (*Preference Externalities Revisited*)**.** We return to the setup of Example 4. Recall that, for some $1 \leqslant k \leqslant n$,

$$F_k[\succsim_1, \ldots, \succsim_n](S) \coloneqq \{x \in S : x = d \text{ or } N[\succsim_1, \cdots, \succsim_n](x, S) \geqslant k\},$$

where d is a default alternative, which belongs to every $S \in \mathcal{M}$, and $N[\succsim_1, \cdots, \succsim_n](x, S) \coloneqq |\{i \in \{1, \ldots, n\} : x \in \max(S, \succsim_i)\}|$. Fix a choice profile $(c_i)_{i=1}^n$ that is collectively F_k-rational. In general, if the analyst does not know F_k and, for a menu $S \in \mathcal{M}$, $\varphi_{\min}(S) = \{x\}$ for some $x \neq d$, she can infer nothing about consumer preferences from S. However, if she knows F_k, she can infer that at least k consumers prefer x to the other alternatives in S and that all consumers prefer x to d.[13]

Similarly, if the analyst does not know F_k and for a menu $S \in \mathcal{M}$, $\varphi_{\min}(S) = \{d\}$, again she cannot extract any information about preferences from S. However, if she knows F_k, she will know that no alternative $x \in S$ is the most preferred alternative for at least k members, or else x would be available and chosen by these members. Assuming that S is finite, there are then two cases to consider. If $n \leqslant (k-1)|S|$, the analyst can only infer that every alternative in $x \in S \backslash \{d\}$ is preferred by, at most, $k - 1$ members. If $n > (k-1)|S|$, then at least $n - (k-1)(|S| - 1)$ consumers must prefer d to any other alternative in the menu.

[12] To show this, fix a menu $S \in \mathcal{M}$ and assume that $x \notin \varphi(S)$. Then, $\varphi(S \backslash \{x\}) = \varphi(S)$ and, hence, $c_i(S) = \max(\varphi(S \backslash \{x\}), \succsim_i) = c_i(S \backslash \{x\})$ for each $i \in \{1, \ldots, n\}$. Thus, $\varphi_{\min}(S) = \varphi_{\min}(S \backslash \{x\})$ and, hence, $x \notin \varphi_{\mathrm{att}}(S)$.

[13] In fact, whenever $x \in \varphi_{\min}(S)$, the analyst can infer that at least k consumers prefer it to any other alternative in the menu.

Example 16 (*What Would Others Think? Revisited*)**.** We return to the setup of Example 5. Recall that

$$F_{\text{Others}}[\succsim_1, \ldots, \succsim_n](S) \coloneqq \begin{cases} S \setminus \left(\bigcup_{i=1}^n \text{MIN}(S, \succ_i)\right) & , \text{ if } \bigcup_{i=1}^n \text{MIN}(S, \succ_i) \subset S \\ S & , \text{ otherwise} \end{cases}.$$

Assume that the analyst observes all menus of the form $\{x, y\}$, where $x, y \in X$ are distinct, and let $(c_i)_{i=1}^n$ be collectively F_{Others}-rational. In this case, if the analyst knows the feasibility restriction, she knows that if $x \in c_i(\{x, y\})$ for some $i \in \{1, \ldots, n\}$, then $x \succsim_i y$ for every $\succsim_i$ that belongs to a profile that collectively F_{Others}-rationalizes choices — even if $\varphi_{\min}(\{x, y\}) = \{x\}$. If we further assume that $\succsim_i$ is strict for every $i \in \{1, \ldots, n\}$, i.e., $\sim_i = \emptyset$, it follows that $x \succsim_{F_{\text{Others}}, c_i} y$ if and only if $x = c_i(\{x, y\})$. In this case, the analyst can recover the preferences of member i from the menus of two alternatives. She can then calculate the constraint F_{Others} and predict the choices of each group member from every menu $S \in \mathcal{M}$.

To illustrate how much is gained by knowing F_{Others} , assume that $\varphi_{\min}(\{x, y\}) = \{x\}$, and $\varphi_{\min}(\{y, z\}) = \{y\}$ for some $x, y, z \in X$. Then, the analyst cannot (cautiously) infer preferences from these menus when she has no information about F_{others}. But if she knows F_{others}, she can infer that $x \succsim_i y \succsim_i z$, for all $i \in \{1, \ldots, n\}$, with $x \succ_{i_1} y$ and $y \succ_{i_2} z$ for some $i_1, i_2 \in \{1, \ldots, n\}$. Moreover, she can now infer that $c_i(\{x, z\}) = \{z\}$, for every $i \in \{1, \ldots n\}$, since $z \in \text{MIN}(\{x, z\}, \succ_{i_1}) \cap \text{MIN}(\{x, z\}, \succ_{i_2})$ and, hence, $z \notin F_{\text{Others}}[\succsim_1, \ldots, \succsim_n](\{x, z\})$.

Example 17 (*Hierarchical Decisions Revisited*)**.** We are back to the setup of Example 6. Recall that

$$F_H[\succsim_1, \ldots, \succsim_n](S) \coloneqq \max(\cdots(\max(\max(S, \succsim_1), \succsim_2)) \cdots, \succsim_n).$$

Let $\text{id}_{\mathcal{M}}$ be the identity correspondence, that is, $\text{id}_{\mathcal{M}}(S) \coloneqq S$, for all $S \in \mathcal{M}$. If a choice profile $(c_i)_{i=1}^n$ is collectively F_H-rational, there exists a profile $(\succsim_i)_{i=1}^n$ such that

$$c_i(S) = \max(F_H[\succsim_1, \ldots, \succsim_n](S), \succsim_i) = F_H[\succsim_1, \ldots, \succsim_n](S)$$

for each $i \in \{1, \ldots, n\}$. That is, this hierarchical procedure leads group members to choose the same alternatives from every menu. Note that

$$\max(\cdots(\max(\max(S, \succsim_1), \succsim_2))\cdots, \succsim_n) = \max(S, L[\succsim_1, \ldots, \succsim_n]),$$

where $L[\succsim_1, \ldots, \succsim_n]$ is the lexicographic order induced by $(\succsim_i)_{i=1}^n$.[14] Since $L[\succsim_1, \ldots, \succsim_n]$ is complete and transitive whenever each $\succsim_i$ is, we conclude that $(c_i)_{i=1}^n$ is collectively F_H-rational if, and only if, $c_i = c_j$, for each i, j, and c_1 is $\mathrm{id}_{\mathcal{M}}$-consistent. Therefore, group members' choices are not only the same but also compatible with preference maximization. Hence, if the analyst assumed that there was no constraint, she would infer that all group members shared the same preference, namely $L[\succsim_1, \ldots, \succsim_n]$. If she knew a constraint existed but had no information about it, then, by Corollary 2, she could only (cautiously) infer indifferences from choices, that is, for each $i \in \{1, \ldots, n\}$, $\succ_{c_i} = \emptyset$. Finally, if the analyst knew F_k, then, by Lemma 1, for each $i \in \{1, \ldots, n\}$ and $x, y \in X$,

$$x \succsim_{F_H, c_i} y \text{ if, and only if, } \begin{cases} x \,\mathrm{tran}(R_{\mathrm{id}_{\mathcal{M}}, c_i})\, y & i = 1 \\ x \,\mathrm{tran}(R_{\mathrm{MAX}(S, \succsim_{F_H, c_{i-1}}), c_i})\, y & i = 2, \ldots, n \end{cases},$$

where $\mathrm{MAX}(S, \succsim_{F_H, c_{i-1}}) \coloneqq \{x \in S : \nexists y \in S \text{ s. t. } y \succ_{F_H, c_{i-1}} x\}$.

5 Concluding Remarks

This paper presents a general framework for studying welfare inferences under unobserved social constraints. Inferring people's individual preferences from choices becomes much harder when these choices are constrained by the rules and norms of the groups one identifies with. In this case, standard approaches to choice-based welfare analysis can lead to incorrect inferences about individual preferences. To avoid or at least qualify such inferences, this paper suggests a notion of revealed preferences that incorporates the existence of constraints. At the very least, the welfare inferences of this paper's approach offer complementary information to those offered by approaches that ignore unobserved social constraints.

When constraints are homogeneous, this paper's proposed notion of revealed pref-

[14] That is, for each $x, y \in X$, $xL[\succsim_1, \ldots, \succsim_n]y$ if $x \succsim_1 y$, or $x \sim_1 y$ and $x \succsim_2 y$, or ..., or $x \sim_i y$ for $i \in \{1, \ldots, n-1\}$ and $x \succsim_n y$.

erences suggests that we should be cautious about inferring individual preferences from choices when people's choices are too similar, as this similarity may be due to the constraint rather than individual preferences. However, when people's choices are heterogeneous, we can leverage the heterogeneity to recover preferences. We can do even better if we learn more about the group feasibility restriction. As we have seen, these lessons remain valid if one assumes that constraints are nested rather than homogeneous.

This paper suggests three avenues for future research. The first is to advance the analysis in Section 4 and study the welfare implications of specific types of group feasibility restrictions, i.e., majority voting. The second is to extend the analysis to incorporate the heterogeneity in the constraints group members face. Example 7 is a first step in this direction. The third is to study the consequences of allowing that group members have different propensities to obey the constraint. This case is relevant when these propensities do not correlate with members' observable characteristics.

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