Testing Simplicity Standards in Uniform Rationing*

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Abstract

Mechanisms often do not perform as well as theory might predict. A potential remedy is the idea of standards of simplicity—properties that are theorized to allow people to understand actions and payoffs in mechanisms more optimally. We theoretically characterize and experimentally investigate four uniform rationing mechanisms. Our design allows us to identify the effect on optimal play of three simplicity properties of a strategy and two simplicity properties of a mechanism, and their effect in overall mechanism performance. All five simplicity standards have positive impacts in at least one of these dimensions. Subjects are most likely to play focal actions in the context of a choice in a deterministic problem, followed by the actions involved in the execution of obviously dominant strategies. However, mechanisms achieve the greatest efficiency and mutual optimal play when subjects have the opportunity for cheap talk pre-play. Even though continuation actions of obviously dominant strategies are more frequent than other types of focal actions, the length of equilibrium play in an obviously dominant strategy mechanism reduces the chance that they are completed. When they fail early, welfare consequences are substantial.

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1 Introduction

Since the introduction of dominant-strategy mechanisms (Gibbard, 1973; Satterthwaite, 1975), economists have formulated different theoretical simplicity standards for economic mechanisms. These requirements are often incompatible. It is an empirical question to evaluate whether mechanisms that possess some of these properties have a practical advantage over those that do not. In this paper, we study two prominent simplicity standards, introduce three intuitive new requirements; and design and carry out an experiment with four Uniform Rationing mechanisms (Benassy, 1982; Sprumont, 1991) that allows us to meaningfully evaluate them. All five simplicity standards have positive impacts in at least one of these dimensions. Allowing for cheap talk pre-play, though not infallible, simplifies the most agent's play. This also induces best performance in both efficiency and frequency of uniform outcomes. Consistent with previous literature, the frequency of dominant actions that are part of strategies that can be identified with no contingent reasoning (Obviously Dominant Strategies, ODS) is higher than those that cannot. However, overall, the existence of ODSs may not simplify enough a mechanism to outweigh the propensity to eventually make a mistake in the chain of decisions that are necessary in an ODS mechanism.

To fix ideas it is convenient to think of a mechanism design environment in which agents' characteristics are described by a "type." A mechanism designer would like the society to obtain an outcome that depends on agents' types, which are private information of the agents. A mechanism is composed of a communication protocol and an outcome function. The mechanism designer asks agents to communicate some information, with precise instructions about its timing and rules. The outcome function maps (histories of) messages to outcomes.

Three examples that are relevant to us illustrate this structure. In the Direct Revelation (DRU) mechanism, the mechanism designer simultaneously asks each agent for their type and the outcome is the mechanism designer's recommendation for these reports. In a Sequential Revelation (SRU) mechanism, the mechanism designer asks agents for their type in a given order and reveals the partial reports as the mechanism progresses. The outcome is the mechanism designer's recommendation for the final history of reports. In the Continuous Feedback (CFU) mechanism, the mechanism designer asks agents for their type, announces them, and provides a window of time in which agents can revise them. The outcome is the mechanism designer's recommendation for the last reports.

When a mechanism is operated in a given information environment it induces a game. Our notions of mechanism simplicity articulate two different ideas. The first is the simplicity of a given optimal strategy in a game. One can say that the strategy is simpler when it is easier for the agent to determine that it is optimal. For instance, a strategy that is always optimal may be more easily identified as that, than a strategy whose optimality depends on the actions of the other agents. To optimally play the second strategy it is necessary that the agent makes an appropriate conjecture on the behavior of the other agents. It is an empirical question whether a simpler strategy is played more often, however. Identifying some strategies as weakly dominant may require some sophistication. In some cases, it may be easier to make an informed guess and play optimally to it.

The second is the simplicity of a mechanism as a whole. A mechanism is simpler for an agent when playing optimally in its induced games is easier for the agent. For instance, consider the DRU and CFU mechanisms, mentioned above. In DRU playing optimally requires that the agent plays an action that ends up being optimal given what the other does. This implies that the agent either (i) discovers that there are actions that are always optimal (if they are available); or (ii) correctly predicts the others' actions and responds optimally to them. CFU is intuitively simpler. In this mechanism, an agent may have a credible signal of the intention of play of the other agents. Thus, they can just optimally respond to these intentions, reducing the need to deeply understand their options. Thus, CFU may be simpler (if cheap talk ends up being informative and credible) than DRU, even when DRU already has a weakly dominant strategy. It is an empirical question to determine whether the agents play simpler strategies with higher frequency in DRU or CFU. The later mechanism can reduce the complexity of finding an optimal strategy in the game, which may reduce the focality of strategies that are unambiguously optimal.

A mechanism succeeds if it obtains the outcomes intended by the mechanism designer. This need not require agents to select simpler strategies. Thus, while having simpler strategies may be desirable, simpler mechanisms that do not bolster the focality of these strategies may serve the mechanism designer best. It is an empirical question, to determine the effect of simplifying a mechanism in terms of its performance. Our experiment allows us to document some of these trade offs in the lab and identify channels by which different simplicity notions improve the performance of economic mechanisms.

Table 1 summarizes the simplicity properties we study, which we discuss in detail in Sec. 2 (our discussion above foretells two of these properties). We conduct experiments with four mechanisms for the rationing of a good when agents have satiable preferences (Benassy, 1982; Sprumont, 1991). To the extent of our knowledge this is the first paper that tests mechanisms in this environment. It is also the first experimental design of the novel ODS Uniform rationing mechanism proposed

	Mechanism					
	DRU	SRU (1st)	SRU (2nd)	*OSPU* (strategy/ path)	*OSPU* (action/ node)	CFU
($f1$) Optimality of focal action does not depend on conjecture of others' play (Gibbard, 1973; Satterthwaite, 1975)	+	−	+	+	+	+
($f2$) Identifying focal action optimality does not require contingent reasoning (Li, 2017)	−	−	+	+	+	−
($f3$) Fat-finger error safety	+	+	+	−	+	+
($m1$) Determinacy	−	−	+	−	−	−
($m2$) Cheap talk allowed	−	−	−	−	−	+

Table 1: Simplicity Properties in Mechanism Design; $f1$, $f2$, $f3$, and $m1$ are properties of focal strategies that achieve the mechanism designer's objective; $m2$ is an information availability property of mechanisms.

by Arribillaga et al. (2020). Our design offers a uniform environment in which hypotheses are tested. It also offers enough variation of mechanism properties for us to identify their effect on performance (Table 1). Indeed, no mechanism satisfies all properties for all participants. All properties are violated by at least one mechanism, and are satisfied by at least one mechanism. Their effects can also be separately identified by treatment variation (see footnote 6).

The remainder of the paper proceeds as follows. Sec. 2 discusses in detail the simplicity properties in our study. Sec. 3 introduces rationing problems and the mechanisms we test in our experiment. Sec. 4 presents our experimental design. Sec. 5 presents our results. Sec. 6 concludes.

2 Simplicity properties

We first identify three simplicity properties of a strategy for an agent in a game. The first property (Table 1-$f1$) is to be weakly-dominant (Gibbard, 1973; Satterthwaite, 1975). These strategies are optimal for an agent independently of the other players' choices. Thus, when they are available the agent can play optimally in the game without having to make a conjecture about the behavior of the other agents.[1] Thus, playing these strategies is simple, for they bypass agents' uncertainty about utility maximization.

There is evidence that agents may fail to choose weakly-dominant actions when these are available (see Velez and Brown, 2022, for a survey). This phenomenon is

[1]Even though Gibbard (1973) was suspicious of the positive content of dominant strategy equilibrium in "non-voting" environmets, the simplicity motivation for the property is frequently used by economists. See, for instance, Sprumont (1991) for the environment in which we perform our experiments.

not uniform across all mechanisms. Indeed, while in the second-price auction agents persistently bid away from their valuations, they drop from English auctions at their valuations with a significantly higher frequency (Kagel et al., 1987). Motivated by these observations, Li (2017) identified a property of weakly dominant strategies in the English auction that is violated by those in the second-price auction. This property arguably captures an essential difference that may explain, at least in part, the difference in behavior in these auction. Li's idea is that in some dominant strategy mechanism as the second-price auction, realizing that a strategy is weakly dominant requires agents engage in contingent reasoning. By contrast, realizing that a strategy is weakly dominant in the English auction, does not require contingent reasoning (Table 1-$f2$).

Agents behave, at best, as noisy utility maximizers in experiments (c.f. Goeree et al., 2016). Even in deterministic choice problems, agents end up choosing suboptimal actions with positive probability (for instance, see behavior of second mover in SRU in our experiment). A possible source of this behavior is fat-finger mistakes, i.e., procedural involuntary errors of strategy implementation. Our third simplicity property (Table 1-$f3$) articulates a comparative measure based on this observation. We compare strategies in the game induced by a mechanism for a given information structure and realization of agents' types. We say that a given strategy S is fat-finger error safer, at the given information structure and the realization of types, than S' if the number of nodes at which an agent is called to act in S is no greater than in S'. We say that S is fat-finger error safer than S' if the comparison always holds. The mechanisms we consider are ranked in two equivalence classes with respect to safety to fat-finger errors (+ is safer in terms of fat-finger errors than -).

A mechanism is Determinate (Table 1-$m1$) for an agent if the agent's payoff depends only on their actions, not on the other agents' actions or nature moves. Differently from the previous properties, which are simplicity standards of a particular strategy, this property applies to a mechanism for a particular agent. It requires that the payoffs of each an every action that is available to the agent does not depend on the other agents' actions.

A mechanism allows for cheap talk if agents are given the opportunity to signal their actions in the game without committing to them (Table 1-$m2$). Intuitively, this simplifies the mechanism. By allowing this release of information the mechanism designer reduces each agent's need to make an informed conjecture about the behavior of other agents if there are no deceitful messages. Our inclusion of cheap talk as a possible information release tool for the mechanism designer is motivated by the practice in market design environments. In some contexts, electronic communication and feedback between participants and a market clearinghouse is realistic. For instance, in the school district of Wake County, N.C., USA, parents are provided a window of time to report their preferences on schools. They are also informed about aggregate information about previous reports (Dur et al., 2018).

It is important to note that our interest in a cheap talk communication phase is limited to mechanisms that have dominant strategies. We want to evaluate whether this phase may affect the focality of dominant strategies and also may possibly affect the overall performance of the mechanism.

3 Uniform Rationing and Mechanisms

In this section we introduce rationing problems with satiable preferences (Benassy, 1982; Sprumont, 1991). We also describe four mechanisms for these problems, which we use in our experimental design, and their benchmark theoretical predictions.

3.1 Uniform rationing

We consider a mechanism designer who needs to allocate twenty units of a good among two agents with satiable preferences. There are two agents $N = \{1, 2\}$. Agent i has a preferred amount of the good $\theta_i \in \{0, 1, ..., 20\} = \Theta_i$. We refer to this amount as the agent's peak. The agent loses utility as their assignment moves away from this ideal consumption.

An example is an instructor who needs to assign twenty hours of grading and twenty hours of tutoring among two teaching assistants. Each teaching assistant needs to be assigned a total of twenty hours of work. Thus, the allocation can be reduced to decide the number of tutoring hours each TA serves. If teaching assistants have convex preferences on bundles of grading and tutoring, their preferences on tutoring are satiable.

For concreteness, and anticipating our experimental design, we assume that if agent i is assigned an amount $x \in \{1, ..., 20\}$, her payoff is

$$u_i(x, \theta_i) = K - |\theta_i - x|. \tag{1}$$

We assume that agents are expected utility maximizers with utility index u_i. We chose $K = 20$ in our experiment, to avoid the possibility of bankruptcy.

In the usual language of mechanism design, agent i's type space is Θ_i. A type $\theta_i \in \Theta_i$ determines a private-values payoff function. We model information by means of a common prior p, i.e., a probability measure on $\Theta = \Theta_1 \times \Theta_2$. A complete information prior places probability one in a single state. We denote these priors simply by their support.

3.2 Uniform rule

A social choice function selects an allocation for each state. Arguably, the most prominent scf in our environment is the Uniform Rule (Benassy, 1982; Sprumont, 1991), which determines the allocation for a given state $\theta = (\theta_1, \theta_2)$ as follows.

1. If $\theta_1 + \theta_2 = 20$: The agents receive their preferred amounts.
2. If $\theta_1 + \theta_2 > 20$: There is a unique $\lambda \geq 0$ for which $\min\{\theta_1, \lambda\} + \min\{\theta_2, \lambda\} = 20$. Agent i receives $\min\{\theta_i, \lambda\}$.
3. If $\theta_1 + \theta_2 < 20$: There is a unique $\lambda \geq 0$ for which $\max\{\theta_1, \lambda\} + \max\{\theta_2, \lambda\} = 20$. Agent i receives $\max\{\theta_i, \lambda\}$.

We denote the allocation chosen by the Uniform Rule for state $\theta \in \Theta$ by $U(\theta)$.

The Uniform rule has multiple desirable properties. It is envy-free, i.e., no agent prefers the allotment of another agent to her own (c.f., Sprumont, 1991). It is Pareto efficient, i.e., no agent can be better off without any other agent being worse off (c.f., Sprumont, 1991).[2] It is non-bossy, i.e., no agent can change the outcome without changing her own welfare (c.f., Bochet and Tumennassan, 2020; Schummer and Velez, 2021). Finally, it is strategy-proof, i.e., for each $\theta \in \Theta$, each $i \in N$, and each $\theta_i' \in \Theta_i$, $u_i(U(\theta)|\theta_i) \geq u_i(U(\theta_i', \theta_{-i})|\Theta_i)$ (c.f., Sprumont, 1991).

We consider four different mechanisms to obtain the Uniform allocation when the mechanism designer has no knowledge of the true type of the agents. We discuss their simplicity properties as defined in Sec. 2 (see also Table 1).

3.3 Direct Revelation Uniform Mechanism (DRU)

The first option we consider is to ask agents directly for their types. Then assign the Uniform allocation for the reports. This mechanism can be modeled as a simultaneous-move game-form in which agent's action space is their type and the outcome function is the Uniform rule. We denote this game-form by DRU. Given a prior p, this game-form induces a game (DRU, p). A (type-)strategy in this game is a function that assigns a probability measure over actions for each agent-type.

Since U is strategy-proof, the truthful strategy, i.e., unconditionally reporting true peak, is weakly-dominant in any (DRU, p) (Sprumont, 1991). This means the truthful strategy satisfies $f1$.

[2] In this environment, an allocation is Pareto efficient whenever all agents consume on the same side of their peak.

θ_2	≤ 10	11	12	13	14	15	16	17	18	19	20
$u_1(4, \theta_2)$	15	16	17	18	19	20	19	19	19	19	19
$u_1(5, \theta_2)$	15	16	17	18	19	20	20	20	20	20	20

Table 2: Contingent reasoning in Simultaneous Uniform Rationing game.

Our Simultaneous Uniform Rationing Mechanism illustrates how identifying a dominant strategy may require contingent reasoning –this means the truthful strategy in DRU does not satisfy $f2$. That is, discovering that reporting an agent's peak weakly dominates any other report requires that the agent conditions the comparison on a given report of the other agent. Suppose that agent 1 has peak 5. Table 2 shows the different payoffs that are obtained by reports 4 and 5 as a function of the other agent's report. If the agent understands the structure of the game in detail, they know that (in a one-shot realization of the game) their actions do not influence the behavior of the other agent. Thus, reporting 5 will always lead to a payoff that is no less than reporting 4, and in some events the payoff of 5 will be higher. If the agent has a coarse understanding of the game, i.e., can only grasp that reporting 4 or 5 both lead to payoffs $\{15, ..., 20\}$ in some events, but is not able to understand the logical relation between these events, reporting 5 may not be identified as unambiguously better than 4.

Since each agent moves exactly once in each induced game of DRU, the truthful strategy, and indeed any strategy in this mechanism, is at least as safe with respect to fat-finger mistakes than the strategies in all mechanisms we consider. Thus, the truthful strategy in DRU is at the top level of $f3$.

DRU is not determinate for any agent. Note that the allotment for an agent depends on the report of the other agent. This mechanisms does not allow cheap talk. Thus, DRU neither satisfies $m1$, nor $m2$.

Two benchmarks are relevant to our understanding of behavior in DRU. The first is the truthful equilibrium, which is the unique equilibrium in weakly-dominant strategies in these games. The second is Nash equilibrium. The following proposition illustrates that there are usually multiple Nash equilibria in these games.

Proposition 1 (Bochet and Tumennasan, 2020)**.** *Let $\theta \in \Theta$ be such that $U(\theta)_i \leq 10 \leq U(\theta)_j$. Then, the space of pure-strategy Nash equilibrium outcomes of (DRU, θ) is the set of allocations (x_i, x_j) where $U(\theta)_i \leq x_i \leq 10 \leq x_j \leq U(\theta)_j$.*

The "no-trade" equilibrium in these games is robust to informational assumptions. Unconditionally reporting a demand of 10 constitutes an ex-post equilibrium of the game. That is this report is a best response to the other agent's equilibrium report for any realization of agents' types.

3.4 Sequential Revelation Uniform Rationing Mechanism (SRU)

Instead of simultaneously ask agents for their type, a mechanism designer may sequentially ask agents for their types and reveal the partial reports to agents down the line. This mechanism can be modeled as an extensive-game-form in which the mechanism designer first randomly chooses an agent and ask for their type. Then the mechanism designer reveals the report to the other agent and asks them for their type. The outcome is the Uniform allocation for the reported types.

We avoid the lengthy formalism and denote this extensive-game-form by SRU. For a common prior p, SRU induces an extensive-form game (SRU, p). A strategy in this game is a function that assigns a probability measure over actions for each agent-type at each node in which they are called to move.

Asking an agent to reveal their type to a second mover destroys the weak-dominance of truthful reports for the first mover. Thus, SRU violates $f1$ for the truthful strategy of first mover. For instance, suppose that agent 1, who will report first, has peak 8 and agent 2 has peak 13. Suppose also that agent 2 will report 10 instead of their dominant strategy 13, unless agent 1 reports 7. Agent 1 has a strict incentive to report 7 instead of 8. This implies that SRU violates $f2$ for the truthful strategy of the first mover as well, and that SRU is not Determinate for this agent ($m1$).

On can argue that truthful strategies are still focal for first mover even though they are not weakly dominant. If the first mover counts on the second mover's rationality, truthful strategies are always a best response for the first mover (Schummer and Velez, 2021). For instance, in our example above, if agent 1 counts on agent 2's rationality, they know that after reporting 8, agent 2 has a disincentive to report 10.[3]

From the point of view of the second mover in SRU, the mechanism is deterministic. Thus, SRU satisfies $m1$ for the second mover. This implies that any utility maximizing strategy satisfies $f1$ and $f2$ for the second mover in SRU. That is, any strategy for the second mover that chooses a utility maximizer at the second node is an Obviously Dominant Strategy.

Similarly to DRU, any strategy in SRU is as safe, with respect to fat-finger errors, as any other strategy in any mechanism we consider. Thus, SRU is at the top level in $f3$.

SRU does not allow for cheap talk ($m2$).

Two benchmarks are relevant to our understanding of behavior in SRU. First,

[3]One can make a further argument for focality of truthful strategies for first mover in SRU. They are best responses to any equilibrium conjecture. See Proposition 2. A related form of simplicity has been studied by Börgers and Li (2019).

the truthful/dominant-strategy equilibrium in which the first mover reports their peak, and the second mover chooses a utility maximizer action. This equilibrium has as outcome the Uniform allocation. Second, the whole set of perfect equilibria of this game.

Proposition 2 (Schummer and Velez, 2021)**.** *For each p, in each perfect Bayesian equilibrium of (SRU, p), and for each realized state, the outcome is the Uniform allocation. Moreover, if any agent replaces their equilibrium strategies with the truthful strategy, it is again a perfect Bayesian equilibrium*

3.5 Obviously Strategy-proof Uniform Rationing Mechanism (OSPU)

Some mechanisms do not require contingent reasoning for an agent to identify an action as weakly-dominant. The following mechanism, proposed by Arribillaga et al. (2020), is one of these. If both agents play their unique weakly-dominant strategies, the outcome is the Uniform allocation for each possible state. Since this weakly-dominant strategy requires no contingent reasoning to identify it, it is referred to as *Obviously Dominant* (Li, 2017). An extensive-form mechanism that possesses an equilibrium in obviously dominant strategies is *Obviously Strategy-proof* (Li, 2017).

Obviously Strategy-proof Uniform Rationing (OSPU): The assignment is done by means of the following clock-auction type procedure. To start, let the initial temporary assignment be $x_1^0 = x_2^0 = 10$.

1. **Step 0**: Inform agents of their temporary assignment. Ask each agent to choose between $x_i^0 - 1$, x_i^0, and $x_i^0 + 1$. Let x_1^1 and x_2^1 be their choices. If some agent chooses her initial temporary assignment or $x_1^1 + x_2^1 \neq 20$, the game finishes and agents are assigned x_1^0 and x_1^0, respectively. Otherwise, revise the temporary assignment to x_1^1 and x_2^1. Let $\Delta_i = x_i^1 - x_i^0$. Note that Δ_1 and Δ_2 are both different from zero and $\Delta_1 + \Delta_2 = 0$.

2. **Step t=1,2,...**: At the beginning of this step, temporary allotments are $x_1^t > 0$ and $x_2^t > 0$. Inform agents that they have been temporarily assigned x_i^1. Inform agent i that unless one of the agents opts out, their temporary assignment will be revised to $x_i^t + \Delta_i$. Provide a fixed time to make this decision. If at least one agent opts out, x_1^t and x_2^t becomes the final assignment and the game finishes. If no agent opts out, the temporary allotments are revised to $x_i^{t+1} = x_i^t + \Delta_i$. The game finishes if one temporary assignment becomes zero. At this point the temporary assignment becomes final. Otherwise, the game continues to Step $t + 1$.

This mechanism can be modeled as an extensive-game form, whose lengthy formalization we avoid (c.f., Li, 2017; Pycia and Troyan, 2019; Arribillaga et al., 2020). The essential characteristic of this mechanism is that agents can identify their weakly-dominant strategy without engaging in contingent reasoning. Thus, this strategy satisfies satisfies $f1$ and $f2$. Suppose for instance that agent 1 has peak 5 and is called to move at stage zero. The agent needs to decide between requesting 9, 10, and 11. Requesting 9 (and then keep asking for less until reaching their peak) leads to payoffs $\{15, 16, ..., 20\}$; requesting 10 leads to payoff $\{15\}$; and requesting 11 (and then dropping at the next node) leads to payoffs $\{14, 15\}$. It is not necessary to know how the events that cause the different payoffs are logically related to conclude that at this information set, requesting 9 is always weakly better and is sometimes strictly better than the other actions.

OSPU is dominated by the other mechanisms in terms of safety against fat-finger mistakes. If the Uniform outcome is different from equal division, the OSPU game requires each agent chooses more than one action. Indeed, at an outcome where agents receive $10 - x$ and $10 + x$, each agent in OSPU is called to move in the equilibrium path $x + 1$ times. Thus, OSPU is at the lower level of $f3$.

Cheap talk is not allowed in this mechanism. Thus, OSPU does not satisfy $m2$. No agent has certainty of payoffs when they take their actions. Thus, OSPU also violates $m1$.

Our benchmark theoretical prediction for this game is the obviously-dominant strategy equilibrium of the game. Since agents move simultaneously, the game also has multiple Nash equilibria that produce outcomes different from the Uniform allocation.[4]

3.6 Continuous Feedback Mechanism (CFU)

The continuous feedback mechanism asks agents directly for their types and makes assignments according to the uniform rule. Agents can adjust their reports over a finite period spanning the time interval $[0, T] \subseteq \mathbb{R}_+$. During the reporting period, agents are informed about their tentative assignments under the currently selected reports. Finalized assignments are determined by the finalized reports selected at the end of the reporting period.

Since the finalized assignments are exclusively based on finalized reports, the tentative reports selected during the reporting period may be interpreted as "cheap talk." Thus, CFU is the only of the mechanisms we consider that allows for cheap talk ($m2$).

[4]Note that if moves are sequentialized in OSPU, there are no weakly-dominant strategies for any agent in the induced games.

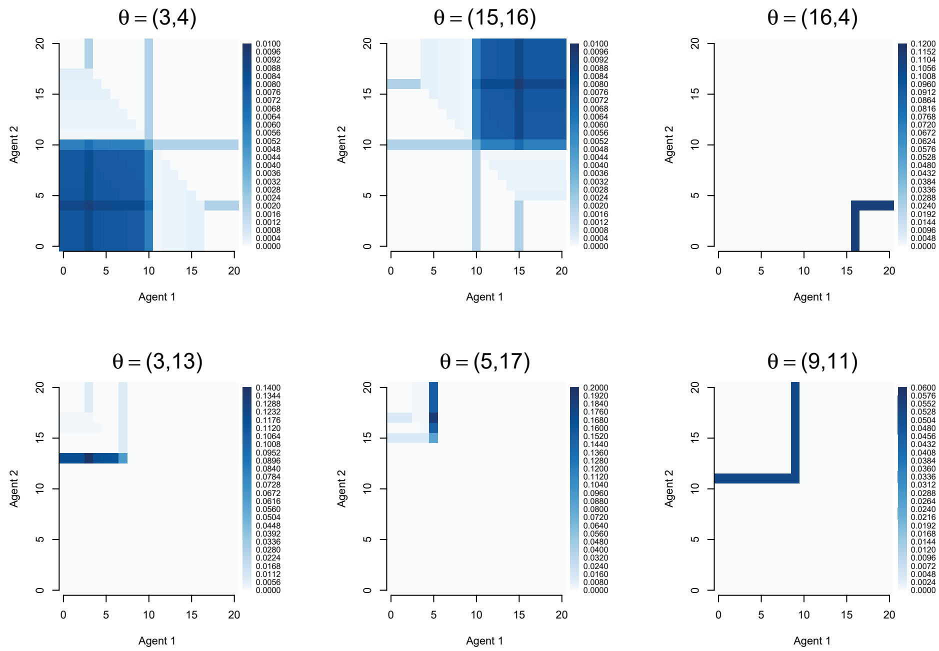


Figure 1: Limiting Report Distribution

Except for allowing for cheap talk, CFU coincides with DRU based on final reports. Thus, it arguably shares all other properties with this mechanism.

Two theoretical benchmarks are relevant for our understanding of the cheap talk stage in CFU, which we assume determines final reports in the mechanism. Both are based on evolutionary dynamics (Fudenberg et al., 1998; Hofbauer and Sigmund, 2003; Sandholm, 2010). This model describes agents who adjust their behavior over time according to simple rules. Let $x_i(r)$ denote the assignment to agent i from the report profile $r = (r_1, r_2) \in \Theta^2$ under uniform rule. Let $\pi_i(r) = u_i(x_i(r), \theta_i)$ denote agent i's payoff from the report profile r under the uniform rule.

The first benchmark is the best response dynamic, which describes agents who myopically select best responses. Let $r_{ti} \in \Theta$ denote the report selected by agent i at time t. Agent i's initial report is uniformly distributed over Θ. Each agent revises her report at points in time generated by an independent Poisson process. Let $b_{ti} : \Theta \to \{0, 1\}$ be agent i's myopic best response (indicator) function at time t.

$$b_{ti}(z_i) = \begin{cases} 1 & \text{if } \pi_i(z_i, r_{tj}) = \max\limits_{y_i \in \Theta} \pi_i(y_i, r_{tj}) \\ 0 & \text{otherwise} \end{cases}$$

Let $P_{ti}(z_i)$ denote the probability that an agent i who revises her report at time t will select the new report $z_i \in \Theta$.

$$P_{ti}(z_i) = \frac{b_{ti}(z_i)}{\sum_{y_i \in \Theta} b_{ti}(y_i)}$$

Figure 1 illustrates the limiting distribution of the report profile r_t as $t \to \infty$ under the best response dynamic. The horizontal axis depicts the report selected by agent 1. The vertical axis depicts the report selected by agent 2. Lighter colors indicate less probable report profiles. Darker colors indicate more probable report profiles.

Some of the report profiles selected with positive probability in the limiting distribution are not Nash equilibria. For example, the report profile $r = (3, 20)$ is not a Nash equilibrium under the type profile $\theta = (3, 4)$ because agent 2 is not best responding.

$$\pi_2(3, 20) = K - |4 - 17| < K - |4 - 10| = \pi_2(3, 4)$$

Non-equilibrium report profiles can persistently reoccur under the best response dynamic because they can be reached from equilibrium via a series of best responses.

$$\begin{aligned}
\pi_1(3, 4) &= K - |3 - 10| = \pi_1(10, 4) \\
\pi_2(10, 4) &= K - |4 - 10| = \pi_2(10, 20) \\
\pi_1(10, 20) &= K - |3 - 10| < K - |3 - 3| = \pi_1(3, 20)
\end{aligned}$$

Our second theoretical benchmark is the logit dynamic (Fudenberg et al., 1998), which describes agents who stochastically adjust their behavior over time. Such agents are more likely to select actions that earn higher payoffs and less likely to select action that earn lower payoffs. Each agent revises her report at points in time generated by an independent Poisson process. Let $P_{it}(z_{it})$ denote the probability that an agent i who revises her report at time t selects the new report $z_{it} \in A$.

$$P_{it}(z_{it}) = \frac{\exp(\lambda_i \pi_{it}(z_{it}, r_{jt}))}{\sum_{y_i \in A} \exp(\lambda_i \pi_{it}(y_{it}, r_{jt}))} \tag{2}$$

The parameter λ_i denotes agent i's sensitivity to payoffs. In the limit as $\lambda_i \to 0$, agent i selects reports uniformly at random. In the limit as $\lambda_i \to \infty$, agent i always selects a payoff maximizing report.

The best response dynamic alerts us about the possible persistence of non-

Period	1	2	3	4	5	6	7	8	9	10	11	12
Subject A	3	15	16	3	5	9	4	16	4	13	17	11
Subject B	4	16	4	13	17	11	3	15	16	3	5	9

Table 3: Type Assignments by Period

Figure 2: Direct Revelation Uniform

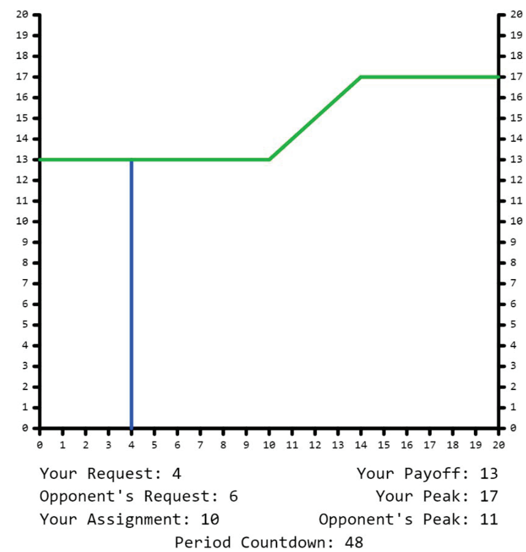


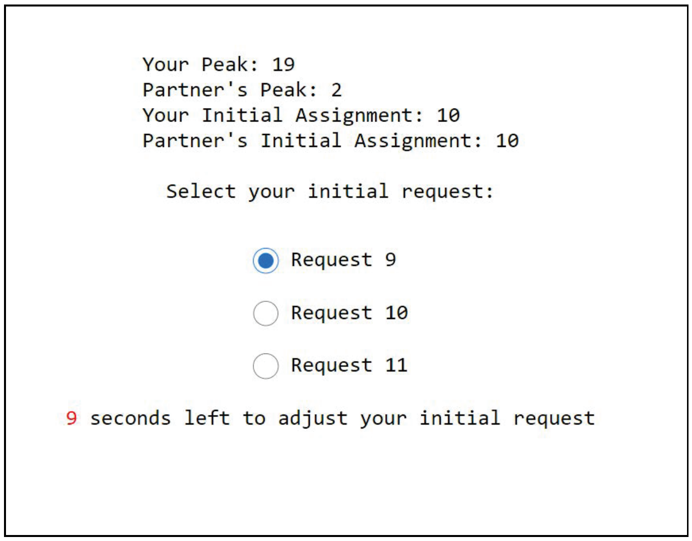
Figure 3: Continuous Feedback

equilibrium behavior in CFU. The logit dynamic gives us a parametric model to evaluate the effect of cheap talk on equilibrium behavior (we observe agents adjustments in both DRU and CFU).

4 Experimental Design

This study implements an experimental design with four experimental treatments in order to test the simplicity standards in Table 1 and to which extent these properties improve mechanism performance. Each treatment implements one of the four mechanisms described in Sec. 3: DRU, SRU, OSPU, and CFU. The treatments were administered between subjects: each experimental session implemented only one of the four mechanisms.

An experimental session consisted of 12 periods. At the beginning of each period,



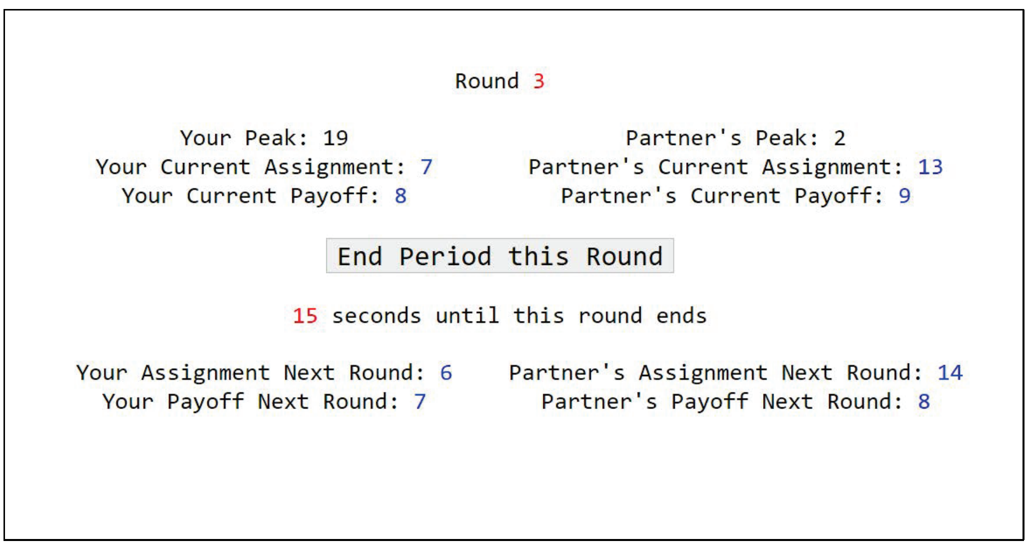


Figure 4: Obviously Strategy-proof

subjects in each pair were assigned types as shown in Table 3. Subjects could observe both their own type and their partner's type. During each period, subjects participated in the assignment mechanism. At the end of each period, payoffs were determined by a subject's type and their assignment as described in Sec. 3. Subjects were randomly rematched after each period.[5]

Figures 2 and 3 depict the experimental interface for the direct revelation uniform treatment and the continuous feedback treatment, respectively. In the sequential feedback treatment, the first mover uses an interface similar to that of the direct revelation uniform treatment and the second mover uses an interface similar to that of the continuous feedback treatment. Figure 4 depicts the experimental interface for the obviously strategy-proof treatment. The first row depicts the interface for selecting initial temporary assignments. The second row depicts the interface for opting out.

4.1 Experimental Procedures

One group of 14 and one group of 10 subjects participated in the continuous feedback uniform mechanism (CFU) sessions. Two groups of 14 and one group of 10 subjects participated in the sequential revelation uniform mechanism (SRU) sessions. Three groups of 14 and one group of 10 subjects participated in the direct revelation mechanism (DRU) sessions. All transpired during October 2017. As a follow-up investigation, five sessions of the obviously strategy-proof uniform mechanism (OSPU) were conducted in June 2021. The five sessions featured three groups of 10 subjects and two groups of 8 subjects, respectively.

All sessions were held at the Economic Research Laboratory (ERL) in the Economics Department at Texas A&M University. The 160 subjects were recruited using ORSEE software (Greiner, 2015) from a variety of majors. Experiments lasted about one hour. Subjects were paid based on their average earnings over all periods, using a conversion rate of $1 = 1 ECU plus a $10 participation payment. The average subject earnings were $26.19.

[5]The SRU treatment was the only treatment to feature asymmetric roles for each subject due to the underlying design of the mechanism. To increase familiarity with the mechanism, subjects preserved their role over all periods, meaning an individual subjects was either a first or second mover for the entirety of the experiment. Under this scheme, a subject could only be randomly matched with half the subjects in any experiment session. For the sake of comparability, we follow this matching scheme across all treatments, randomly dividing subjects into two arbitrarily groups and matching accordingly for the other symmetric mechanisms.

4.2 Hypotheses

At the individual level we have identified specific simplicity properties for agents that may impact how often they play strategies. A baseline hypothesis is that these properties do not matter and we will see equal rates of strategic play across mechanisms.

Hypothesis 1. *Across all four mechanisms, agents play focal strategies and best respond at roughly equal rates.*

A very similar alternative baseline hypothesis is that strategies are played at these rates but at the node level. (Most mechanisms feature only one action node per player.)

Hypothesis 1′. *Across all four mechanisms, agents play actions at nodes that correspond to focal strategies and best responses at roughly equal rates.*

Alternatively for each property x in Table 1 we consider the following hypothesis.

Hypothesis 1-x. *Property x increases the rate of focal and best-response at the relevant strategy or action level.*

There is also the issue of the outcome of the mechanism. A basic starting point for evaluating different mechanisms is whether they achieve the outcomes predicted by theory and the overall efficiency of the mechanism.

Hypothesis 2. *All four mechanisms achieve similar levels of uniform outcomes and efficiency.*

We consider the DRU the baseline mechanism, and look to ascertain whether the other mechanism can improve upon its performance.

Hypothesis 2-1. *The SRU achieves higher levels of uniform outcomes and efficiency than the DRU.*

Hypothesis 2-2. *The OSPU achieves higher levels of uniform outcomes and efficiency than the DRU.*

Hypothesis 2-3. *The CFU achieves higher levels of uniform outcomes and efficiency than the DRU.*

Panel A: Rate of Focal Play						
Valuation	*DRU*[a]	SRU	SRU	OSPU		*CFU*[a]
		1st-mover[b]	2nd-mover[c]	Path-wise[d]	Node-wise[e]	
1	0.240	0.368	0.763	0.413	0.511	0.313
2	0.269	0.158	0.789	0.533	0.571	0.333
3	0.452	0.421	0.868	0.391	0.745	0.625
4	0.385	0.342	0.816	0.511	0.732	0.479
5	0.221	0.263	0.947	0.478	0.777	0.479
6	0.548	0.526	0.947	0.413	0.604	0.792
overall	0.353	0.346	0.855	0.457	0.678	0.503
Panel B: Rate of Playing Best Response						
Valuation	DRU	SRU	SRU	OSPU		CFU
		1st-mover[f]	2nd-mover	Path-wise[g]	Node-wise[g]	
1	0.769	0.789	0.763	0.663	0.640	0.917
2	0.875	0.684	0.789	0.750	0.699	0.958
3	0.635	0.421	0.868	0.522	0.786	0.792
4	0.702	0.553	0.816	0.652	0.799	0.813
5	0.615	0.500	0.947	0.565	0.807	0.813
6	0.683	0.684	0.947	0.565	0.701	0.958
overall	0.713	0.605	0.855	0.620	0.751	0.875

Table 4: Rates of focal strategy and focal action play.
a. Peak reports/Dominant strategy play.
b. Peak reports/Truthful equilibrium play.
c. Observed actions that are fully consistent with utility maximization. In SRU the second mover cannot reveal their full strategy, only an action at one node. Value is an upper bound on Dominant Strategy play.
d. Observed strategy paths consistent with Obviously Dominant Strategy play. In OSPU agents do not reveal their strategy in a single play. Value is an upper bound on Obviously Dominant Strategy play.
e. Observed actions consistent with Obviously Dominant Strategy play at a decision node in which the agent is called to play.
f. The second mover in SRU maximizes utility with a 85% frequency, with a range [76%, 95%] across valuations. Thus, a reasonable measure of rate of empirical best response is the rate of actions that are optimal given the second mover will maximize utility. That is, actions that are part of a perfect equilibrium of the game.
g. Frequency of action/path being a best response to the action/path played by the other agent.

5 Results

We begin our analysis with an evaluation of subjects' play of focal strategies and actions. For the DRU, SRU first mover, and CFU such play is consistent with playing a strategy directly tied to type, that is, submitting one's ideal preference peak. For the SRU second mover, it is simply to play a payoff maximizing action (these are all Obviously Dominant Strategies). In the OSPU the focal strategy corresponds to the sequential path towards the agent's type, but due to the type and decisions of the other player, the full realization of that path may not be observed. We focus on realized decision paths that, while possibly censored, do not exclude the possibility of the subject having intended to follow the optimal path. The reported value should be be considered an upper bound of subject play. Alternatively, one might focus on the observed actions at each decision node.

Result 1. *Rates of play of focal strategies vary considerably across mechanisms and valuations. Nonetheless, subject behavior is informed by payoffs: rates of best-response are high across all mechanisms and valuations.*

Table 4 provides summary rates of play of the four mechanisms across valuations. Both the SRU and OSPU are categorized in two ways. The SRU is separated by first and second movers. The OSPU mechanism is the only mechanism to involve the possibility of a single player strategy taking place over multiple nodes. We analyze OSPU both at the node and continual path-of-play observed. Valuation specific rates of focal strategy play vary from 0.158–0.947 across all mechanisms. The SRU 2nd mover, which essentially features an individual decision, and the OSPU at the node-level feature the highest rates of their respective focal strategy play. All types show some improvement over the baseline DRU. (Though, again, the values reported for the second mover in the SRU and OSPU are upper bounds on the value of focal play.)

Regression results in Table 5 confirm these general relations. A subject under the OSPU is ten percentage points more likely to play a focal strategy than in the baseline DRU mechanism ($p < 0.001$) and twenty-seven percentage points more likely at a single node. However, such subject does not significantly differ from one in the CFU in the rate of focal strategy play ($p \approx 0.396$). Subjects in the first-mover role in the SRU and those in the DRU play focal strategies at statistically identical rates ($p \approx 0.889$). The second-mover in the SRU plays the focal strategy 50 percentage points higher than the baseline.

Table 4, panel B provides an interesting counterpoint to the rates of focal-strategy play in the rates of best response. Across all our mechanisms, there exist non-focal strategies that could still be best responses to certain strategies of the

	(1) plays focal strategy	(2) plays best response
second half	0.047*	0.030
	(0.026)	(0.034)
CFU	0.151***	0.162***
	(0.054)	(0.024)
OSPU node level	0.266***	0.011
	(0.052)	(0.032)
OSPU path level	0.104**	-0.094***
	(0.048)	(0.026)
SRU first mover	-0.006	-0.108***
	(0.043)	(0.028)
SRU second mover	0.503***	0.142***
	(0.035)	(0.017)
observation level[a]	node/action	node/action
observations	3160	3160
r-squared	0.121	0.036

Notes: All three regressions use random effects terms for each subject. Other specifications do not change main results.

[a] Both regression models use cluster-robust standard errors at the session level.

Table 5: Regression Analysis of Individual-Level Decision Rationality by Mechanism

other player. Under the DRU and for both second mover in the SRU, a majority of best responses involves non-focal strategic play. With the exception of the OSPU, the other three mechanisms admit optimal Nash equilibria that are not in focal strategies. Thus the emphasis on focal play is both a strength and weakness for the OSPU. It pushes subjects to play focal strategies but at the expenses of a lower overall best response. Looking at it another way, we can conclude subjects' failure to play focal strategies in the non-OSPU is not necessarily due to a failure of game-form recognition, but instead a subject playing a strategy associated with a Nash equilibrium not intended by the mechanism designer. In the case of weak-dominance, multiple equilibria may exist where one equilibria involves the play of dominant strategies and one does not (see Velez and Brown, 2022). Both Tables 4, panel B and 5 (column 3) indicates that subjects in the OSPU are 9.4 percentage points less likely to choose a best response than under the baseline DRU mechanisms ($p < 0.001$). This rate is statistically indistinguishable from first movers in the SRU, a sequential mechanism that is not designed for simplicity with respect to that role ($p \approx 0.671$).

Table 1 shows how each of these five categories of agents differ in their simplicity standards. If we think of the results in Table 5 as due to these standards rather

	(1) plays focal action/ strategy	(2) plays best response
f1: existence of dominant strategy	0.006	0.108***
	(0.043)	(0.028)
f2: existence of ODS	0.266***	0.011
	(0.052)	(0.032)
f3: higher level of fat-finger error safety	0.162***	0.105***
	(0.010)	(0.014)
m1: has determinacy	0.236***	0.131***
	(0.042)	(0.032)
m2: allows for cheap talk	0.151***	0.162***
	(0.054)	(0.024)
observation level[a]	node/path	node/path
observations[b]	3,160	3,160
r-squared	0.121	0.036

***$p < 0.01$, **$p < 0.05$, *$p < 0.10$.

[a] Both regression models use cluster-robust standard errors at the session level. Valuation dummy variables and a second half dummy variable are also included in all regressions. Subject-level fixed effects are included though alternative specifications do not change main results.

[b] There are 1,240 individual node actions and 552 strategy choices in the OSPU treatments. Observations of both action choice and strategy choice are separately compared. The other treatments provide the other 1,368 observations.

Table 6: Regression Analysis of Individual Strategy or Node by Effect of Simplicity Standard

than the underlying mechanisms, we may evaluate our five hypotheses 1–1E. We consider the regression model

$$y_{it} = b_0 + b_1 f_1 + b_2 f_2 + b_3 f_3 + b_4 m_1 + b_5 m_2 + \gamma_i + \epsilon_{it} \tag{3}$$

where f_1, f_2, f_3, m_1 and m_2 are indicator variables satisfying whether the given observation is satisfied in Table 1 and γ_i is a subject random effects term. We do not include treatment indicator variables here, the impact of treatment identifies each term.[6] Table 6 provides regression results across rates of focal and best response.

It is somewhat satisfying to see that each simplicity standard is associated with a positive value in the regression, meaning no standard is predicted to cause a decrease in focal or best response play. We reject Hypotheses 1 and 1'. However $f1$ is not associated with increasing the rate of focal strategy play and $f2$ is not associated

[6] Specifically, once can see the difference between CFU and SRU (first-mover) determine b_1, differences between OSPU (node) and DRU determine b_2, differences between OSPU (node) and OSPU (path) determine b_4 and CFU and DRU.

with significantly increasing the rate of best-response play. It is worth noting that our evaluation of these properties uses as implicit benchmark a mechanism for which truthful behavior is still focal, SRU. Thus, what we are finding is that removing the dominant strategy property, but still retaining robustness of truthful actions in the sequential game (see Sec. 3.4) does not decrease significantly focal play.

The three properties f3, m1, and m2 are associated with gains of 10–25 percentage points in both play of focal strategy and best response ($p < 0.001$). Overall we accept the non-mutually exclusive Hypotheses 1-1–1-5, as all simplicity standards offer improvements at least partially.

We now turn to ranking mechanisms entirely-based on their allocative performance, ignoring the strategies employed by the players.

Result 2. *Regardless of valuation structure, the continuous feedback mechanism achieves higher rates of Uniform outcomes, efficient allocations, almost efficient allocations and shares of earnings relative to efficient allocations than either of the other three mechanisms. SRU generally performs better than DRU and OSPU, especially in cases where the Uniform allocation differs from equal division.*

Table 7 provides four different performance measures for each of the four mechanisms separated by valuation and overall: Frequencies of Uniform, efficient, and near efficient outcomes, and share of efficient outcome earnings realized. Recall that in our environment an allocation is efficient if both agents receive an allotment on the same side of their peak. Since agents' utility has the same slope on both sides of their peak, the summation of their utilities is constant on all efficient allocations. Thus, this last statistic is a meaningful measure of performance, as well as the distribution of efficiency losses (see below).

The most striking result is that the continuous feedback mechanism (CFU) achieves higher performance over each measure across every valuation. Table 8 provides regression results. The CFU mechanism achieves roughly 25 percentage points higher rates of uniform and efficient outcomes, a nearly 20 percentage point higher rate of a near efficient outcomes,[7] and a 4 percentage point higher share of maximum possible earnings than the baseline DRU mechanism ($p < 0.001$, all four comparisons). These differences slightly increase when we consider only valuations 3-6, where the uniform allocation differs from equal division (see Table A.1). While the SRU mechanism also falls short of the CFU mechanism in performance ($p < 0.001$ all four measures, not shown), it is a clear second in performance among the four mechanisms. For the first three measures, it outperforms the DRU by 5–10 percentage points overall and 12–16 percentage points for valuations 3–6. The

[7] "Near efficiency" refers to outcomes within 1 point of the fully efficient outcome. For example, an allocation of (5, 15) would be near efficient if the efficient outcome were (4, 16).

Panel A: Rate of Uniform Rule Outcome				
Valuation	DRU	SRU	OSPU	CFU
1	0.788	0.684	0.696	0.875
2	0.865	0.632	0.739	0.958
3	0.269	0.421	0.196	0.583
4	0.423	0.395	0.239	0.625
5	0.212	0.474	0.261	0.583
6	0.365	0.632	0.500	0.792
overall	0.487	0.539	0.438	0.736
Panel B: Rate of Efficient Outcome				
Valuation	DRU	SRU	OSPU	CFU
1	0.981	0.974	1.000	0.958
2	1.000	0.974	1.000	1.000
3	0.269	0.421	0.196	0.583
4	0.538	0.447	0.283	0.708
5	0.231	0.579	0.304	0.750
6	0.365	0.632	0.500	0.792
overall	0.564	0.671	0.547	0.799
Panel C: Rate of Within 1 of Efficient Outcome				
Valuation	DRU	SRU	OSPU	CFU
1	0.981	0.974	1.000	1.000
2	1.000	0.974	1.000	1.000
3	0.308	0.526	0.283	0.667
4	0.596	0.500	0.304	0.750
5	0.308	0.632	0.326	0.875
6	0.962	1.000	0.935	1.000
overall	0.692	0.768	0.641	0.882
Panel D: Share of Efficient Outcome Earnings Realized				
Valuation	DRU	SRU	OSPU	CFU
1	0.996	0.994	1.000	0.997
2	1.000	0.993	1.000	1.000
3	0.838	0.855	0.784	0.902
4	0.929	0.905	0.880	0.956
5	0.849	0.903	0.818	0.961
6	0.964	0.982	0.972	0.990
overall	0.930	0.939	0.909	0.968

Table 7: Overall Performance Measures for Each of the Four Mechanisms

	(1) uniform outcome	(2) efficient outcome	(3) within-1 of efficient outcome	(4) share of efficiency
second half	0.052*	0.030	0.048	0.011
	(0.028)	(0.022)	(0.030)	(0.010)
CFU	0.249***	0.235***	0.190***	0.038***
	(0.0510)	(0.058)	(0.037)	(0.011)
OSPU	-0.049	-0.017	-0.051	-0.021*
	(0.043)	(0.049)	(0.047)	(0.012)
SRU	0.052*	0.107***	0.075**	0.009
	(0.028)	(0.030)	(0.033)	(0.007)
observation level[a]	decision-pair	decision-pair	decision-pair	decision-pair
observations	960	960	960	960
log likelihood	-587.555	-447.586	-355.445	997.705

Notes: All four regressions use separate, crossed, random effects terms for the subject with the higher peak and the subject with the lower peak each period. Valuation dummy variables are also included in all regressions.

[a] All four regression models use standard errors estimates from 100 cluster bootstraps taken at the session level.

Table 8: Regression Analysis of Pair-Level Outcomes by Mechanism

OSPU mechanism performs worse across all four measures, but only significantly differs from DRU on the share of the efficient outcome attained ($p < 0.10$, Tables 8 and A.1, column (4)).

Figure 5 displays the CDF of utility loss, per group, compared to the efficient assignment for valuations where the uniform allocation is not equal division. With one exception for a low probability event in valuation 3, $(4, 16)$, for each level of efficiency loss x, the cumulative frequency of outcomes with a loss at least x is lower for CFU than for each of the other mechanisms.

Taken together, our results falsify the null hypothesis 2. We find evidence in favor of the non-mutually-exclusive hypotheses 2A and 2C, but cannot confirm 2B. In other words, the OSPU mechanisms is the only alternative mechanism that fails to outperform the baseline DRU mechanism in terms of allocative outcomes at the subject-pair level.

Having addressed the two main hypotheses of the paper the remainder of results will focus on more descriptive analyses of the alternative mechanisms. Specifically why they may "work" better or worse than the baseline DRU function.

Result 3. *Even though second-movers choose their dominant actions with high frequency in SRU, first-movers do not adjust their behavior (compared to DRU) to take advantage of the predictability of second-mover behavior. There is no evidence of other regarding behavior/reciprocity motivated actions by second-movers.*

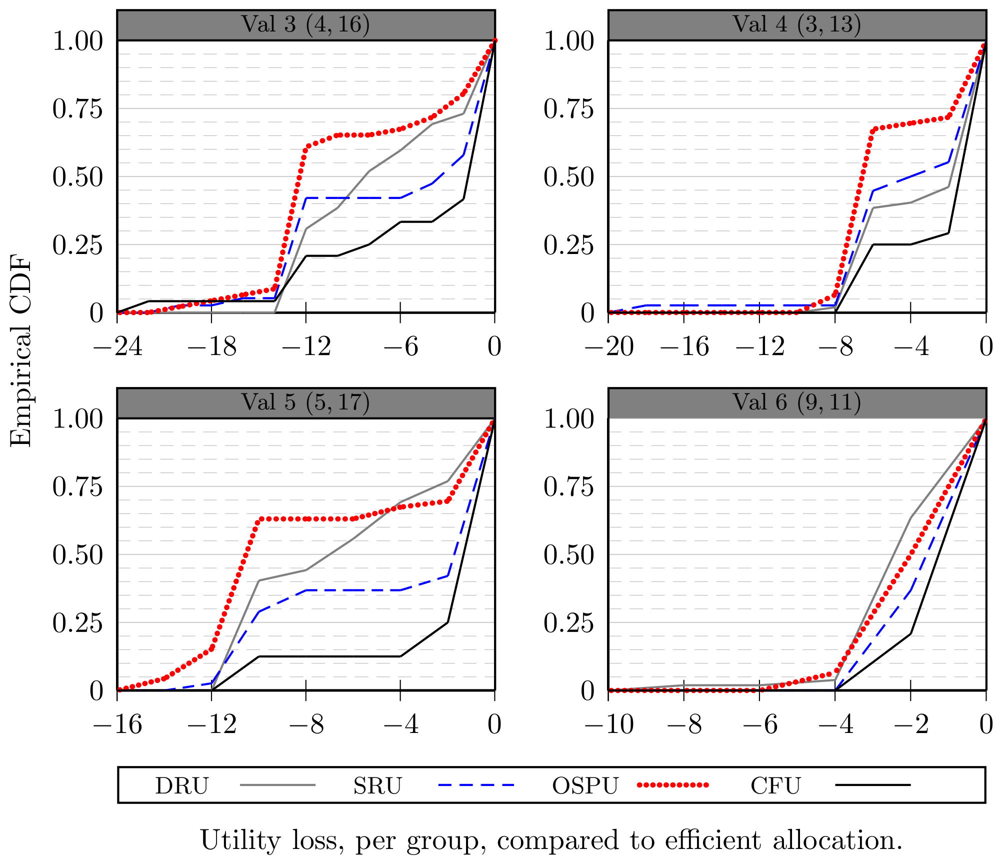


Figure 5: Stylized empirical CDF of utility loss, per group, compared to efficient allocation. Realized utility losses belong in $\{-24, -22, ..., -2, 0\}$. The lines in the graph join the values of the CDF in the domain of utility losses. Thus the values of the CDF can only be read from the graph for the realized utility losses. The lines allow an easy visual comparison of the distributions.

Table 4 indicates the overall rates of focal strategy play in the DRU and SRU first mover are 0.353 and 0.346, respectively. Regression results predict a difference in rates of dominant strategy play of 0.6 percentage points between treatment, values that are neither economically nor statistically meaningful (Table 5, column (2)). Thus we see no evidence that first movers in the SRU are deviating from truthful revelation to impose a sequential equilibria. On the other side, second movers in the SRU choose the best response roughly 85% of the time. The rate does not vary greatly, whether the first mover truthfully reveals or deviates from truthful revelation (87.3% vs. 84.6%, respectively, $p \approx 0.706$, not shown). There is little evidence second movers are playing a punishing reciprocal strategy based on whether first movers are deviating from truthful revelation.

Result 4. *Because the OSPU often requires multiple decision nodes for players, it necessarily requires higher rates of equilibrium play at each node to produce similar outcomes to the other mechanisms. With boundedly rational subjects, it is prone to stopping early relative to the equilibrium prediction rather than later. Though subjects tend to make better decisions in the later stages of the mechanisms, the predisposition toward early stopping explains why the mechanism performs better in the first two valuation structures.*

The OSPU is fundamentally different from the other mechanisms tested in this experiment because it may require players to make decisions at multiple nodes in a game. All other mechanisms feature only one decision node for each player. While the optimal path in valuations 1 and 2 require no additional rounds of decision making, valuation 3–6 requires an additional 6, 3, 5 and 1, round(s) respectively. The length of equilibrium play in OSPU is demanding. For simplicity think of an environment in which subjects played equilibrium strategies with 50% i.i.d. probability under a simultaneous baseline treatment that obtains equilibrium outcomes only when these strategies are played. Then, the equilibrium outcome would occur 25% of the time. A corresponding treatment with two nodes for each player would require a roughly twenty percentage point higher rate of dominant strategies to achieve the same end $0.707^4 \approx 0.25$.

Actual play under the OSPU mechanism is a bit more complicated than this hypothetical.[8] Since it only requires the decision of one player to end the game, the mechanism is prone to stoping after a shorter number of rounds when players are boundedly rational. With the valuations in the experiment, optimal play dictates the mechanism average 2.5 rounds over the 12 periods. In actuality, the mechanism averaged 1.25 rounds per period, with none of the five session averaging more than 2 rounds per period, significantly less than the equilibrium prediction.[9]

A quick look at Table 7 shows how this tendency in the mechanism alters outcomes. The OSPU achieves uniform outcomes at a rate of 0.717 for the first two valuations and 0.300 for the latter four ($p < 0.1$, two-tailed binomial test). However, it is not the case that subjects perform better in the first stage of the mechanism relative to the latter stages. For one, the first stage involves three options while all latter stages only involve two. Rates of obviously dominated play are 0.565 in the first round, but 0.684 in later rounds ($p < 0.1$, two-tailed binomial test). Thus, while the OSPU achieved the uniform outcome in 92 observed cases for valuations 1 and 2, only 21 (20.6%) of those cases occurred because both players played their

[8] Appendix figures A.1 and A.2 provide node level diagrams of the frequency of outcomes for valuations 1–3 and valuations 4–6, respectively.

[9] By a simple two-tailed binomial test, treating each session as an independent observation, this implies a p-value of $\frac{1}{2^{(5-1)}} < 0.10$.

obviously dominant strategy. In the other 72, in 52 (56.5%) of those cases one player played an obviously dominant strategy and in the other 21 neither player played their obviously dominant strategy, but their strategy choice ended the stage nonetheless.

This result has policy relevant implications. It gives us a warning that a change in a game form to simplify it in some dimension may not achieve its intended purposes. The structure of ODS mechanisms seems to lead to procedures in which agents are sequentially offered the opportunity to climb in their welfare ranking (c.f., Mackenzie, 2020; Pycia and Troyan, 2019). Thus, for ODS mechanisms the accumulation of failure rate, a natural practical problem, should be carefully considered. The problem is not universal of all ODS mechanisms. For instance, the second-price auction (non ODS) is safer to fat-finger errors than the English auction. However, there is a consensus that the later one outperforms the first one, both in achieving the desired allocations and in the rate of focal play (Li, 2017).[10] Serial priority mechanisms have strategies that are both ODS and in which each agent plays only once.[11]

Result 5. *Dominant strategy play in CFU is significant, but weakly dominated play does not dissipate. Utility maximizing behavior is prevalent. These two observations imply that the success of CFU can be traced back to the structure of its Nash equilibrium set and its non-bossiness. It is sufficient that one agent with extreme peak plays closer to their peak, so the other agents have incentive to move towards their true peak. In particular, whenever one agent plays their dominant strategy and the other agent maximizes utility the mechanism obtains the socially optimal outcome.*

As our previous analysis indicates, the CFU significantly bests all other mechanisms on overall performance measures (Result 2), despite unremarkable performance on inducing subjects to play dominant strategies (Result 1). The reason is that subjects under the mechanism generally play best responses even when those strategy choices are weakly dominated. Figure 6 shows the rates of mutual dominant strategy play, mutual best response and uniform rule outcomes for valuations in their first and second occurences. With the exception of valuation 6—which has a very high rate of mutual dominant strategies—generally the rate of dominant strategies is quite low, but the rate of mutual best response and the rate of uniform rule outcomes attained is quite high.

The Nash equilibrium structure of DRU, which is general for any number of

[10] Some evidence points to the framing of ascending clock auctions as being particularly relevant in its operation (Breitmoser and Schweighofer-Kodritsch, 2022).

[11] Serial priority mechanisms have some of the highest reported focal play among ODS mechanisms (Li, 2017). This mechanisms are determinate for each agent ($m1$).

players, has a role in how the high rates of best responses translates in better performance of CFU. The pure strategy equilibria of this game are a lattice with respect to Pareto domination. All agents have the same preference (some weak, some strict) between any two equilibria (Bochet and Tumennassan, 2020). In general, as an agent with an extreme peak chooses an equilibrium report closer to their peak, the incentive of the other agents is also to move towards their peak. Thus, it is sufficient that a single agent moves in the right direction so incentives of the other players align with better performance of the mechanism. Note that this implies that as long as cheap talk does not decrease the rate of dominant strategy play, the order of the probability of success of the mechanism when agents play best responses with high probability is at least the rate of dominant strategy play of a single agent. In DRU we can bound below the probability of success only by the individual rate of dominant strategy play *to the power* of the number of agents.

In the two agent case, one can expect a similar feature for dominant strategy mechanisms that, as DRU, are also non-bossy. This property requires that by misreporting type, an agent cannot change the outcome without changing their welfare. If both agents report their true peak in DRU, the mechanism selects the true Uniform allocation. Since the mechanism is non-bossy, it is only necessary that at least one agent reports truthfully for the mechanism to operate well when agents best respond with high probability. The best response of an agent to a truthful report obtains the same utility as the truthful report. Thus, this misreport does not change the outcome. Thus, again the order of the probability of success of the mechanism when agents play best responses with high probability is at least the rate of dominant strategy play for a single agent.

Using the logit dynamic described in section 3.6, we can calculate individual estimates of payoff sensitivity for each of the 76 subjects that took part in the CFU and DRU sessions. The mean subject under the CFU had a sensitivity parameter twice as large as the corresponding subject in the DRU (0.866 vs. 0.432, $p < 0.10$, session-level rank-sum test). Thus while subjects under both mechanisms were able to improve their best-response over time relative to the other player, actually seeing the pre-play strategy of the other player provided useful information that could lead to better payoffs. This reinforces this idea that cheap talk pre-play increases the propensity of subjects to best respond (see Result 1).

6 Discussion and concluding remarks

Our paper looked at a particular problem in mechanism design from the perspective of the standard dominant-strategy mechanism and also three alternative mecha-

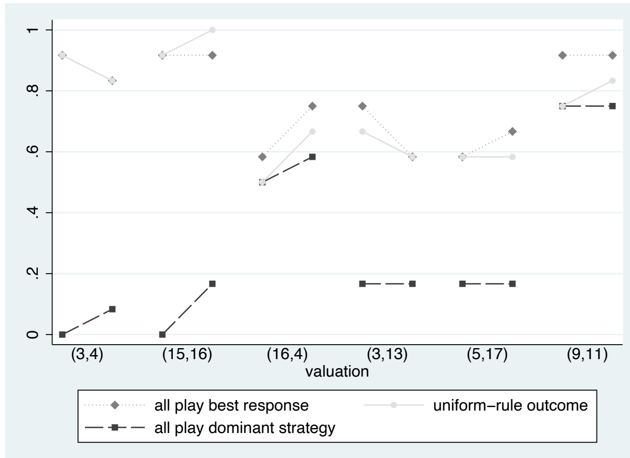


Figure 6: Rates of mutual best response, mutual dominant strategy play, and uniform rule outcome under the CFU mechanism by valuation. Note that the leftmost point in each line segment is first occurrence of the valuation (i.e., Periods 1–6) and the rightmost point is the second occurrence of the valuation (i.e., Periods 7–12).

nisms inspired by alternative streams of literature. We identified various simplicity properties that vary between the mechanisms and were able to identify the impact of each of the properties.

In our experiment, there is a best performing mechanism in terms of the frequency of desirable outcomes obtained. It is also the best mechanism in terms of how frequently the agents ended up playing optimally in it. This could be desirable for a mechanism designer when agents may litigate their right to revise their reports. We do not see this result as identifying this mechanism as universally best among the ones we tested, however. What is of general validity of our results, and has policy relevance, is that the reasons why the other mechanisms did not succeed, are serious risks when these mechanisms are operated. Moreover, that the adjustment dynamics that predict the performance of the cheap talk pre-play correctly points to the strength of the mechanism. Thus, this provides a means to inform the mechanism designer of the possible benefit or shortfall of adding cheap talk pre-play.

Additionally, the sole purpose of the mechanism designer may not be to achieve a certain welfare or fairness objective regardless of the strategies employed. If instead, the purpose is to simplify the problem to induce agents to play strategies that resemble those desired by the mechanism-designer, other mechanisms like OSPU may need to be considered. In the case where a mechanism designer is blind to agent preferences, reports could be used to generate calculations of welfare. In the event these reports are best responses but non-truthful, this may greatly distort perceived mechanism performance. So we may need to restrict our use to mechanisms in which truthful revelation is focal.

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A Additional Tables and Figures

	(1) uniform outcome	(2) efficient outcome	(3) within-1 of efficient outcome	(4) share of efficiency
second half	0.043	0.041	0.065*	0.014
	(0.027)	(0.026)	(0.037)	(0.011)
CFU	0.329***	0.357***	0.280***	0.057***
	(0.076)	(0.082)	(0.058)	(0.016)
OSPU	-0.018	-0.030	-0.081	-0.032*
	(0.072)	(0.075)	(0.072)	(0.018)
SRU	0.163***	0.169***	0.121**	0.016
	(0.049)	(0.051)	(0.050)	(0.011)
observation level[a]	decision-pair	decision-pair	decision-pair	decision-pair
observations	640	640	640	640
log likelihood	-388.257	-390.708	-342.053	561.813

Notes: All four regressions use separate, crossed, random effects terms for the subject with the higher peak and the subject with the lower peak each period. Valuation dummy variables are also included in all regressions.

[a] All three regression models use standard errors estimates from 100 cluster bootstraps taken at the session level.

Table A.1: Regression Analysis of Pair-Level Outcomes by Mechanism Excluding Valuations where Uniform Outcome is Equal Division.

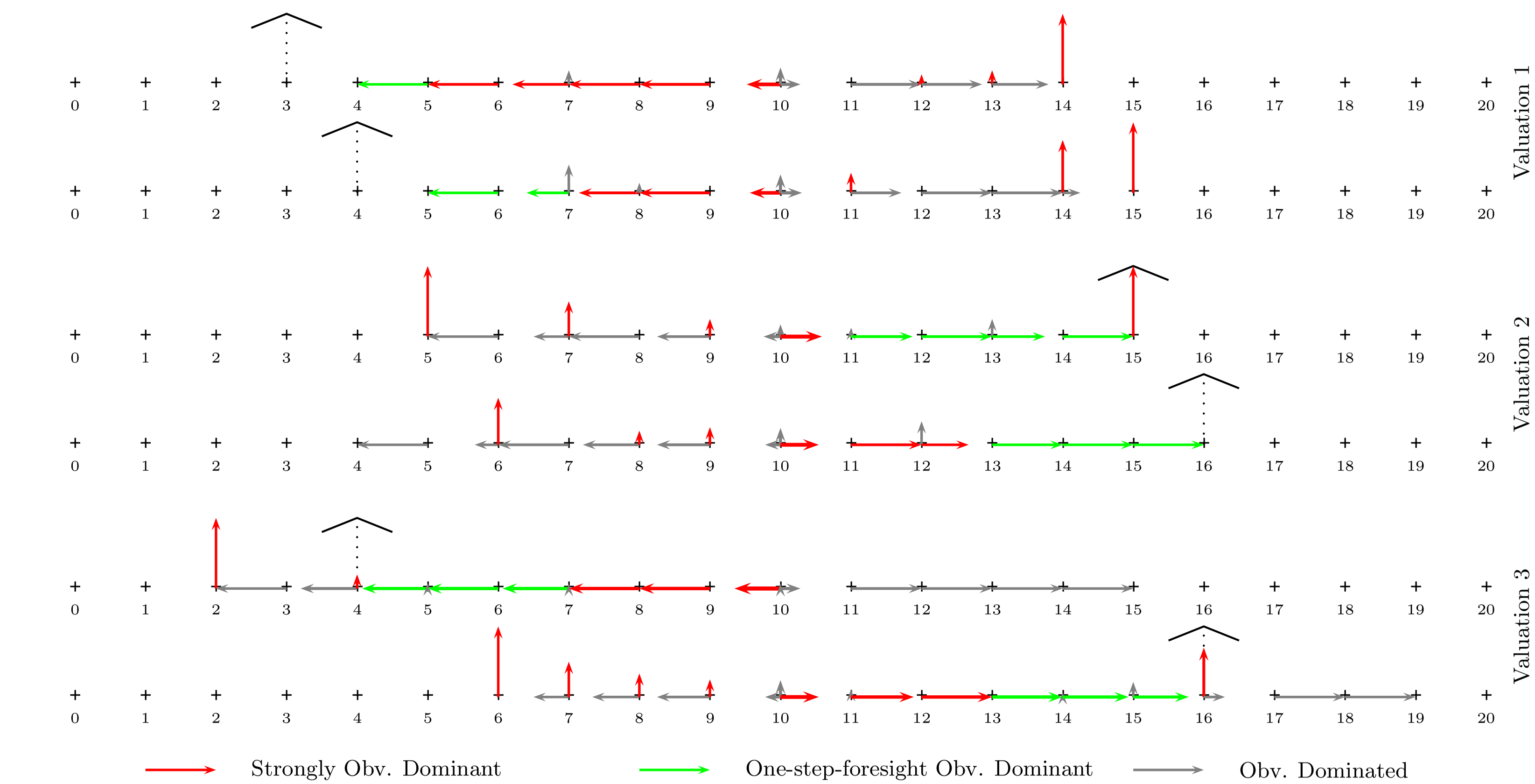

Figure A.1: Obviously Strategy-proof Uniform Rationing. Frequency of choice of Strongly Obviously Dominant (red), One-step-foresight Dominant (green), Obviously Dominated (gray) strategies. Size of arrows denotes relative frequency conditional on reaching the node.

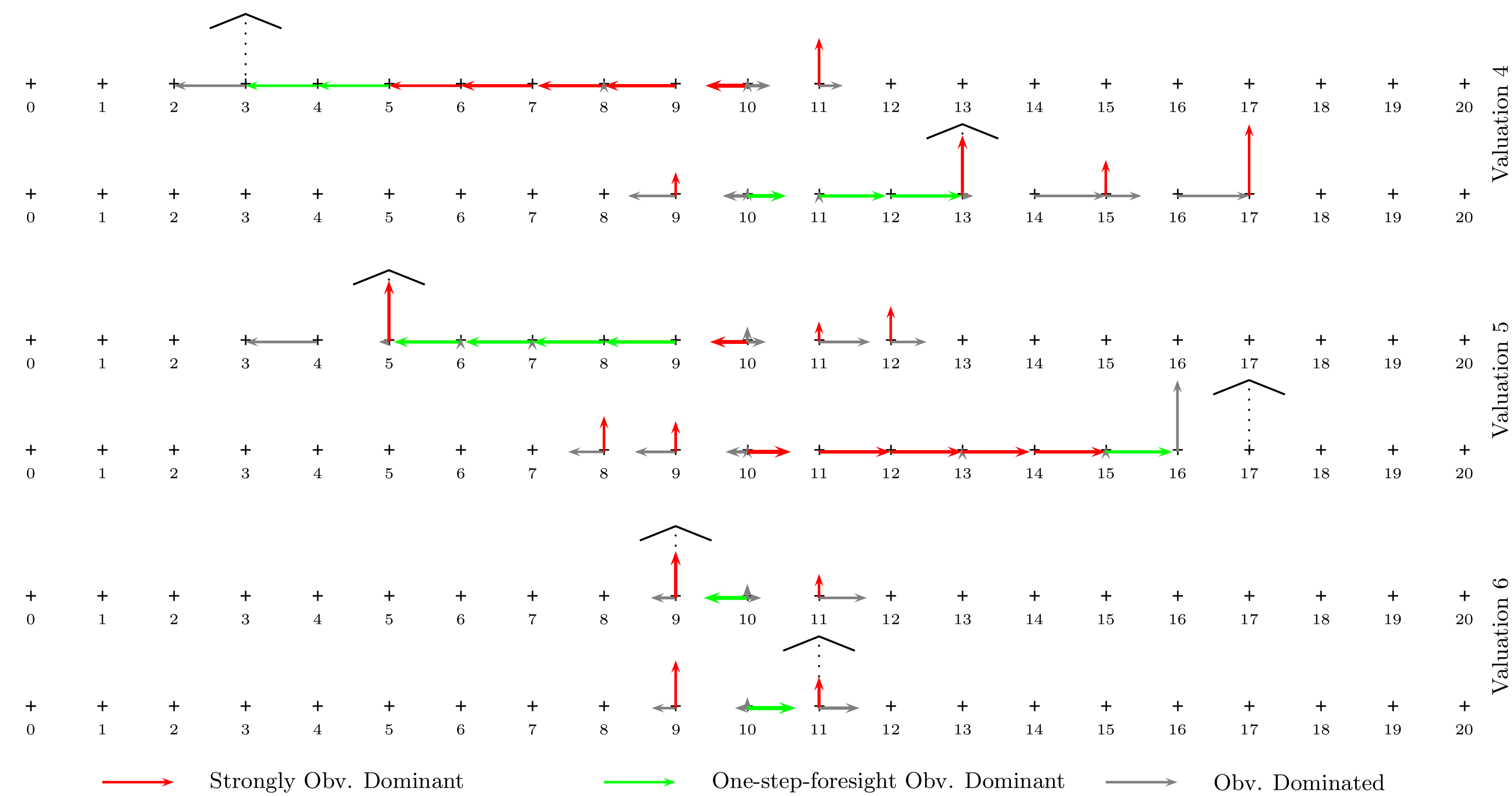

Figure A.2: Obviously Strategy-proof Uniform Rationing. Frequency of choice of Strongly Obviously Dominant (red), One-step-foresight Dominant (green), Obviously Dominated (gray) strategies. Size of arrows denotes relative frequency conditional on reaching the node.