Report-dependent utility and strategy-proofness

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Motivation

Strategy-proof mechanisms are celebrated for "leveling the playing field" and properties like stability/efficiency. However, ...

- No such properties if participants play dominated strategies! There is evidence that this happens!

Low- and mid-priority participants misrepresent $\succ$ for popular options.

Why?

- Cognitive limitations/complexity vs. behavioral biases

Here: I blame report-dependent utility.

- Participants enjoy to get what they declare desirable.
- Participants dislike rejections.

Literature

- Lab evidence: up to 62% misrepresent.
  - Chen & Sönmez (2006), ..., survey: Hakimov & Kübler (2020).
  - Relationship between truthfulness and priority/school popularity. District-school bias, small-school bias.
  - Rees-Jones & Skowronek (2018): NRMP participants.
- Field evidence: up to 19 % obvious misrepresentations.
  - Hassidim, Romm & Shorrer '17, Shorrer & Sóvágó '17, Artemov, Che & He '18.
  - Survey evidence.
- Approaches:
  - OSP (Li, 2017), level-k (Zhang '21), ...
  - Disappointment (Dreyfuss, Heffetz & Rabin '21, Meisner & von Wangenheim '21), regret (Fernandez '20), ...

In this paper

I propose report-dependent utility as an explanation

- Payoff from a match decreases in its position in submitted ranking.
- Strategic trade-off $\rightarrow$ self selection!

Main results:

- For any ranking, there are beliefs that rationalize it for all preferences (even is report-dependence arbitrarily small).
- Truth is optimal if and only if there is no conflict between feasibility and preferences.
- Testable predictions.

Model

- Consider a participant in a strategy-proof mechanism.
  - n options, $\mathcal{S} = \{1, 2, \ldots, n\}$.
  - submits ROL $\widetilde{R} : \mathcal{S} \rightarrow \text{Ranks} = \{1, 2, \ldots, n\}$.
  - $\widetilde{k} = \widetilde{R}^{-1}(k)$, k-th ranked option.
- Fix beliefs on others' ROLs, priorities, and capacities.
  - $\widetilde{f}_k$ probability to match with k-th ranked option in $\widetilde{R}$.
- Report-independent preferences v_s for option s and report-dependent preferences ρ_k for rank k.

$$v_1 \geq v_2 \geq \cdots \geq v_n \qquad \text{and} \qquad \rho_1 > \rho_2 > \cdots > \rho_n.$$

$$\text{Payoff:} \quad U_\rho(\mathbf{v}|\widetilde{R}) = \sum_{k=1}^{n} \widetilde{f}_k (v_{\widetilde{k}} + \rho_k)$$

Attainability reduced form

- Given others' ROLs, priorities, capacities, s is attainable if there is a ROL so that mechanism assigns to s. $A_s \in \{0, 1\}$.
- Attainability distribution P over states $(A_s)_{s \in \mathcal{S}}$.
  - Reduced form summarizing beliefs about ROLs, priorities & capacities.
- SP mechanism always matches participant to her highest-ranked attainable option: Proof

$$\widetilde{f}_k = \Pr(A_{\widetilde{k}} = 1, A_{\widetilde{t}} = 0 \, \forall t < k).$$

- Possible outside option: option that is always attainable.
  - Options worse than outside option are unacceptable.

Rationalize all ROLs

Proposition 1

For every ROL $\widetilde{R}$ there is an attainability distribution $\widetilde{P}$ such that $\widetilde{R}$ is strictly optimal for all $\mathbf{v}$ and $\boldsymbol{\rho}$.

- Actually, for all P in an open ball around $\widetilde{P}$!
- Intuition: Last chooser in SD.
- Everything goes? First chooser? Information conditions?

Attainability			123		231	
A_1	A_2	A_3	u_v	u_ρ	u_v	u_ρ
1	1	1	v_1	ρ_1	v_2	ρ_1
1	1	0	v_1	ρ_1	v_2	ρ_1
1	0	1	v_1	ρ_1	v_3	ρ_2
1	0	0	v_1	ρ_1	v_1	ρ_3
0	1	1	v_2	ρ_2	v_2	ρ_1
0	1	0	v_2	ρ_2	v_2	ρ_1
0	0	1	v_3	ρ_3	v_3	ρ_2

Predictions

Suppose there are n participants and n options with unit capacity.

Prediction: Low-priority agents

Consider a participant who knows to have the lowest priority at all options. In DA, TTC, or (priority-ordered) SD, and for any $\mathbf{v}$ and any $\boldsymbol{\rho}$, this participant optimally ranks options from most to least attainable.

Useful to differentiate from EBLA!

Prediction: Self selection

Suppose all participants have a common preference vector $\mathbf{v}$ and all options have the same priority ranking. If participant k knows to have the k-th priority, she ranks option k first in DA, TTC, or SD (in order of priority) for any $\boldsymbol{\rho}$.

Experimental data: Li '17, self selection in field: Chen & Pereyra '19.

True ROLs

Proposition 2

Fix an arbitrary $\mathbf{v}$ and a non-truthful ROL $\widetilde{R}$. Then, $U_\rho(\mathbf{v}|R) \geq U_\rho(\mathbf{v}|\widetilde{R})$ for all $\boldsymbol{\rho}$ if and only if

$$\sum_{r=1}^{\bar{r}} (f_r - \widetilde{f}_r) \geq 0 \quad \forall \bar{r}$$

Hence, the true ROL R is optimal for every function $\boldsymbol{\rho}$ if and only if the above inequalities hold against all non-truthful ROLs.

- Truth if and only if no conflict between attainability and preference.
- Truth must maximize match probability of top $\bar{r}$ ranks for all $\bar{r}$.

Predictions

- For truthful equilibrium, Prop 2 conditions seem contradictory.
  - All individual preferences must reverse popular preferences?
  - No. Weak inequality!

Prediction: Truth and information

Suppose all participants believe all ROLs and priority rankings of others are equally likely and that all options have the same capacity. Consider a participant who does not know her relative priority at any option. In DA or TTC, and for any $\mathbf{v}$ and any $\boldsymbol{\rho}$, this participant ranks options according to $\mathbf{v}$, i.e., submits the true ROL.

- Data: Pais & Pintér '08: More info $\rightarrow$ less truth!

Other results

- If P has full support, truth is optimal if $\boldsymbol{\rho}$ suff' weak.
- Not true that manipulation optimal if $\mathbf{v}$ suff' weak (see Prop 2).
- Swap at the top (modal manipulation) is profitable if and only if

$$\frac{\widehat{f_1} - f_1}{\delta} > \frac{v_1 - v_2}{\rho_1 - \rho_2}$$

- Never swap when it decreases the top-match probability!
- Similar logic with jump deviations.

Predictions

Prediction: weak preferences

Suppose $v_1 = v_2 + \epsilon$. In DA, TTC, and SD, the optimal ROL reverses the order of 1 and 2, if one of the following is true:

- the capacity of 2 is larger, but the options do not differ in terms of relative priority and popularity; or
- the participant's relative priority at 2 is higher, but the options do not differ in terms of capacity and popularity; or
- the perceived popularity of 2 is lower, but the options do not differ in terms of capacity and priority.

- Data: Klijn, Pais & Vorsatz '13.

Conclusion

- Report-dependent preferences can explain observed manipulation patterns in strategy-proof mechanisms!
  - Channel: Participants inherently value assignment to options they ranked highly.
  - Due to emotional factors (self selection, rejection aversion), but also bigger games.

- Insights:
  - Beliefs matter! We can construct attainability distributions for each ROL to be optimal.
  - Information matters, intensity of preferences matter.

- Testable predictions! Let's play around with them!

Discussion

- Amplifies strategic trade-offs in Boston mechanism.
- Evidence for intentional randomization, Dwenger, Kübler & Weizsäcker '18.
- Remedies? Dynamic mechanisms like Pick-an-object, Bó & Hakimov '21.
- Strategic interaction? We can do it (if we want to...)
- Response to advice?

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Proof

- Fix others' ROLs and priorities.
- Let s be highest ranked attainable option in $\widetilde{R}$.

- Suppose mechanism matches to s' ranked above s.
- Since s' unattainable, prefer $\widetilde{R}$ over true R if s' top choice.

- Suppose mechanism matches to s' ranked behind s.
- If $\widetilde{R}$ was true ROL, prefer ROL that gets s over $\widetilde{R}$.

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