Experiments in Legislative Bargaining

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2025 New Frontiers in Experimental Political Science

The most inappropriate thing in my early 40s

- Marriage Officiant (주례)...
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- This keynote speech is the second-most inappropriate thing.

Experiments in Political Economy

From a perspective of an economist

- Some economists apply economic theories into the context of political economy.
- A subset of them combine theories with experiments. I am one of the few.
- I hope this talk to be a chance to introduce how economists experimentally study political economy.

Legislatures

- A policy is typically made by a legislature.
- Legislators are assumed to have different policy preferences because they are elected by different constituencies (e.g., different geographical districts).
- Consider a legislature consisting of n legislators indexed by i.
- Assume that n is odd and ≥ 3, and the legislature operates by majority rule.
- The legislators have to choose some policy p from some set of alternative policies P.
- Legislator i's utility if policy p is selected is $V_i(p)$.
- This utility function will reflect both the legislator's ideology and how the policy will impact him and his constituents.

Distributive Politics with no Condorcet Winners

- A policy $p^* \in P$ is said to be a *Condorcet Winner* if it would defeat or tie any other policy in a pairwise majority vote.
- If a unique Condorcet winner exists, it may be reasonable to think that the legislature would select it. The Condorcet winner exists
  - when a policy choice is binary,
  - when a preferred policy is on a single dimension,
- I am interested in one particular situation where a Condorcet winner doesn't exist: distributive politics

(Simplified) Distributive Politics

- Suppose that the legislators divide a fixed budget, normalized to 1, between projects located in the legislators' districts.
- A policy is a vector $p = (p_1, \cdots, p_n)$, where p_i is the spending in legislator i's district. $P = \{p \in [0,1]^n : \sum_i p_i = 1\}$.
- Assume that $V_i(p) = p_i$. Each legislator would prefer that all the projects are located in his own district.

The Legislative Bargaining Model

Baron and Ferejohn (1989)

- The legislative bargaining model builds on the agenda-setter model (Romer and Rosenthal, 1978).
- Consider a many-person divide-the-dollar game.
- One legislator is randomly selected to make a proposal about how to split a dollar, $p = (p_1, \ldots, p_n) \in [0,1]^n$, $\sum p_i = 1$.
- All legislators then vote for or against the proposal.
- If $q \in [1, n]$ or more legislators vote for the proposal, it is implemented. Otherwise, another legislator is randomly selected to make a policy proposal and repeat the proposal–voting procedure until the proposal is approved.

  ($q = 1 \Leftrightarrow$dictator. $q = n \Leftrightarrow$unanimity. $q = \frac{n+1}{2} \Leftrightarrow$majority.)
- Legislators' policy payoffs are discounted by δ^{t-1} if the policy is implemented in round t. $\delta \in (0, 1]$.

The Legislative Bargaining Model

Baron and Ferejohn (1989)

Stationary Subgame-Perfect Equilibrium (SSPE)

- It is known that for sufficiently large δ, folk theorem applies: Virtually all allocations can be the equilibrium outcomes.
- Focus on stationary subgame-perfect strategies. SSPE is described by a player's proposal strategy and voting strategy.
- When selected as a proposer, the player offers $\frac{\delta}{n}$ to $q-1$ randomly-selected players and keeps $1-\delta\frac{q-1}{n}$ to herself.
- Nonproposers vote for a proposal if the offered payoff is $\geq \frac{\delta}{n}$.
- The first proposal is approved.

If $\delta = 1$, $n = 3$, and $q = 2$, the proposer offers one member $\frac{1}{3}$ and keeps $\frac{2}{3}$. Here $\frac{1}{3}$ is the continuation value, the expected payoff of rejecting the offer and moving on to the next round.

The Legislative Bargaining Model: Experiments

Many interesting theoretical predictions. Changes in n, changes in q, changes in δ, heterogeneity in δ, proposer selection rule, length of potential bargaining rounds, etc. Refer to Baranski and Morton (2022) if interested. Main experimental findings are

- Minimum winning coalitions are most frequently observed.
- Delay becomes infrequent with experience.
- Proposer's partial rent extraction: There is a significant proposer power, but it is less than predicted by theory.

Roughly speaking, when $n = 3$, $q = 2$, and $\delta = 1$, typically observed allocation is about $(0.55, 0.45, 0)$.

The Legislative Bargaining Model: Experiments

Some of my work in this literature

- Kim (2019): If the proposer is randomly selected, but the previous proposers are not selected until everyone has the same number of proposal opportunities, then the 'partial proposer advantage' can be explained.
- Kim (2023): Among the possible reasons behind the 'partial proposer advantage,' fairness concern is not at all the driver.
- Kim and Kim (2022): Experimental examination of the effect of the competition to be selected as the proposer in a subsequent multilateral bargaining game.
- Kim and Lim (2024): The many-person divide-the-dollar game is fundamentally different from the many-person divide-the-penalty game.
- Baranski and Kim (2024): Experimental examination of the allocation of costs resulting from a negative externality, such as pollution-induced economic costs.

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Motivation

Many-person bargaining is everywhere, including:

- Budget appropriations among legislators
- Setting tax rates to different groups
- Free trade agreement among many countries
- Climate change summit to set the CO2 level of each country
- Search committee hiring a junior
- Location of noxious facilities
- Condominium board meeting for the use of common area

These may be modeled by a many-person divide-the-dollar game, but...

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the highlighted ones are about dividing a kind of losses, penalties, or burdens. Are these the same?

Key illustration

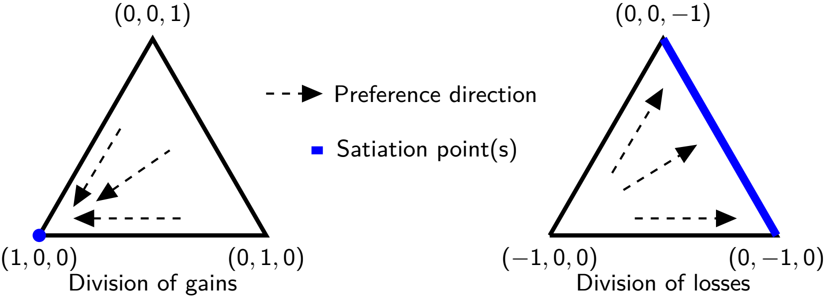


Figure: Different preference directions and satiation points

It is not about loss ‘domain’

Adding endowment to shift the game to a gain domain doesn’t affect the key difference.

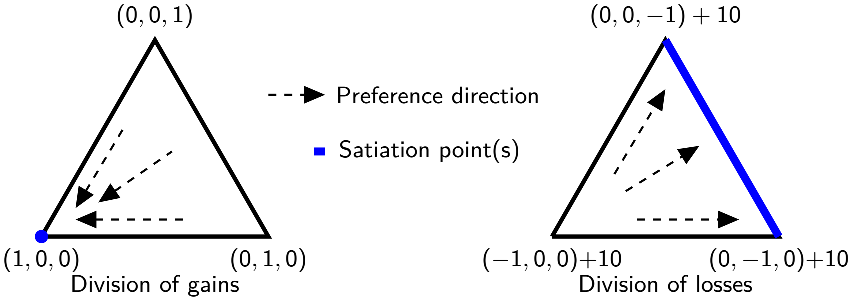


Figure: Different preference directions and satiation points

Preview of Results

- Unlike the divide-the-dollar game, the stationary equilibrium of the divide-the-penalty game is no longer unique in payoff.
- Among the continuum of the stationary equilibria, an equilibrium at one extreme is a mirror image of that in the divide-the-dollar game.
- Experimental evidence is consistent with the other extreme.
- Many interesting studies in multilateral bargaining on a gain domain are worth revisiting.

Plan of this talk

1. A quick recap of many-person divide-the-dollar (DD) game
2. A many-person divide-the-penalty (DP) game
3. Experiments
4. Results
5. Discussions

A quick recap of many-person divide-the-dollar (DD) game

Assume three members, a simple majority rule, and $\delta \leq 1$.

- In round t, a randomly selected member proposes how to split a surplus normalized to 1.
- The proposal is voted on. If two or more members vote for it, the proposal is implemented, and the game ends.
- If the proposal is rejected, they repeat the process, with a new proposer randomly selected. Payoff discounted by δ^{t-1}.
- When disagreed infinitely, everyone gets zero.

In the stationary subgame-perfect equilibrium, when $\delta = 1$, the randomly-selected proposer (say, member 1) in the first round offers (2/3, 1/3, 0).

A quick recap of many-person divide-the-dollar (DD) game

Theoretical predictions (Stationary Subgame-Perfect Equilibrium) and experimental findings

- **Minimum winning coalition**: A proposer forms a winning coalition whose size is the smallest for approval.
  $\Rightarrow$ Experimental evidence
- **Full rent extraction of the proposer**: The proposer offers MWC members their continuation value, offers other members zero, and keeps all the remainder.
  $\Rightarrow$ Experimental evidence
- **Full (utilitarian) efficiency**: The first-round proposal is approved without a delay.
  $\Rightarrow$ Experimental evidence
- Uniqueness in payoff: The SSPE is essentially unique.

A many-person divide-the-penalty (DP) game

Assume 3 members, a simple majority, and $\delta \geq 1$.

1. In round t, the randomly recognized member proposes an allocation of -1 in terms of proportions: $p \in \{(p_1, p_2, p_3) | p_i \in [0, 1], \sum p_i = 1\}$
2. If 2 or more members vote for the proposal, the proposal is implemented, $-\delta^{t-1} p_i$ is accrued, and the game ends. If not, the game moves on to round $t + 1$.
3. In round $t + 1$, a new player is randomly recognized as the proposer. The game repeats at $t + 1$.
4. When disagreed infinitely, everyone gets -1.

Multiple Stationary Subgame-Perfect Equilibria

Focus on stationary strategies only. SSPE is unique in payoff in the DD game, but not in the DP game. For illustration, consider $n = 3$, $\delta = 1$, and a simple majority.

- One equilibrium allocation is $(0, -1/3, -2/3)$. We call it Most Egalitarian (ME).
- Another equilibrium allocation is $(0, 0, -1)$. We call it Utmost Inequality (UI).
- Anything between ME and UI is a SSPE. For example, $(0, -0.1, -0.9)$ is another equilibrium allocation.

There are a lot more to say in theory.

Why experiment?

- Equilibrium selection: We honestly do not know which equilibrium will be selected.

$\Rightarrow$ If the observed patterns are similar to the mirror image of the SSPE on the division of gains, "we are good to go."

$\Rightarrow$ Otherwise, it is worth revisiting all the important studies on a gain domain, if the main motivating situations are about dividing a loss.

(Part of) Experiments

Table: Experimental Treatments

		Voting Rule	
		Majority	Unanimity
Group Size	3	***M3***	U3
	5	***M5***	U5

- 12 to 15 Games ("Days") to divide $-50 * n$ tokens. $\delta = 1.2$, in the second round ("Meeting") divide $-50 * \delta * n$.
- 400 tokens endowed each Day. Worth discussing, but the results (both theoretical and experimental) are not affected.
- At HKUST. Random rematch. Between-subject. Random payment. 271 subjects. 16 $(= 4 \times 4)$ session

Predictions recap, Majority

ME equilibrium is the mirror image of the SSPE in the DD game.

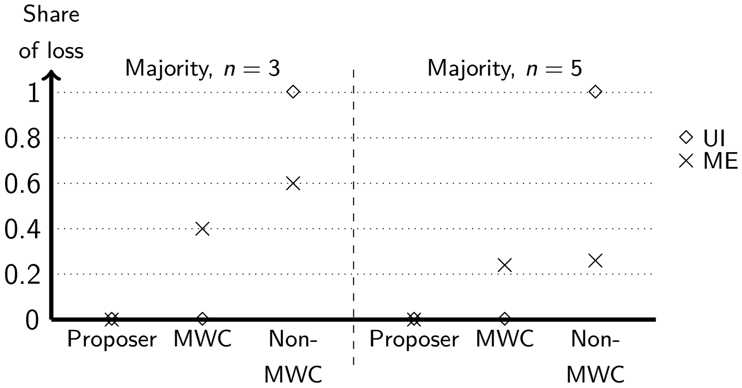


Figure: Hypotheses from theoretical predictions

Results

UI equilibrium is clearly dominant. MWC is clearly formed.

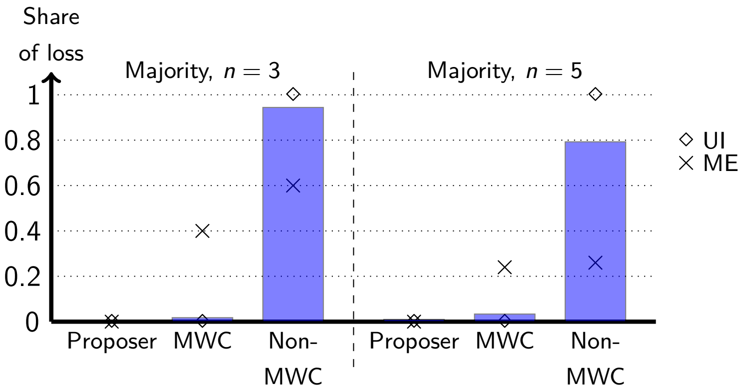
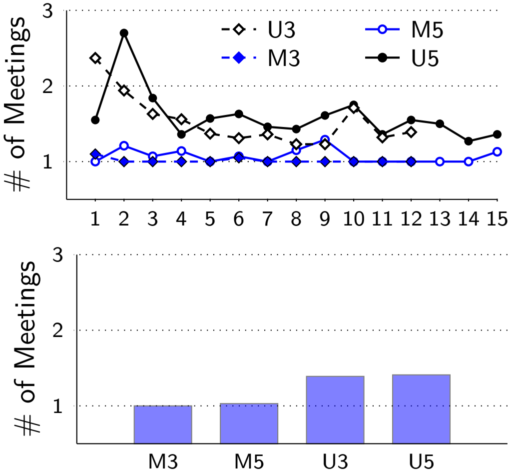


Figure: Proposed Shares, Majority

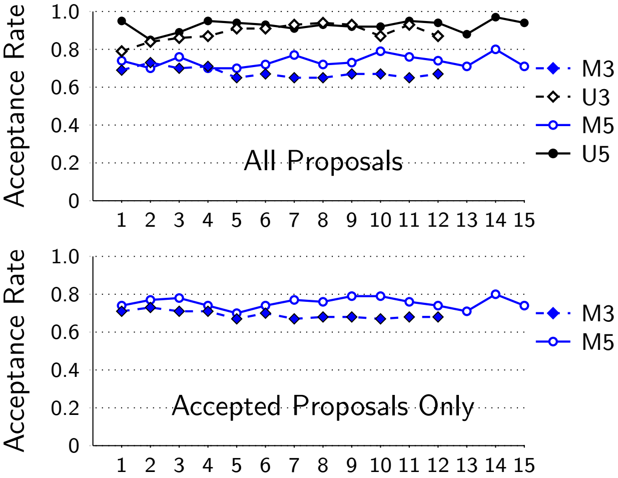
Results

Agreement is made without (or with little) delay.



Results

In M5, the size of the winning coalition is larger.



Take-away messages

- DD vs. DP is not like a half-full vs. a half-empty cup of water, but like a cup of clean water vs. a cup of filthy water.
- Theoretical predictions, contrary to our naïve conjectures, are quite different.
- The most unequal allocation is accepted under a majority. This has little to do with fairness concern.

If the main motivation for studying legislative bargaining model is to gain insights about distributive politics on the losses, think twice before applying the many-person divide-the-dollar game.

If Time Permits: Allocation of Pollution Costs

Baranski and Kim (2024)

How to allocate the costs of public bads? Public bads are byproducts of individuals' self-interested actions;

- The budget deficits due to the excessive private spending for locally-targeted projects $\Rightarrow$ insufficient public infrastructure.
- Firms' and countries' profit-maximizing decisions $\Rightarrow$ GHG emissions.

The costs induced by public bads need to be charged in a certain form of allocation of burdens (e.g., taxes), often resulting from political bargaining.

Research Question: How does **posterior bargaining of the costs** affect the voluntary production of public bads?

- How would a voting rule affect?
- How would a size of negative impact to the society affect?

A Simple Model

Let's focus on the environmental pollution context. Public bads = pollution. Production of public bads = polluting behavior.

- Three players indexed by $i = \{1, 2, 3\} \equiv N$, two stages.
- 1st stage: Every player is endowed with $E > 0$ units of resource, and player i claims $g_i \in [0, E]$ for his/her own sake.
- The total sum of claims generates public bads, which incurs the costs of $C = \alpha \sum_i g_i$, $\alpha \in (0, 2)$.
- Everyone observes who claimed how much.

Interpret g_i as the activities beneficial to self but harmful to society, such as profitable productions that produce pollution. α describes how good/bad the production technology is for the environment.

Note that if $\alpha \in (0, 1)$, full contributions for the production of public bads maximize utilitarian welfare.

A Simple Model

- 2nd stage: A many-person ultimatum(*) to allocate the costs.
- One of the players is randomly selected with equal probability, and she proposed how to split the costs, $p \in \mathcal{P} = \{(p_1, p_2, p_3) \in [0,1]^3 | \sum_i p_i = 1\}$.
- If $q \in \{2, 3\}$ or more players vote for the proposal, it is approved, and player i accrues the payoff of $g_i - p_i$.
- Otherwise, player i accrues the payoff of $g_i - \frac{C}{2}$.

  (* Why $C/2$? Simple representation of $\delta > 1$)
- $q = 2$: majority. $q = 3$: unanimity.

(*The ultimatum game is simpler than the many-person divide-the-penalty game (Kim and Lim, 2024), while capturing the essence of legislative bargaining over the division of costs.)

Equilibrium When $q = 3$

Each player's strategy consists of

- the amount of claims,
- the proposal when selected as a proposer, and
- the voting decision when not selected as a proposer.

The subgame-perfect equilibrium (SPE) is our solution concept.

Proposition

(In words,) under unanimity, the unique equilibrium is for all players to fully claim ($g_i^* = E$), offer half of the entire costs to the other two players as a proposer, and accept the offer if the offered cost is less than half of the entire costs as a non-proposer.

This result holds regardless of the size of $\alpha < 2$.

Equilibrium When $q = 2$

When $q = 2$, there is a **continuum of SPEa**. This is different from political bargaining over public goods (Baranski, 2016).

- We focus on two "extreme" ones.

  (extreme in the sense that other SPEa are between the two.)
- One equilibrium is practically identical to that when $q = 3$.

Proposition

(In words,) under a majority rule, one equilibrium is the following: All players fully claim ($g_i^* = E$), offer half of the entire costs to the other two players as a proposer, and accept the offer if the offered cost is less than half of the entire costs as a non-proposer.

Equilibrium When $q = 2$

A distinctively different SPE may arise when

(1) the proposer assigns the entire costs to **one person** and
(2) when the proposer selects the one who bears the entire costs based on the first-stage observations.

Considering (1) only doesn't change the equilibrium level of pollution, $g_i^* = E \; \forall i$.

Proposition

(In words,) under a majority rule, one equilibrium is the following: All players fully claim ($g_i^* = E$), offer the entire costs to one of the other two players as a proposer, and accept the offer if the offered cost is less than half of the entire costs as a non-proposer.

Equilibrium When $q = 2$

A distinctively different SPE may arise when

(1) the proposer assigns the entire costs to **one person** and

(2) when the proposer selects the one who bears the entire costs based on the **first-stage observations**.

Considering both (1) and (2) can drastically change the equilibrium prediction, given α is sufficiently large.

Proposition

(In words,) under a majority rule and when $\alpha > \frac{3}{2}$, *one equilibrium is the following: All players claim nothing* ($g_i^* = 0$), *offer the entire costs to one whose claim was the largest (randomly select if tied) as a proposer, and accept the offer if the offered cost is less than half of the entire costs as a non-proposer.*

Interim Summary

Deterring polluting behavior is hard.

Under unanimity, everyone fully pollutes, regardless of the size of α.

Under majority, full pollution "may" sustain. Pollution can be deterred only when three conditions hold.

- Majority rule
- Allocating the entire costs to the largest polluter.
- The environmental harm of pollution (α) is substantial.

Risk and social preferences?

Perhaps risk aversion and social preference may play a role. When $q = 2$, allocating half of the costs to two players

- is least "risky" (if the players perceive that the bargaining outcomes merely depend on the realization of the proposer selection) and
- lead to the least skewed allocation, which maximizes Rawlsian social welfare (given the same level of pollution)

than allocating the entire cost to one player. Also, when $\alpha > 1$, utilitarian social welfare decreases when pollution is produced.

Experimental Design

Treatment	Voting Rule (q)	Cost Multiplier (α)	#Sessions
U08	Unanimity (3)	0.8	2
M08	Majority (2)	0.8	2
U12	Unanimity (3)	1.2	3
M12	Majority (2)	1.2	3
U16	Unanimity (3)	1.6	3
M16	Majority (3)	1.6	3

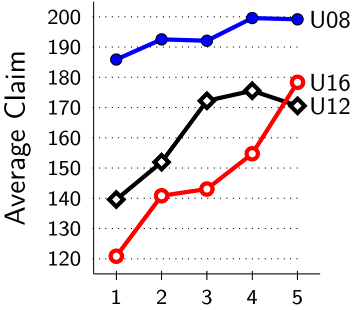
- The subjects are anonymously divided into groups of three.
- Each person can claim up to 200 tokens.
- 1st stage: Claim $g_i \in [0, 200]$. $C = \alpha \sum g_i$ is later known.
- 2nd stage: Submit a proposal. When q or more members vote for the one randomly selected proposal, the costs are distributed accordingly. If not, $C/2$ is charged to all.
- Repeat this for 5 periods. Random rematch

Hypotheses

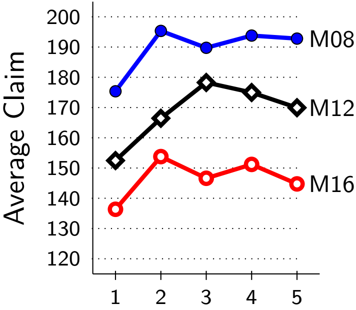
1. Within each voting rule, the pollution amount decreases as the cost multiplier increases.
2. When the cost multiplier is less than 1.5, pollution under majority and unanimity rule is the same, holding the cost multiplier fixed.
3. Under the majority rule, proposals that assign the largest cost share to the highest polluter are the most frequently observed, and such proposals are more commonly observed than under the unanimity rule.
4. If aligning a large share to the higher polluter is more likely under majority, pollution is lower in M16 than in U16.
5. Within each voting rule, the disagreement rate is unaffected by the cost multiplier.

Result 1

The pollution amount decreases as the cost multiplier increases.



(a) Unanimity treatments



(b) Majority treatments

Figure: Average Claim by Period

Result 2

When the cost multiplier is less than 1.5, the average pollution levels are indifferent in voting rules, holding the cost multiplier fixed.

Treatment	Socially Optimal Pollution	Pollution in Equilibrium	Observed Avg. Pollution	Observed Avg. Pollution Level
U08	100%	100%	96.93%	193.86
M08	100%	100%	94.70%	189.40
U12	0%	100%	80.99%	161.98
M12	0%	100%	84.22%	168.44
U16	0%	100%	73.78%	147.56
M16	0%	0% or 100%†	73.27%	146.54

†: Prediction varies by equilibrium. See propositions for details.

Table: Theoretical and Observed Average Levels of Pollution

% as a proportion of maximum pollution

Result 3

In Majority, proposals assigning almost all costs to one player are modal, but these are rarely observed in Unanimity. The recipient of the largest cost is typically the highest polluter.

Proposal Type		Three-way split	Two-way split	One-way split	Egalitarian	Proportional
Unanimity	All	0.852	0.123	0.025	0.273	0.313
	Accepted	0.981	0.019	0.000	0.433	0.413
Majority	All	0.433	0.071	0.496	0.075	0.110
	Accepted	0.400	0.034	0.566	0.062	0.103

Table: Types of the Submitted and Accepted Proposals

n-way split: n members receive costs more than 5% of the entire costs.

Egalitarian: similar to (1/3, 1/3, 1/3).

Proportional: Similar to $(g_1/G, g_2/G, g_3/G)$.

Result 4

Although the largest polluter is likely punished under majority, high polluters often penalize others when proposing, and as such, the relationship between pollution and share of the costs is weak. As a result, the overall pollution in M16 is not significantly different from that in U16.

Table: The determinants of Proportion of Costs Offered

	Majority			Unanimity		
	(1)	(2)	(3)	(4)	(5)	(6)
Pollution (relative)	0.48***	0.73***	0.74***	0.42***	0.46***	0.46***
	(0.11)	(0.18)	(0.17)	(0.06)	(0.07)	(0.07)
Share to self (0 or 1)	−0.31***	−0.14*	−0.14*	−0.12***	−0.10**	−0.10**
	(0.03)	(0.06)	(0.06)	(0.01)	(0.03)	(0.03)
Pollution × Share to self		−0.52***	−0.52***		−0.09	−0.09
		(0.19)	(0.19)		(0.08)	(0.08)
CostMultiplier			0.04			−0.02*
			(0.03)			(0.01)
Num. Obs.	960	960	960	960	960	960
R^2	0.251	0.259	0.260	0.347	0.349	0.351

Result 5

The likelihood of disagreement increases as the cost multiplier increases, within each voting rule.

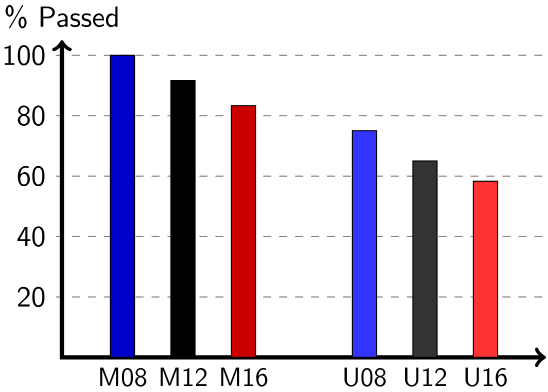


Figure: % Proposals Approved by Treatment

Takeaway Messages

- Pollution is (very) hard to deter.
- Theoretically and experimentally, unanimity doesn't help to reduce pollution. ("If you mess up that much, why wouldn't I, who has the same veto power, do that much?")
- A "threat" to allocate the entire costs to one member whose environmental harm was the largest doesn't help to reduce pollution. ("If everyone fully pollutes, it all boils down to a lottery. Why would I reduce pollution?")
- An increase in α reduces pollution to some degree in both voting rules, but it decreases the agreement rate.