

Dynamic Committee Decision-Making*

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Abstract

Political institutions make many decisions. Sometimes they have to decide which projects to fund, which policies to make, and often they even get to decide what they want to decide by choosing which policies or programs come up for consideration. Much is known about how institutions arrive at any one decision, but less is known about how the institution's larger agenda is formed or how the decisions made early in a session affect the decisions made later. We take up these questions by constructing a model of committee decision-making in a dynamic context.

In our model, a committee encounters a series of draws and may take or reject each until either a fixed number of slots are filled or the draws are exhausted. In each round, the members of the committee have to decide whether to use a slot on the current option or hold off in hopes of a better draw. We show three core results: First, sometimes committee members will follow a sacrifice strategy and try to take a loss even when they could pass on a draw and get zero. Second, they will often turn down positive outcomes even when there are slots remaining creating gridlock. Third, they will sometimes try to accept and other times try to reject the same option depending on how many draws and slots remain. We apply our model to funding decisions at a bureaucracy, agenda setting at the Supreme Court, and a hiring committee.

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Introduction

Politics, almost by definition, is about individuals and groups making constrained decisions over time. Bureaucracies can fund a limited number of grants. Legislatures have to choose which bills to take up in limited time. Committees choose which bills and nominations to move to the floor. The Supreme Court chooses which cases to put on its limited docket. Politicians have so many patronage positions to dole out.

All of these decisions have two things in common: First, decision-makers have to fill up slots from a larger applicant pool, and once the slots are full, the game ends. Second, decisions are made in the context of a larger political agenda and the decisions are interdependent. The decisions made at one moment affects the decisions made later. Nominating the son of one donor for a slot at a military academy means the congressman cannot nominate the daughter of another. Funding a skin cancer study may mean there is one less grant available for colon cancer. Examples extend beyond politics. Consider large corporations that need to hire three-hundred new computer programmers. The more applicants are hired early, the harder it is to get a job if you apply late.

This article introduces a model to explore such situations. At a general level, our model considers how committees fill a finite number of slots from a series of sequential draws. These could be applications for grants, cases appealed to the Supreme Court, or pieces of legislation that might be passed before the close of a legislative session. In all such instances, players balance the (relatively) certain payoff now against an uncertain future. The model returns three results of interest. First, individuals may vote to accept a draw at one point in the game and vote to reject it at another: what is decided often depends on when it is considered. Second, sometimes individuals will *sacrifice* and vote to take a draw that provides negative utility even if rejecting the draw would give a higher immediate payoff. Third, sometimes a majority will pass on a draw that would make them all better off. This creates a *gridlock region*.

The intuition is straightforward. Members of the committee who expect to end up in the minority may want to take a small loss now to head off a bigger loss later. Members of the committee who expect to be in the majority may want to pass up small wins hoping for bigger ones in the future. And since the probability of drawing a bigger win or loss at some point in the future changes as draws are revealed and slots are filled, players treat the same cases differently based on their future expectations.

Our model is related to three distinct literatures. First, our model is a cousin of the classic “secretary problem” (Ferguson, 1989, 2005; Eriksson, Sjöstrand, and Strimling, 2007). The key differences are that instead of an individual trying to find the highest ranked option from a sequence of draws, we have members of a committee trying to choose the best possible collection of draws. Second, recent work by Godefroy and Perez-Richet (2013) examining the Supreme Court shows that when a committee has a selection stage and a decision stage, uncertainty over the outcome of the final decision and differences in the decision rules at the different stages affects players’ strategies. Our model differs in that we do not rely on uncertainty, and our results hold even if there is no selection stage. Finally, Fong and Krehbiel (Forthcoming) show that legislative minorities can use delaying tactics to influence the agenda and affect policy outcomes. Our model applies where these delaying tactics are not available. Instead, minorities can try to “stuff the docket” with less distasteful draws.

A Simple Example

To get a feel for the model, consider the following two-period example of a three member committee. Suppose three officials at the National Institutes of Health have enough money to fund one more cancer study and only enough time to consider two more applications.¹ They have a stack of applications that propose to develop new cancer treatments. Studies may be related to chemotherapy drugs, acupuncture, or use embryonic stem cells in their research. We assume that all of the applications are of equal quality, so the only difference between them is the type of treatment to be studied. The applications come before the committee sequentially, drawn from a uniform distribution across the three types of studies with replacement. Upon reviewing the application, each committee member chooses individually whether to *support* or to *oppose* the grant. If a majority of the committee supports the grant, then the study is funded. If less than two members of the committee support the grant, the committee moves on to the next application. If the committee fails to fund a study, the money is returned to the Treasury.

Suppose the utilities the three players receive from the different types of treatments are as given in the following table. Player 1 has a large preference for stem cell research, while Player 3 has a strong aversion to such work. Player 3 also would prefer to return the money to the treasury than spend it on an acupuncture study. Player 2 is indifferent between chemotherapy and stem cell research, but would very much like to fund an acupuncture study.

Table 1: NIH Grant Committee Example

	Chemotherapy	Acupuncture	Stem Cell	Treasury
Abby	0.5	0.4	1.5	0
Brady	0.1	1	0.1	0
Christine	1	$-\frac{1}{3}$	-2	0

We want to demonstrate the following:²

- For the first draw, there is a therapy that a majority prefers to returning the money to the Treasury, but it will not gain a majority.
- Therapies a person is willing to support depend on whether it is the first or second draw.
- In the first round, a player may choose to support a study even if she would prefer to return the money to the Treasury. That is, it gives a negative payoff.

Begin by asking what happens if the group rejects the first draw. When the committee gets its second and final draw, it will clearly accept it. Notice that at least two people prefer every treatment to returning the money: Everyone would vote to fund the chemotherapy study, and Abby and Brady would fund the other studies—over Christine’s objection—rather than return the money. Since every treatment is just as likely to arise in period two, the expected utility for each player from the second draw is $v = \{0.8, 0.3, -\frac{4}{9}\}$.

Now consider the first draw. Suppose the committee first draws a chemotherapy study. Abby and Brady prefer chemotherapy to Treasury, but neither will select chemotherapy in the first round

¹We will consider more than two periods in an extended example later.

²We look for weakly nondominated, subgame perfect equilibria and proceed by backward induction.

because they expect to get a payout of .8 and .3, respectively, in round two. chemotherapy provides each less than their reserve utilities. So the chemotherapy study will not be funded if drawn first, though it would be funded if drawn second. If the first draw is stem cells, Brady and Christine will vote no. Christine hates stem cell research, and Brady would rather wait and see if the committee draws acupuncture in the final round.

But if an acupuncture application comes up on the first draw, the study will be funded. Christine will support the proposal even though she would rather send the money back to the treasury than spend it on acupuncture. But because she realizes that if stem cells come up in the final round Abby and Brady will support that proposal, Christine will grab at the chance for acupuncture in the first round. She is willing to take a smaller loss now to head off the risk of a larger loss later. That is, Christine is willing to *sacrifice* during the first round.

In this short example, we observe all three features of interest. chemotherapy and stem cell studies are viewed favorably by a majority but cannot pass in the first round. Players change their votes on options based on the round (e.g. Abby votes against chemotherapy at first but for it on the second draw). And finally, Christine is willing to take a loss on the first draw even though it costs her.

In the following sections, we consider a wide range of applications of this model. We adapt it to a spatial framework, use it in agenda-setting, and adapt it to minority rules. The paper proceeds as follows. After a brief review of the relevant literature, we apply a simplified version of our model to three different political processes across the two familiar branches of government: agenda setting at the Supreme Court when cases arise randomly (minority rule) and staffing an administration (majority rule). We then describe the general model for arbitrary numbers of draws and slots, prove equilibrium results, describe interesting features of that equilibrium related to the sacrifice region, and provide a numerical example. After a discussion of the larger model, we conclude.

Related Literature

Since at least Black (1948) and Downs (1957), committee decision-making has been a foundational study in political science. The median voter theorem has been a workhorse for the study of political institutions ever since. But majority rule is only one way that committees make decisions. Further, committees often make more than one decision, and strategic committee members look ahead to see how decisions in one period affects future rounds.

Our paper joins recent and ongoing work in dynamic games that explores the ability of a minority on a committee to influence the outcome of committee decision-making over several periods. Chen and Eraslan (2015) shows that parties out of power may strategically manipulate the agenda by making use of checks and balances. Krehbiel, Meirowitz, and Wiseman (2015) shows that the minority's ability to offer amendments and to expend resources to build coalitions generates more moderate outcomes. Finally, Fong and Krehbiel (Forthcoming) shows that when floor time is scarce, the Senate minority can use the stick of obstructing tactics and the carrot of unanimous consent agreements to influence what issues the majority places on the agenda.

Along these lines, our model speaks to a large literature of dynamic games that examines how individual policies are made. For example, Romer and Rosenthal (1979) explains how monopoly agenda setters pass a proposal, while other models explore how to divide a single pie in alternating offer games (Rubinstein, 1982; Baron and Ferejohn, 1987, 1989). Similarly, legislative scholars

have modeled conditions under which a proposal survives institutional hurdles to become a law (Krehbiel, 1998; Cameron, 2000), and a large literature examines the amendment process (McKelvey, 1976, 1981; Denzau, Riker, and Shepsle, 1985; Austen-Smith and Riker, 1987). For a more complete review of this literature, see Bernheim, Rangel, and Rayo (2006) and Bernheim and Slavov (2009).

We present a dynamic model as well, but our model is dynamic in a substantive way as well as the technical sense of the term. We are interested in how behavior changes as committees make many different decisions. Where the existing literature examines committee decision-making and agenda-setting related to a single policy issue, we are interested in how individual behaviors change as committees set many different policies. We consider how an executive staffs an administration, not just on how it makes a single hire and broaden the focus from a single piece of legislation to the larger legislative agenda.

Our model is particularly relevant to a longstanding literature that shows that the order in which alternatives are compared matters greatly. This literature includes Black et al. (1958), McKelvey (1976), and Gerber, Barberà et al. (2016). In most of these models, the choices faced by members of a committee are pairwise and sequential: keep the present bill or vote for the amendment. We move away from pairwise comparisons—for example, status quo vs. proposal—or tournament-style models and focus instead on the temporal trade-offs of a constrained committee. We explore how the order in which options are sequentially brought before the committee affects the willingness of the committee to accept those draws in a dynamic fashion that depends both on the existing set of draws and on any possible future draws. In that way, this article more closely relates to Iaryczower (2008), exploring decision making on sequential committees, Lizzeri and Yariv (2013), focusing on information gathering, and Feddersen and Pesendorfer (1996), focusing on juror welfare under uncertainty.

There is also a close relationship between our inquiry and previous studies of jury selection (See Brams and Davis (1978), DeGroot and Kadane (1980), Alpern and Gal (2009), and Alpern, Gal, and Solan (2010)). The jury selection literature shares our interest in filling up a fixed number of slots from sequential draws from a known distribution. Seen in one light, our model is a generalization of the jury selection game. The main stylistic difference is the traditional jury selection game relies on vetoes rather than selections, but this difference can be fit into our model without difficulty.

Our work has immediate application to political institutions such as the United States Supreme Court and various state courts of last resort that follow a minority rule for case selection. At the Supreme Court, for example, it takes only four of nine justices supporting a petition to put a case on the docket. There is an extensive literature on Supreme Court agenda setting. Perry (2009); Boucher and Segal (1995); Caldeira and Wright (1988); Ulmer (1984); Epstein and Knight (1997). Within this vein, our paper is most closely related to work by Lax (2003) and Godefroy and Perez-Richet (2013).

Lax shows that if monitoring lower courts requires paying a fixed cost, the Rule of Four is median enhancing, because lower courts know that the four most extreme members of the Court (on either side) will take cases where the lower court deviates too far from the median's ideal policy. The Rule of Four helps keep lower courts in line. One interesting feature of Lax's model is that as the cost of taking cases increases, there is a growing range of decisions that will not be reviewed even though the lower court is not implementing the median's preferred policy. We derive an analogous version of this *gridlock region*, but in our model this zone expands and contracts

throughout the game and flows not from a fixed cost assumption but emerges endogenously due to a constraint on the size of the Court's docket.

Godefroy and Perez-Richet (2013) examines the Rule of Four as a part of a more general study of the effects of different selection rules when a committee first decides whether or not to decide a particular case. In their model, members of a committee individually receive signals about a case. The committee first votes on whether or not to accept the case using a *selection rule*. If the case is selected, the committee decides the case based on a (possibly different) *decision rule*. They show that when the selection rule becomes more stringent, players become more conservative in the selection phase and send fewer cases on to the decision stage. Their model shows that justices' strategies are affected by uncertainty about the decision that will follow a selection: an uncertainty that flows from their private value model. We remove that uncertainty and allow players to be perfectly aware of other players' preferences and beliefs. This allows case outcomes to be common knowledge even at the selection stage. What drives our model is instead expected gains or losses in future cases. This allows us to speak both to institutions where the selection and decision happen in different stages and those where there is only a decision stage.

Finally, our model is an extension of the "secretary problem" (Ferguson, 1989, 2005; Eriksson, Sjöstrand, and Strimling, 2007). In the traditional formulation, a single player tries to optimize the *rank of quality*. In our model, individual committee members try to maximize quality while acting as part of committee in a game theoretic context. Similarly, our model extends that offered by Cox and McCubbins (1993) which applies a variant on the multi-armed bandit problem to agenda setting decision in the United States House of Representatives.

Two Political Applications

We now turn to two instances of such committee decision-making in American politics. Since many formal models of politics rely on some policy space, we set the examples in the familiar one-dimensional left-right continuum. However, we stress that while the model works well when restricted to such a policy space, as the previous numerical example and later proofs show, our results do not depend on any underlying spatial model. In the examples, we focus on the end of the process where there are two draws and one slot available. The first of these examples shows how our model applies in the context of agenda-setting. The Supreme Court of the United States—as with courts of last resort in many individual states—has control over its docket. The justices examine cases appealed from lower courts and select which ones will be reviewed on the merits. Since the Court cannot control the stream of cases it chooses from, we assume draws come randomly. Our second example is staffing a new presidential administration. Here, there is no agenda setting stage. While the applications appear in some (possibly random) order, the decision to hire is the only decision. As our model will be agnostic as to the size of the selectorate, we choose these examples to demonstrate that flexibility. The Supreme Court follows a minority rule for agenda-setting, and we assume that the hiring committee operates under majority rule.

The Supreme Court

The Supreme Court actually has had a few different minority voting rules over its history (Revesz and Karlan, 1988). The most famous and important of these is the so-called Rule of Four. When

cases are appealed to the Court, any combination of four of the nine justices may vote to grant the writ of certiorari and accept the case. Once accepted, the nine justices decide the case on the merits by majority rule.

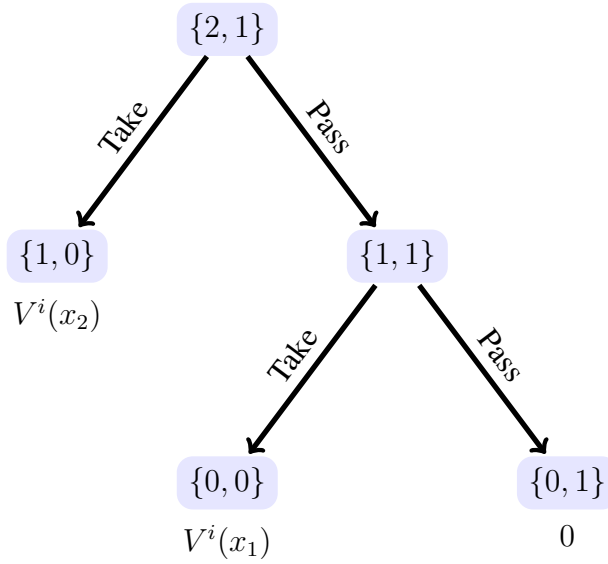
Our first example is a reduced form of this agenda-setting process. Consider a simple, two-period example of a three-member court that follows a Rule of One—that is, a court that fills a discretionary docket by voting over candidate cases according to a Q -rule with $Q = 1$. Suppose there is a single moderate justice, a liberal justice, and a conservative justice with ideal points, $\theta^L \leq \theta^M \leq \theta^R$, respectively in the unit interval. In each of the two rounds, the court randomly draws a case, $x_n \in [0, 1]$, from the uniform distribution on the unit interval policy space. The value x_n is the ideological location of the status quo policy to be reviewed in that case when there are n draws remaining. Each justice chooses whether to accept or reject the case as it is observed and prior to observing any subsequent draw. If any justice votes to accept, then the case proceeds to disposition. The court will sequentially draw two cases and may accept no more than one.

If a case with a status quo, x_n , is drawn and accepted for a hearing, the court decides the policy outcome by simple majority rule, adopting the median justice's ideal point, θ_M , at which point each justice, i , earns utility,

$$V^i(x) = |\theta^i - x| - |\theta^i - \theta^M| \quad (1)$$

Figure shows the extensive form of this game. For simplification, we denote every node with a set $\{n, k\}$, where n is the number of draws remaining and k is the number of slots.

Figure 1: Game form with two draws and one slot.



We begin our analysis of this model by examining player strategies at each node. Since rejecting both draws results in a current payoff of zero, at $(1, 1)$ players will take any case that provides a weakly positive payoff. That is, players will follow some individualized cutpoint rule, $\alpha_{1,1}^i = 0$ such that they will vote to accept the draw if $V^i(x) > \alpha_{1,1}^i$. This implies that L will take any case $x \geq \theta^M$ and R will take any case $x \leq \theta^M$. Since the end players will take any case on the opposite side of the median, in equilibrium, the court will take any draw at $(1, 1)$. This means that the slot

will be filled in equilibrium. Importantly, this is not a requirement of the game but is, instead, induced by equilibrium behaviors.³

If we now define justice i 's expected value at this last draw to be μ^i , then a player will only want to take a case at (2,1) if it offers at least μ^i . There is no requirement that $\mu^i = 0$. That is; there is no reason to believe that players all expect to receive zero payouts from the final draw. As such, it is entirely possible—indeed likely—that player strategies vary when n and k change. What this means is that some draws will not be taken at (2, 1) but would be taken at (1, 1). Conversely, some players may be willing to take draws at (2, 1) that they would not want to take at (1, 1).⁴

Figure 2 shows this model graphically. The blue diagonal lines represent the payoffs to justice L for a case drawn at a particular location. For instance, if the Court takes a case with a status quo position at L 's ideal point and then moves the policy to the median justice's ideal, that is the worst possible outcome for L , and so it is the lowest point along the blue lines. If the Court accepts a case at M 's ideal point and in deciding the case keeps the policy there, L receives zero utility as the policy has not moved. Hence the blue line—representing $V^L(x|a)$ —passes through the axis at M . The red diagonal lines, which represents the current payoffs for player R , show the same payoff structure for justice R . The payoffs for justice M are along the red line going up and to the left from M on the axis, and along the blue line up and to the right. Justice M gets no utility from taking and deciding a case at her ideal point, since there is no policy change, but draws to the right or to the left yield policy payoffs as the case outcome would pull the decision back to M 's ideal point.

The dashed lines represent each justice's expected payoff at (1, 1). Notice that since M always gets her ideal policy in the end, she expects the highest payout. Justice L , on the other hand, recognizes that M is to the right of center and expects to lose out in the final round. Equivalently, these are the justices' cutpoint strategies at (2, 1). The gray region is the gridlock interval. Cases in this region will be rejected at (2, 1) but accepted at (1, 1). Judge R wants to take any case to the left of the gray region. Judge L wants to take any case to the right of the gray region.

Figure 3 compares the gridlock region that results from using the minority rule with the gridlock induced by a majority rule. Notice that under a majority rule, the individual justice strategies would not change at (2, 1). What does change is the set of cases the Court would take, since M is pivotal under a majority rule. When M is pivotal, the gridlock region widens considerably.

Staffing the Executive Branch

When a new President takes office, there are roughly 4,000 political appointees that need to be hired. Obviously some are *sui generis* (e.g. agency heads, chief-of-staff, etc.), but many are roughly interchangeable across departments. Beyond the political domain, journals must select a finite number of articles, admissions committees can admit only so many students, and corporations need to hire so many engineers or programmers. Many, if not most, of these decisions are made by

³We also stress that even under a majority rule, every case would be accepted in the final round. We can assume that M weakly prefers to take a case drawn at her ideal point and are certain that she strictly prefers to take a case not at her ideal point. So in fact, every case will get two votes at (1, 1).

⁴To be clear, all draws would still be accepted by the committee at (1, 1). It is only that some players will support taking the draw at (2, 1) but not support the same draw at (1, 1). The change in support, however, would not be enough to prevent the committee from taking the draw.

Figure 2: Three Member Court under Rule of One. The gridlock region is shaded.

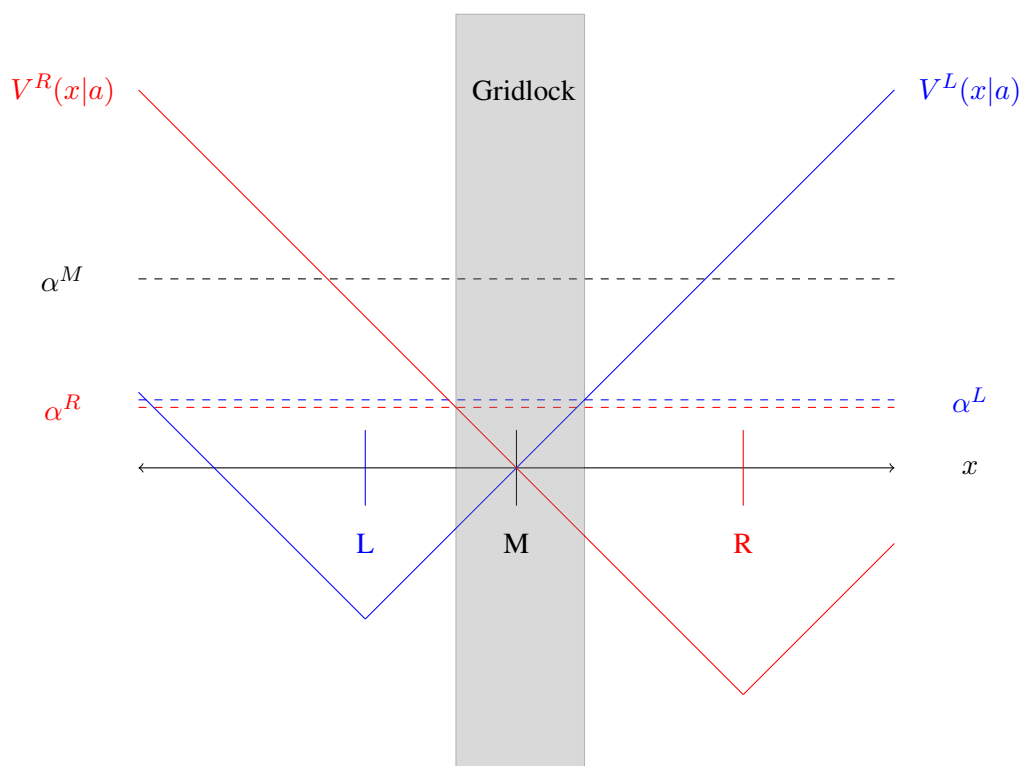
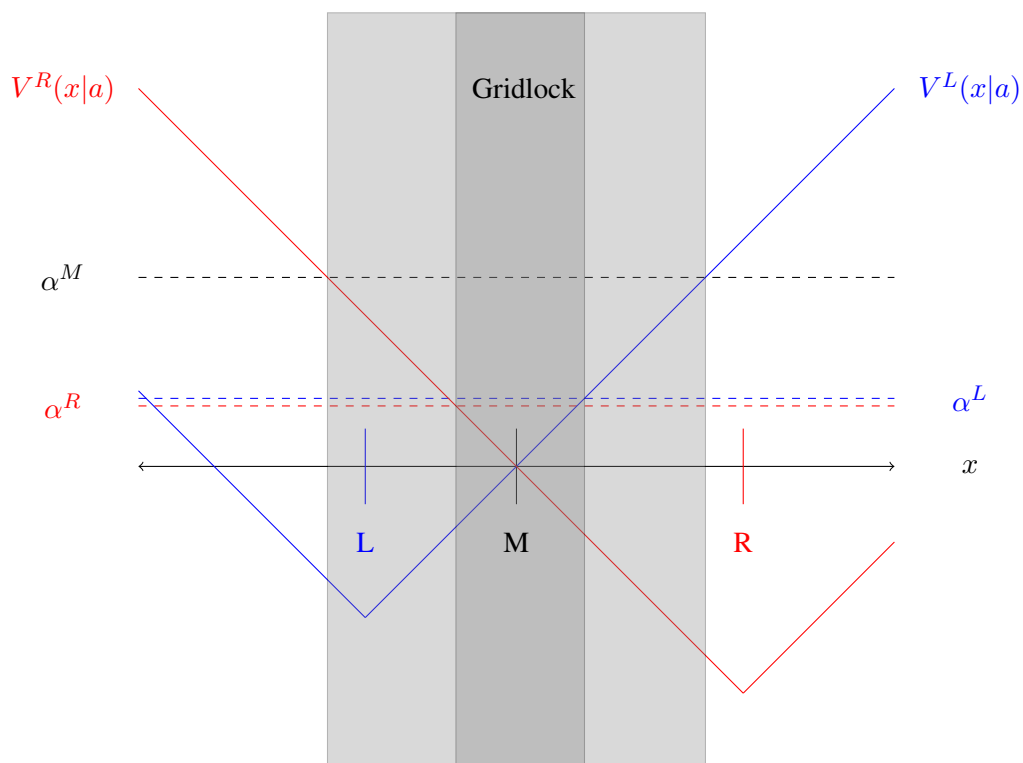


Figure 3: Three Member Court under Rule of Two. Note the expanded gridlock region in light gray.



committees.⁵

Again we focus on the end of the hiring process, where there are two candidates remaining and only one job left. Suppose that we have three committee members: L, M, R with player i having an ideal point θ^i in the same $[0, 1]$ space. Two applicants are drawn from the uniform distribution. As before, each applicant (draw) is some $x \in [0, 1]$. As with the previous models, we will assume linear utilities. But as nothing is pushed to the median in this model, players receive utilities based only upon their distance from any drawn and accepted applicant. We say that the payoffs to player i from accepting an applicant at x is

$$V^i(x) = \pi^i - 2|\theta^i - x| \quad (2)$$

where π^i is the value player i receives from taking an applicant at her ideal point.

In the judicial model, the court took all cases at $(1, 1)$ because R would like to take any case to the left of M and move it to the right, and L has corresponding preferences to the other side. But in this model, if there is no additional constraint that requires the committee to fill up the slots, it is possible for the committee to pass on a draw x at $(1, 1)$ if $V^i(x) < 0$ for enough players. That is, there can be a failed search.

Figure 4 shows the utility functions and strategies for each player at $(2, 1)$. As before, M 's reserve utility is higher than those for L and R . Before this followed from M getting her way via the median voter theorem in the disposition phase of the court's decision-making process. In this extension, the result follows because each of the extreme players suffer greatly when the committee draws and the other members accept an applicant on the other side of the interval. Since the median is always pivotal, the committee never hires a candidate she dislikes.

As in the court example, we observe a gridlock region. Panel (b) shows, in grey, three gridlock regions. More extreme candidates cannot get median support, but there is a central region where neither L nor R is willing to join M to accept a centrist candidate. Notice, M cannot get the committee to accept a candidate at her ideal point on the first draw.

Panel (c) highlights that Player R has a small sacrifice region in the area denoted by red stripes. These are candidates that R would not accept in the final round, but is willing to accept on the first draw to head off the risk of L joining with M to take a more leftist candidate in the next round.

⁵Note that our model also applies to a single decision-maker. In that instance, the committee simply has one member with a unanimity rule.

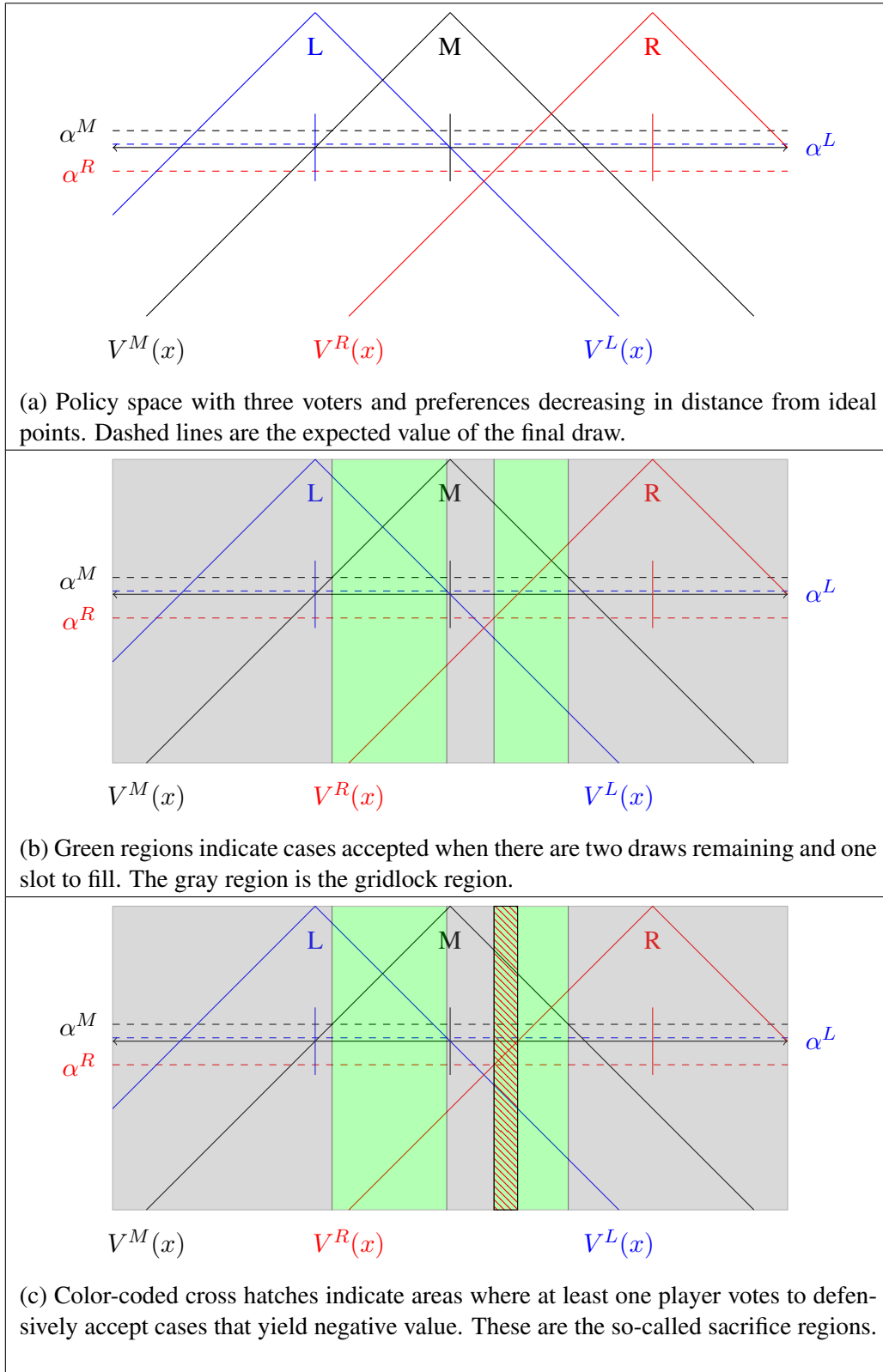


Figure 4: Utility increasing in distance from ideal points.

The General Model

Having shown the existence of a sacrifice region, gridlock, and mobile cutpoints in a two-period game, it remains to show that these phenomena—especially the sacrifice region—remain in a larger game where the number of draws and slots increase. The concern may be that while these effects are clearly of substantive interest in a wide range of situations, if they are merely artifacts of the imminent conclusion of the decision-making process, they are less important than they would be if they were present throughout the game.

In addition to allowing an arbitrary number of draws and slots, we also generalize away from the class of games that follow a spatial representation. We note that while the two examples in the preceding section all rely on spatial preferences, the initial example about a committee choosing among applications for cancer treatments does not have an obvious spatial representation. In this section, we describe and solve the larger game in more general terms and demonstrate our results are robust to scenarios that are or are not represented by spatial preferences.

There is a committee of C members. Players are members of the committee $i \in \{1, 2, \dots, C\}$. Nature presents the committee with N sequential draws $\{x_N, x_{N-1}, \dots, x_1\}$ from a compact Baire space, \mathcal{X} .⁶

From these draws, the committee may select up to K . After any draw x_n , when there are $0 < k \leq K$ slots remaining, players individually and simultaneously choose an action $a_{n,k}^i \in \{take, pass\}$. If at least Q members of the committee choose to take the draw, the committee accepts the draw, and the number of available slots decreases by one. If fewer than Q players choose to take the draw, the committee passes on the draw and the number of slots remains unchanged. In our baseline version, no player has a veto.⁷ Then nature reveals the next draw.

The game continues until either there are no draws or no slots remaining. If the game concludes with the exhaustion of draws, each remaining slot pays out zero to each player. Once the game ends, payoffs are realized for all accepted draws. Our initial assumption is that the draws are independent, so the value to any player for taking any draw j does not depend on whether or not some j' was also accepted.⁸

Each draw x_n is drawn from \mathcal{X} according to a commonly known distribution with cumulative density, $F(\cdot)$, having support over the entire domain. While this common knowledge assumption is not strictly necessary for our results, we maintain it for two reasons. First, it simplifies the notation. Secondly, by eliminating the possibility of private information, we highlight that our results do not depend on information asymmetries. When the committee accepts the draw, players receive (possibly) unique current payouts. We define $V^i(x)$ where $V^i : \mathcal{X} \rightarrow \mathbb{R}$ represents a bounded function that maps draws to payoffs for each member of the committee such that $V^i(x_n)$ is the current payoff of draw x_n to player i in the event that the draw is accepted. Moreover, let the inverse relation of V^i , $V^{i-1} : \mathbb{R} \rightarrow \mathcal{X}$, have continuous support over its full domain.

Figure 5 shows the larger game where there are an arbitrary number of draws and slots. Note that a node is indexed by $\{n, k\}$ where n is the number of draws remaining and k is the number of slots the committee has left to fill. When the committee accepts a draw, the game proceeds to the

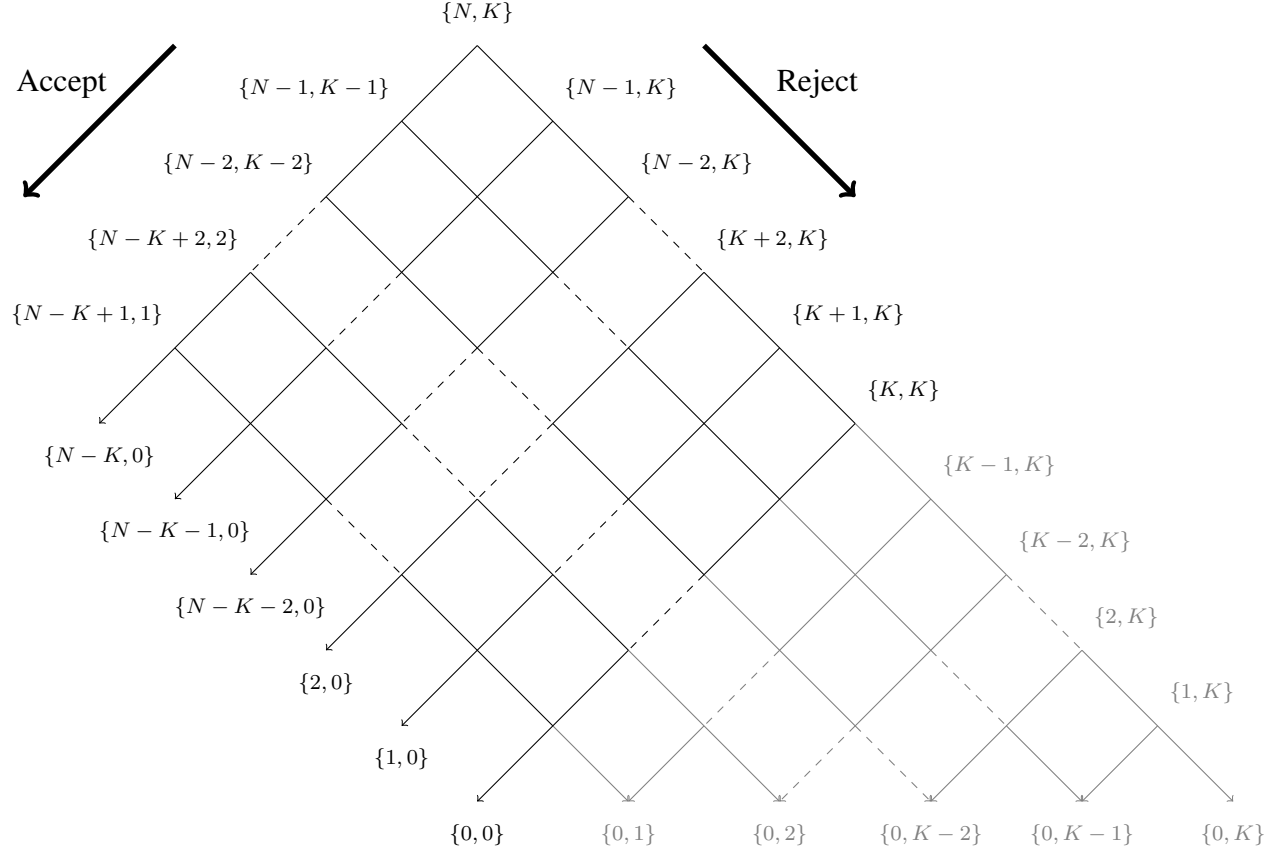
⁶In basic terms, a Baire space is a space in which any intersection of a countable collection of open dense sets is similarly dense. Any complete metric space satisfies this condition.

⁷This is one key difference between our model and jury selection models like Brams and Davis (1978).

⁸We argue later that this assumption is not essential to any results, but it is useful to focus attention on the core tradeoff in the model.

node where there are $n - 1$ draws and $k - 1$ slots remaining. If the committee passes on the draw, the game proceeds down to the right with $n - 1$ draws and k slots remaining.

Figure 5: Game Tree



Let $c_{n,k}(x) = \{i \mid a_{n,k}^i = \text{take}, x, n, k\}$ and $\mathcal{A}_{n,k}^Q = \{x \mid \#(c_{n,k}(x)) \geq Q\}$. In words, $c_{n,k}(x)$ is the set of players who will vote to take a draw x when there are n draws and k slots remaining. The set $\mathcal{A}_{n,k}^Q$ is the set of draws taken at (n, k) by at least Q players. Define $p_{n,k} = \Pr(x \notin \mathcal{A}_{n,k}^Q)$ as the probability that the committee will reject a draw, x , when there are n draws and k slots remaining. Further, let $\nu_{n,k}^i = E[V^i(x) \mid x \in \mathcal{A}_{n,k}^Q]$ be the expected value of a draw to player i conditional on the draw being accepted. Strategies map from the draw and the number of slots and draws remaining to an action. So player i 's strategy is a mapping $\sigma^i : \mathcal{X} \times n \times k \rightarrow \{\text{take}, \text{pass}\}$. We define $\Sigma = \{\sigma^1, \dots, \sigma^C\}$.

Let x^j denote the case accepted in the j th slot and define

$$u_{n,k}^i(\sigma^i | n, k, \sigma^{-i}) = E \left[\sum_{j \leq k} V^i(x^j | n, k, \Sigma) \right] \quad (3)$$

where for any slot z left unfilled, $V^i(x^z) = 0$. This simply means that at the end of the game, the players only receive payoffs from the cases they take. If they do not take as many cases as they could, then they forgo the payoffs they might have had from those empty slots.

We now want to determine the expected value of a particular draw. Equation 4 defines player i 's expected utility when there are n draws and k slots remaining. That expected value is the weighted sum of two components. The first is the sum of the expected value of a current payoff from the next draw conditional on it being taken plus the continuation value of the game when there is one less draw and one less slot. The second is the continuation value of the game when there is one less draw but the same number of slots. These terms are weighted by the probability that the committee accepts the next draw. We now write

$$\begin{aligned} u_{n,k}^i &= (1 - p_{n,k}) (\nu_{n,k}^i + u_{n-1,k-1}^i) + p_{n,k} u_{n-1,k}^i \\ &= (1 - p_{n,k}) (\nu_{n,k}^i - \alpha_{n,k}^i) + u_{n-1,k}^i \end{aligned} \quad (4)$$

where $\alpha_{n,k}^i = u_{n-1,k}^i - u_{n-1,k-1}^i$. Finally, since the game ends when there are no draws or slots remaining, we define $u_{n,0}^i = u_{0,k}^i = 0$ for all n, k .

Markov-Perfect Equilibrium

We assume players' strategies do not depend on other players' strategies in previous rounds⁹ and look for Markov-perfect, weakly non-dominated, subgame perfect equilibria. Each draw represents a new subgame. Once players choose to accept or reject the draw, a new subgame begins with the subsequent draw. In this next subgame, the parameters depend on what happened in the previous round. A cutpoint strategy is some set, $\mathbf{x}^{\dagger i} = \{x_{n,k}^{\dagger i}\}$, such that player i will accept any draw, x , at (n, k) if and only if $V^i(x) \geq V^i(x_{n,k}^{\dagger i})$. We will focus on these strategies.

At the final draw, if there is a slot remaining, each player faces a well-defined optimal decision for any possible draw. In particular, since leaving the slot unfilled yields a payoff of zero, each player optimally sets her cutpoint at zero. By backward induction, the players can make optimal decisions under the assumption that all players will act optimally in the subsequent periods. The collection of optimal decisions by a player at each point is, by construction, a weakly undominated subgame perfect strategy. We show that they are also cutpoint strategies. The set of such strategies forms an equilibrium strategy profile, $\Sigma^* = \{\sigma^{1*}, \dots, \sigma^{C*}\}$, with $\sigma^{i*} = A^i = \{\alpha_{n,k}^i \forall n, k\}$ denoting the cutpoint strategies such that player i will accept any draw x at (n, k) when $V^i(x) \geq \alpha_{n,k}^i$. Defining $\mu^i = u_{1,1}^{i*}$, we obtain the following:

Theorem 1: Equilibrium

Equilibrium

1. $u_{n,n}^{i*} = n\mu^i$ for all i , and $\alpha_{n,k}^i = \alpha_{1,1}^i = 0$ for all i whenever $k \leq n$.
2. $\alpha_{2,1}^i = \mu^i$.
3. Player i has a unique interior Markov-perfect, weakly non-dominated, subgame per-

⁹This assumption bites only in the cases where players are uncertain of their peers' preferences or in special cases where there is uncertainty over the true distribution of possible draws. In the former, there may be incentives for a player to bluff on certain cases in the hope of obtaining better payoffs at a later draw by misleading peers' beliefs regarding her preferences. In the latter case, subject to her own beliefs, she may be incentivized to strategically accept or reject some draws as a means of manipulating the number of draws and thereby influencing their ability to update their beliefs regarding the distribution of possible draws. See Appendix A for more on this.

fect equilibrium strategy σ^{i*} , and Σ^* is the corresponding equilibrium. Specifically, players play cutpoint strategies of $\sigma^{i*} = A^i = \{\alpha_{n,k}^i \forall n, k\}$ and accept any draw x at (n, k) when $V^i(x) \geq \alpha_{n,k}^i$.

4. Whenever $\alpha_{n,k}^{i*} \geq \max\{V^i\}$, any cutpoint, $\sigma_{n,k}^i$ (or combination thereof in mixed strategies) satisfying $\sigma_{n,k}^i \geq \max\{V^i\}$ is a best response. Whenever $\alpha_{n,k}^{i*} < \min\{V^i\}$, any cutpoint, $\sigma_{n,k}^i$ (or combination thereof in mixed strategies) satisfying $\sigma_{n,k}^i < \min\{V^i\}$ is a best response.

All proofs are in the appendix. Theorem 1 says that players take any draw that returns at least as much as the difference between the continuation values from passing on and accepting the draw. Notice that the cutpoints here are reservation utilities. In a model with spatial utilities, this would translate directly to cutpoints in the relevant spaces. Further, when the number of slots equals or exceeds the number of draws, players' strategies lock and expected payoffs are fixed. So players use the same cutpoints at $(1, 1)$, $(2, 2)$, and (z, z) , and since we normalize all players' payoffs for a lost slot to zero, every player uses a cutpoint of zero in these scenarios. More generally, for any $n \leq k$, the players use the same strategy, $\sigma_{n,k}^i = 0$, and $u_{n,k}^i = n\mu^i$.

The following Lemma follows directly from the definition of $\alpha_{n,k}^i$.

Lemma 1.1: Cutpoint Summation

$$u_{n,k}^i = \sum_{0 \leq z < k} \alpha_{n+1,k-z}^i$$

Lemma 1.1 links strategies and utilities in the previous period. Consider the extended game tree in Figure 5. Note that any horizontal row has a common number of draws remaining, n . From any node (n, k) , rejecting the draw moves the game down and to the right while accepting the draw moves the game down and to the left. Lemma 1.1 says that the expected utility at node (n, k) is equal to the sum of the optimal cutline strategies on the row above when there are k or fewer draws remaining.

It also leads to the following theorem.

Theorem 2: Row Cutpoints

For any $n \leq K + 1$,

$$\sum_{k < n} \alpha_{n,k}^i = (n - 1)\mu^i$$

Equivalently, $\overline{\alpha_{n,k}^i} = \frac{1}{n-1} \sum_{k < n} \alpha_{n,k}^i = \mu^i$ for any node (n, k) where $n > k$.

Theorem 2 follows from Lemma 1.1 and Theorem 1.1. It says that the sum of the optimal cutlines in the row where all nodes have n draws remaining is $(n - 1)\mu^i$. That is, the sum is equal to the number of draws remaining across the row minus one times the expected value of the last draw when there is at least one slot remaining. Equivalently, the average cutpoint value for any node in any row—save the nodes along the ray where $n = k$ —is μ^i . Since it is true for every row, it follows that the average value for all cutpoints at nodes where $n > k$ is μ^i .

However, things may look a bit different when the number of draws gets arbitrarily large. When the number of draws is practically infinite and the number of slots is finite, then players no longer care about the diminishing number of slots or draws. Essentially the draws all begin to look the same. Theorem 3 formalizes this result.

Theorem 3: Large- n Limit

As $n \rightarrow \infty$, there exists a ν_∞^i such that $\alpha^i \rightarrow \nu_\infty^i$ for all finite k .

The full proof is in the Appendix, but the intuition is straightforward. From the definition of $u_{n,k}^i$ in equation 4, we have

$$u_{n,k}^i = (1 - p_{n,k}) (\nu_{n,k}^i + u_{n-1,k-1}^i) + p_{n,k} u_{n-1,k}^i \quad (5)$$

However, since n is arbitrarily large we have $n \approx n - 1$, which allows us to drop the n subscripts. Simplification yields

$$u_k^i - u_{k-1}^i = \nu_k^i \quad (6)$$

But notice that the left-hand side of that equation is equal to α_k^i . Further, ν_k^i is a function of α_k , and so the index, k , only appears on the variables we are solving for in each period. That is, the solution does not depend on k , and we are left with $\alpha^i = \nu^i$.

Further, we do know several things about optimal strategies at many points where n is finite. First, since \mathcal{X} is bounded, $\alpha_{n,k}^i$ is bounded. This prevents the cutpoints from spinning off to plus or minus infinity. We can bound cutpoints even more strongly with the following Lemma:

Lemma 3.1: Bounded α^i

$\alpha_{n,k}^i$ is bounded such that

$$\min\{\alpha_{n-1,k}^i, \alpha_{n-1,k-1}^i\} \leq \alpha_{n,k}^i \leq \max\{\alpha_{n-1,k}^i, \alpha_{n-1,k-1}^i\}$$

for $k \geq 3$.

Lemma 3.1 says that the cutpoint for any node (n, k) in the tree where $k \geq 3$ is bounded by the cutpoints connected to it below.

Theoretical Implications

We focus on three particular implications of our model. First, there are instances where a player will choose to accept a draw even if it means taking a negative current payoff instead of a zero payoff. These sets of cases we call *sacrifice regions*. Second, we examine the set of draws the committee will not take and call it a *gridlock region*. Third, we show that a monopolist agenda-setter always has an optimal strategy.

Definition 1: Sacrifice Region

A sacrifice region is a set, $S_{n,k}^i = \{x \mid \alpha_{n,k}^i \leq V^i(x) < 0\}$. That is, it is a player-specific collection of draws that i will vote to take, even though i receives a negative payoff.

Definition 1 follows directly from the definition of $\alpha_{n,k}^i$ and Theorem 1. A sacrifice region is a strategy for a player who recognizes that the best defense is an aggressive offense. Rather than sitting back and hoping that bad draws do not come her way, a player that expects to lose big in the next round acts aggressively in this round to take a small loss instead. Notice that there is no risk-aversion driving this result. Risk neutral players with cutpoint strategies less than zero simply follow this logic to its inevitable conclusion. Filling up the slot with a small loss is better than leaving the slot open when the player expects a big loss in a following round.

While operating at this level of generality makes it impossible to specify exactly where a sacrifice region will occur in a given game, the following lemma follows from Theorem 2 and Lemma 3.1.

Lemma 3.2: Sacrifice Regions

1. If $\mu^i \leq 0$, then for any $n > 2$ there is some $k > 0$ such that $\alpha_{n,k}^i \leq 0$, and the last inequality is strict if the first is also strict.
2. If for some node (\bar{n}, \bar{k}) where $\bar{k} > 2$ we have $\alpha_{\bar{n}, \bar{k}}^i \leq 0$, then there is a path of connected nodes from (\bar{n}, \bar{k}) to some node $(\tilde{n}, 2)$ such that $\alpha_{n,k}^i \leq 0$ for all $\tilde{n} \leq n \leq \bar{n}$ and $\tilde{k} \geq k \geq 2$.

The first part of Lemma 3.2 says that a sufficient condition for a sacrifice region is $\mu^i < 0$. If a player expects to suffer a utility loss at $(1, 1)$, she is willing to play a strategy in an earlier round that takes a small negative payout to ward off the risk of a very negative payoff in a future round. Such a player takes a negative current payoff in lieu of a zero payoff, simply to defend against the expected downside from a subsequent draw. Put differently, if Player i follows a sacrifice strategy in the two period game, then if we expand to the arbitrary game shown in Figure 5, then no matter how many extra draws we add, there is always some number of slots such that the player will also follow a sacrifice strategy. That is, if there is a sacrifice strategy in the two-period game, that strategy will also exist in the larger game with more draws, so our results from the two-period model extend well-beyond the two-period setting.

The second part of the lemma says that if while playing the game Player i follows a sacrifice strategy at some point when there are more than two slots remaining, then there is a sequence of draws for which Player i would continue to play a sacrificing strategy at least until there are only two slots remaining. Together, Lemma 3.2 shows that the presence of a sacrifice region is guaranteed up the game tree if there is a sacrifice strategy in the two-period game, and if there is a sacrifice strategy in the general game where $k > 2$, then the sacrifice strategy flows down the tree until hitting a left diagonal where $k = 2$ in Figure 5, even if there is no sacrifice region in the two-period game.

Definition 2: Gridlock Regions

A gridlock region is a set, $\Gamma_{n,k} = \{x \mid x \notin \mathcal{A}_{n,k}^Q\}$. It is the set of draws that the committee will not take under a Q -rule at n, k .

Our concept of a gridlock region is similar to the gridlock interval well known to legislative scholars as the region in a policy space between pivotal players in the legislative process (Krehbiel

(1998), Cameron (2000), Krehbiel (2010)). In the traditional, legislative formulation, the gridlock region exists because lawmaking requires a coalition that must include certain players: median member, filibuster pivot, president or veto override pivot, etc. If at least one of these players prefers the status quo to the proposal, the proposed policy fails.

In our model, the gridlock interval exists because no coalition of Q players finds it valuable enough to accept any draws in that region. The formal definition follows the standard usage from pivotal politics and includes all policies—draws in our model—that the committee will reject. However, we are particularly interested in the subset of policies that would yield a positive current payoff for a sufficient selectorate and yet the committee still rejects the draw. This happens because enough players are willing to forgo a small gain now in the hopes of a larger gain later.

Finally, our model also demonstrates how it is possible for a monopolist agenda setter like the Senate majority leader or the Speaker of the House to choose his or her optimal agenda. Suppose the Senate majority leader has access to a range of potential bills in \mathcal{X} and can propose N of them but the legislature only has time to pass K . From the perspective of the other senators, each bill is drawn according to some distribution $F(\cdot)$. But now this distribution is not randomly generated by nature but is the strategic selection of the agenda-setter. However, so long as $F(\cdot)$ is a cdf, the model is unchanged. From Theorem 1 and subsequent discussion, we know that each legislator will follow a cut-point strategy based on $F(\cdot)$. Any agenda, \mathbf{A}_j selected by the majority leader will induce outcomes consistent with the equilibrium behavior of the rest of the legislators. Theorem 4 shows that there is always at least one optimal agenda for the agenda-setter that maximizes her payoffs.

Theorem 4: Optimal Monopoly Agenda

Let \mathbf{A}_N be the set of all possible agendas of size N , where any element, $\mathbf{A}_j \in \mathbf{A}_N$, is an ordered subset of \mathcal{X} . If the committee can accept K draws and player i has monopoly agenda-setting power, there exists some nonempty subset $\mathbf{A}_N^* \subset \mathbf{A}_N$ where every agenda in \mathbf{A}_N^* maximizes the setter's total utility.

An Extended Example

The values of particular equilibrium cutpoints are not so easily discovered. This follows from understanding that the $\nu_{n,k}^i$ value in equation 4, the expected value of a draw conditional on the draw being taken, depends not only on player i 's strategy but on all players' strategies, Σ^* . To motivate our exploration of the larger game and the sacrifice region in particular, recall the example of NIH committee selecting a study to fund under majority rule.

Table 2: NIH Payoffs

	Chemotherapy	Acupuncture	Stem Cell	Treasury
Abby	0.5	0.4	1.5	0
Brady	0.1	1	0.1	0
Christine	1	$-\frac{1}{3}$	-2	0

When there are two draws, Christine is forced to sacrifice when $n = 2$ and to support the acupuncture study if offered so as to head off the risk of a stem cell study in the final round. But

things change if we add additional draws to the game. Table 3 shows the final ten periods of the game where there is only one slot left.

Column two in Table 3 shows the probability that the committee will reject a drawn application. The three columns on the right show the expected value to each player at the point where there are n draws remaining to fill one slot. Recall that when there is only one slot remaining, players will take any draw that offers them at least as much as their expected utility in the next round. So for example, $u_{4,1}^i$, the utility for player i in round 4, is that player's cutpoint strategy in round 5. Notice that if there are six or fewer draws, then Christine plays a sacrifice strategy.¹⁰ But when there are six draws remaining, Abby will vote for chemotherapy, which greatly improves the outlook for Christine.

Table 3: Ten Draws and One Slot

n	$p_{n,1}$	$u_{n,1}^{Abby}$	$u_{n,1}^{Brady}$	$u_{n,1}^{Christine}$
0	1.000	0.000	0.000	0.000
1	0.000	0.800	0.400	-0.444
2	0.667	0.667	0.600	-0.407
3	0.667	0.578	0.733	-0.383
4	0.667	0.519	0.822	-0.366
5	0.667	0.479	0.881	-0.355
6	0.333	0.460	0.660	0.104
7	0.667	0.473	0.474	0.403
8	0.667	0.482	0.349	0.602
9	0.667	0.488	0.266	0.734
10	0.667	0.492	0.211	0.823

What is happening is that when there are sufficiently many draws, Christine aligns with Abby to form a chemotherapy faction. But as the number of draws shrinks, Abby leaves the coalition hoping for a lucky sequence of draws that will lead to stem cells. Having lost her coalition partner, Christine has to shift strategies as well to defend against stem cells by voting for acupuncture.

Notice that if the committee followed a rule of one (like the Supreme Court example), then Abby is always holding out for stem cells, so Christine would have to play a sacrificing strategy for any n .¹¹ However, under the majority rule, if there are sufficiently many draws, then Christine can hope for chemotherapy.

Abby is willing to join the chemotherapy coalition because she prefers the chemotherapy study to acupuncture. If she enjoyed them both equally (e.g. if she received a .4 payout from chemotherapy and acupuncture), then something surprising happens. Since she is indifferent as to the two, Abby has no reason to join a coalition to take chemotherapy over acupuncture. In this case, she simply holds out hoping for a sequence of draws leading to a stem cell study in the final round. Because Abby will never join the chemotherapy coalition and because the loss from stem cells overwhelms the potential gain from chemotherapy in the final round, Christine sacrifices and supports acupuncture from the start. Thus a change in Abby's payoffs induces a change in Christine's

¹⁰Recall that the cutline when $n = 6$ is equal to the expected value if the node where $n = 5$.

¹¹Of course, in this example, Brady would also take acupuncture, but we could alter his payoffs so that he would not choose acupuncture, and then Christine's sacrificing strategy would be pivotal.

strategy. This shows that as the game expands, what drives behavior is how aligned or opposed preferences are between sufficiently large coalitions.

Discussion

In the presented model, we made several simplifying assumptions to focus attention on the key tradeoff in our model between certainty now and expectations in the future. However, in practice, committees will not conform to our precise specifications. Draws may not come randomly; instead, the order may be predetermined by nature, convention, or a monopolist agenda-setter. Committees may put a candidate aside and come back to it later. Different options may be compliments or substitutes such that the combined value of two or more options may not equal the sum of their stand-alone values. We now argue that our model is robust to relaxing these assumptions.

We take first the case where the potential current payoffs and order of all subsequent draws are common knowledge. Recall from Theorem 4 that a monopolist agenda-setter always has an optimal strategy. Supposing the optimal strategy is unique, all players know the sequence of draws. In this case, the model works just as before. The only difference is that instead of drawing each case from \mathcal{X} , each case is drawn from a singleton set, $\mathcal{X}_{n,k} \subset \mathcal{X}$. All that changes in this extension is that players have better information about future cases. This does not change their desire to maximize their payouts. Indeed, this scenario closely resembles that offered by Cox and McCubbins (1993) to describe agenda setting by the Speaker of the House, however our model focuses on the decision-making process of the rank and file voters.

Consider two different two-period games where players only have one slot to fill. In both games, the first draw—if taken—would provide player i a payout of one. In the first game, suppose player i knows that the second draw would offer her a payoff of two. Clearly, she would want to wait. But suppose that player i only knows that the payoff from the final draw would be distributed $\mathcal{N}(0, 1)$. Then she will want to accept the first draw, since in expectation, waiting will only offer a payoff of zero. The difference between the two scenarios is the information available, but from the player’s perspective, all she wants to do is maximize her payoff subject to the information available. The informational environment clearly influences the equilibrium cutpoints, but providing better information does not alter the fundamental structure of equilibrium decision-making.

Committees are also likely to look at options that are hard to judge. They may be good options, but there may be a desire to hold off on a final decision. Indeed, the Supreme Court has formal procedures to delay a final decision on petitions for certiorari. In such situations, the draw may return for consideration at either a known point in the game—say after the next draw is observed—or it may simply return with some positive probability at one or more future points. Notice that setting the case aside again provides more information about future draws.

Suppose at node (\hat{n}, \hat{k}) the committee draws \bar{x} and sets it aside. When the committee makes subsequent draws, it now has additional information, since it will consider \bar{x} again with some positive probability. If there is some commonly known, positive probability π at node (n, k) that \bar{x} will be considered, then the draw at (n, k) must come from a commonly known distribution with cdf $F^*(\cdot)$ which places positive probability π on drawing \bar{x} and will draw from $F(\cdot)$ with probability $1 - \pi$. Again, the change in information will influence the realization of a particular equilibrium, but it will not alter the fundamentals of the game.

The equilibrium is also robust to systems in which the draws during each period may not be

independent. It could be that accepting one draw affects the marginal value of accepting a different possibility. For instance, if the hypothetical NIH committee has already decided to fund one study on a particular type of cancer treatment, a subsequent application to study that same treatment is possibly less valuable. In our model, if taking option A changes the value of B , this simply changes the distribution of values. The underlying distribution of draws does not change, but the cutpoints would adjust after A is accepted to account for the change in B 's value. This change in the cutpoints could open or close different gridlock or sacrifice regions, but the tradeoffs are the same and the results of the model remain.

Relevance to Scaling Models

Scaling models are ubiquitous in political science. These models are used to recover ideal points for congressmen, Supreme Court justices, members of the British House of Commons, and many other actors in political institutions. These models almost always assume that individuals vote sincerely for a proposal or status quo based on expressive or policy payoffs determined by the spatial distance between the two options and the player's ideal point. The idea is that if the proposal is farther from player i 's ideal point than the status quo, then player i will vote against the proposal. That is, the models assume that when legislator i votes for proposal j , she prefers the proposal to the status quo.

Our model shows that when placed in a dynamic environment, this assumption cannot be sustained. Players have to account for not only the current payoffs, but also for the effect on the larger agenda. If an individual is following a sacrifice strategy, she will vote for a proposal even if she prefers the status quo policy. If there is a gridlock region, players that prefer the proposal to the status quo will vote for the status quo. In both instances, players are swayed by the effects their decision could have on the rest of the agenda.

The problem from an estimation point of view is that it is impossible to incorporate moving cutpoints for the legislators. If cutpoints are allowed to move, then the estimation procedure could simply set the players' cutpoints at $-\infty$ when they vote in favor of taking a draw and at $+\infty$ when they vote against taking a slot. The problem from a theoretical point of view is less severe. Since different players have different cutpoints, there is no longer a common cutpoint—in the familiar one-dimensional pivotal politics framework—that cleanly divides supporters and opponents of a proposal.

Conclusion

The work of politics is largely done in committees, and committees often make decisions sequentially. When earlier decisions affect later ones, it is important to pay attention to the effects of earlier decisions on later rounds. Committee members look ahead and figure out whether they should take what is offered now or hold off in hopes of something better.

In our model of dynamic committee decision-making, players trade off certain payoffs in the present period against prospective payoffs in future periods. As such, whether players accept a draw depends on what stage the game is in. What they are willing to take changes as the game goes on. At each stage, players will accept draws if it exceeds an equilibrium threshold value.

In our examples, we demonstrate that players who expect to win are patient in that they turn down small gains to protect the ability to get a big payoff later. Conversely, players that expect to lose may accept small losses now to avoid larger losses in the future. We also show that players will occasionally pass up a certain win in hopes of getting a better draw later. This is a cousin of the legislative gridlock interval, but it differs in several ways. Our gridlock interval is not directly the result of institutionally empowered specific pivots. These results extend to the larger game where the number of draws and number of slots are arbitrary. The model applies under a broader range of conditions making it a useful tool for the study of agenda-setting and committee decision-making across a range of institutions. In addition, it raises concerns with a core assumption of most scaling models. Specifically, these models may interpret votes pursuant to sacrifice or gridlock strategies incorrectly.

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A Differing Beliefs

It may be the case that some players pay more attention to the mechanism that governs the drawing process. For instance, suppose in the context of the Supreme Court, some justices are watching the lower courts more closely than others, and such justices have a better sense of the distribution of cases likely to come up on appeal. Similarly, justices may have different priors about the true distribution of draws, and they may update differently based on the sequence of observed draws.

Define $F^i(\cdot)$ be player i ’s beliefs about the distribution of draws and $V^i(x) : \mathcal{X} \rightarrow \mathbb{R}^C$ be the justice’s belief as to the payoff function that allocates finite payoffs to each player for each draw. Justice i is now able to form beliefs about other players’ strategies, σ^{-i} . At this point the game follows in exactly the same fashion as the preceding analysis with complete information. While the

realized payoffs may change as a result of uncertainty and differing beliefs, the decision-making processes of the individual players are quite similar.

If the players' beliefs are weak, they may also update those beliefs as the game unfolds. Denote the set of draws already observed as $\hat{\mathbf{x}}_n = \{x_m | m > n\}$ and the set of votes on those draws as $\hat{\mathbf{c}}_n(\hat{\mathbf{x}}_n) = \{c_m(x_m) | m > n\}$ where $c_n(x)$ is the observed distribution of votes over whether to accept or reject x_n . We can now write the players' updated beliefs as a function of the prior beliefs, $F_N^i(\cdot)$ and $\mathbf{V}_N^i(\cdot)$, as well as the observed pattern of observations and votes so that we have $\{F_n^i \times \mathbf{V}_n^i\} : \{F_m^j | m > n, j \in C\} \times \{\mathbf{V}_m^j | m > n, j \in C\} \times \hat{\mathbf{c}}_n \times \hat{\mathbf{n}}_n \rightarrow \mathbb{R}_+^{C+1}$. That is, the players' beliefs about the distribution of draws and other players preferences are determined as a function of the observed histories of the game.

Nuance arises in this state, however, as F_n^i and \mathbf{V}_n^i are not uniquely determined in this scenario. In particular, consider an example in which beliefs about the distribution are relatively strong but players are completely uninformed about the preferences of the other players. In one case, the first draw is unanimously accepted so that in the subsequent period, players still have uniform beliefs over the preferences of their peers. However in a second case, the draw is only marginally selected so that there is now a clear dichotomy differentiating the preferences of the players supporting the draw and those opposing it. As a result, despite being at the same node in the game, the beliefs of the players about each others' preferences in the two cases will differ depending on the individual draws that are realized.

This intuition opens up the game to strategic play by sophisticated players. While we do not rigorously solve the game in such scenarios, we offer a basic intuition of the conditions under which strategic play may develop. In the first case, when players' preferences are highly uncertain, a player may prefer to strategically accept or reject a draw in order to bluff other players into believing that her preferences are either more or less aligned with their own. In doing so, she may hope to induce the committee to ultimately accept a more favorable subset of the draws by eliminating or enhancing defensive play by the other players. Whether the goal of this strategic play is elimination or enhancement of defensive play will depend on the particular preference profiles of the players.

In the second case, if players are uncertain about the distribution of cases, a savvy player may choose to make a strategic choice over a draw to influence the number of draws taken and thereby affect the ability of other players to update their beliefs about the underlying distribution of draws. Accepting cases at a faster rate may lead other players to retain false beliefs about the distribution that benefit the strategic player whereas strategically rejecting cases can induce them to update their beliefs, even opening the large-N game to the possibility that the first several draws are essentially treated as burn-in draws that the committee uses to learn about the distribution.

B Proofs

Proof of Theorem 1: *Equilibrium*

1. $u_{n,n}^{i*} = n\mu^i$ for all i , and $\alpha_{n,k}^i = \alpha_{1,1}^i = 0$ for all i whenever $k \leq n$.
2. $\alpha_{2,1}^i = \mu^i$.
3. Player i has a unique interior Markov-perfect, weakly non-dominated subgame perfect equilibrium strategy σ^{i*} , and Σ^* is the corresponding equilibrium. Specifically, players play cutpoint strategies of $\sigma^{i*} = A^i = \{\alpha_{n,k}^i \forall n, k\}$ and accept any draw x at (n, k) when $V^i(x) \geq \alpha_{n,k}^i$.
4. Whenever $\alpha_{n,k}^{i*} \geq \max\{V^i\}$, any cutpoint, $\sigma_{n,k}^i$ (or combination thereof in mixed strategies) satisfying $\sigma_{n,k}^i \geq \max\{V^i\}$ is a best response. Whenever $\alpha_{n,k}^{i*} < \min\{V^i\}$, any cutpoint, $\sigma_{n,k}^i$ (or combination thereof in mixed strategies) satisfying $\sigma_{n,k}^i < \min\{V^i\}$ is a best response.

We proceed by backward induction and begin by proving parts (1) and (2). Recall that the value of an unfilled slot at the end of the game is zero. If she is pivotal, player i votes to take a draw x_n if $V^i(x_n) + u_{n-1,k-1}^i \geq u_{n-1,k}^i$. That is, she votes to take a draw if the current payoff plus the continuation value of the next draw when there is one less slot is greater than the continuation value of the next draw when the court does not fill a slot in this period. If she plays any strategy in which she accepts some draw, x'_n , such that $V^i(x_n) + u_{n-1,k-1}^i < u_{n-1,k}^i$ or rejects some x''_n such that $V^i(x_n) + u_{n-1,k-1}^i \geq u_{n-1,k}^i$, she can improve her expected payoff by deviating to reject x'_n or accepting x''_n , respectively.

Thus, at $(1, 1)$, player i plays the strategy, $\sigma_{1,1}^{i*} = 0$ yielding an expected payoff of μ^i whenever she is pivotal. If she chooses some alternative, $\sigma_{1,1}^i > 0$, her expected payoff

when pivotal is

$$E[U^i(\sigma'_{1,1})] = \int_{\alpha'_{1,1}}^{\infty} p(x)V^i(x)dx \leq \int_0^{\infty} p(x)V^i(x)dx = \mu^{\star i} \quad (7)$$

since $\int_0^{\alpha'_{1,1}} p(x)V^i(x)dx \geq 0$. Thus, $\sigma'_{1,1} > 0$ cannot yield a profitable deviation. Conversely, if she chooses some $\sigma'_{1,1} < 0$, her expected payoff in $(1, 1)$ is

$$E[U^i(\sigma'_{1,1})] = \int_{\alpha'_{1,1}}^{\infty} p(x)V^i(x)dx \leq \int_0^{\infty} p(x)V^i(x)dx = \mu^{\star i} \quad (8)$$

Since $\int_{\alpha'_{1,1}}^0 V^i(x)p(x)dx \leq 0$. Thus, $\sigma'_{1,1} < 0$ cannot yield a profitable deviation. Therefore, $\sigma_{1,1}^{\star i} = 0$ is an equilibrium strategy for player i when she is pivotal. If she is not pivotal, her actions do not affect the outcome of the game and there cannot be any strictly profitable deviation, so the equilibrium is weakly undominated regardless of other players strategies.

For the remainder of the proof, we likewise consider weakly undominated strategies

Moreover, for any proposed equilibrium, $\sigma''_{1,1} \neq 0$,

$$E[U^i(\sigma''_{1,1})] = \int_{\alpha''_{1,1}}^{\infty} p(x)V^i(x)dx \leq \int_0^{\infty} p(x)V^i(x)dx = \mu^{\star i} \quad (9)$$

so that there is a weakly profitable deviation that is strict whenever $V^i(x)$ has continuous support over some neighborhood around zero, as with our model.

Now consider the strategy at $(1, 2)$, $\sigma_{1,2}^{\star i}$. In this case, the committee can select at most one case, x_1 , and the remaining slot will necessarily remain unfilled, yielding a payoff of zero.

Therefore, this strategy is identical to that in the state, $(1, 1)$, and $\sigma_{1,2}^{\star i} = \sigma_{1,1}^{\star i} = 0$.

Finally, consider the general strategy in (n, k) for $n \leq k$, $\sigma_{n,k}^{\star i}$. By induction from the base cases of $(1, 1)$ and $(1, 2)$, if she accepts the case, x_n when pivotal, player i expects to earn μ^i in the subsequent state, $(n - 1, k - 1)$. If she rejects, she expects μ^i in the subsequent state, $(n - 1, k)$. Thus, her strategy in this period does not affect her payoff in the remaining

periods, and she need simply maximize the single-period payoff. Following the same logic as above, this implies $\sigma_{n,k \geq n}^{\star i} = \sigma_{1,1}^{\star i} = 0$. Recognizing that we have continuous support over the entire range of V^i , all inequalities above are strict in that range and there can be no other interior strategies which are supported in equilibrium, as every such pure strategy is strictly dominated by $\sigma_{1,1}^{\star i} = 0$. This precludes both pure and mixed alternatives and concludes the proof of part (1).

For part (2), consider the payoff of player i playing strategy, $\sigma_{2,1}^{\star i}$. If player i rejects x_2 when pivotal, the case is rejected and she subsequently expects $u_{1,1}^i = \mu^{\star i}$. If she accepts the case, she earns the payoff from that case and a payoff from subsequent draws that is equivalent to $u_{1,0}^i = 0$. Thus for a strategy, $\sigma_{2,1}^i$, she earns the expected payoff,

$$E[U^i(\sigma_{2,1}^i)] = \int_{\alpha_{2,1}^i}^{\infty} p(x)V^i(x)dx + \int_{-\infty}^{\alpha_{2,1}^i} p(x)\mu^{\star i}dx \quad (10)$$

Following the same logic as in part (1), the unique optimal strategy in equilibrium is $\sigma_{2,1}^{\star i} = \mu^{\star i}$. Any deviation, higher or lower, will result in a lower payoff. This completes part (2).

Applying the logic of parts (1) and (2) to each player, the full equilibrium strategy profile, Σ^* is a unique interior subgame perfect equilibrium, completing part (3)

Whenever there is not an interior equilibrium such that $\alpha_{n,k}^{\star i} \notin (\min\{V^i\}, \max\{V^i\})$ for all i , the payoff of playing any cutpoint, $\sigma_{n,k}^i$ satisfying $\sigma_{n,k}^i \geq \max\{V^i\}$ (if $\alpha_{n,k}^{\star i} \geq \max\{V^i\}$) or $\sigma_{n,k}^i < \min\{V^i\}$ (if $\alpha_{n,k}^{\star i} < \min\{V^i\}$) is equivalent to that of any other such cutpoint and so any such cutpoint or combination thereof in mixed strategies is a best response. This completes the proof.

Proof of Lemma 1.1: *Cutpoint Summation*

$$u_{n,k}^i = \sum_{0 \leq z < k} \alpha_{n+1,k-z}^i \quad (11)$$

Recall the definition, $\alpha_{n,k}^i = u_{n-1,k}^i - u_{n-1,k-1}^i$. Rearranging and incrementing the indices on n yields,

$$\begin{aligned}
 u_{n,k}^i &= \alpha_{n+1,k}^i + u_{n,k-1}^i \\
 &= \alpha_{n+1,k}^i + \alpha_{n+1,k-1}^i + u_{n,k-2}^i \\
 &= \alpha_{n+1,k}^i + \alpha_{n+1,k-1}^i + \alpha_{n+1,k-2}^i + u_{n,k-3}^i \\
 &= \alpha_{n+1,k}^i + \alpha_{n+1,k-1}^i + \cdots + \alpha_{n+1,1}^i + u_{n,0}^i \\
 &= \sum_{0 \leq z < k} \alpha_{n+1,k-z}^i
 \end{aligned} \tag{12}$$

Proof of Theorem 2: *Row Cutpoints*

For any $n \leq K + 1$,

$$\sum_{k < n} \alpha_{n,k}^i = (n-1)\mu^i$$

Equivalently, $\overline{\alpha_{n,k}^i} = \frac{1}{n-1} \sum_{k < n} \alpha_{n,k}^i = \mu^i$ for any node (n, k) where $n > k$.

Consider again the definition of $\alpha_{n,k}^i$. Recall that

$$\alpha_{n,k}^i = u_{n-1,k}^i - u_{n-1,k-1}^i \tag{13}$$

We can rearrange terms, yielding

$$u_{n-1,k}^i = u_{n-1,k-1}^i + \alpha_{n,k}^i \tag{14}$$

But this in turn implies that

$$u_{n-1,k-1}^i = u_{n-1,k-2}^i + \alpha_{n,k-1}^i \tag{15}$$

And thus we can rewrite Equation 14 recursively as

$$u_{n-1,k}^i = \sum_{0 \leq z < k} \alpha_{n,k-z}^i \quad (16)$$

From Theorem 1.1, we know that the expected utility for each node along the right diagonal where $n = k$ is $n\mu$ and at such nodes, $\alpha_{n,k}^i$ is zero. Since we know the value of $\alpha_{n,k}^i = 0$ when $n = k$, we are interested in the value of $\alpha_{n,k}^i$ when $n > k$. Equation 16 tells us that those cut-points—along the row where there are n draws remaining but $n > k$ —sum to $(n-1)\mu^i$. This in turn implies that the average value of these $n-1$ cut-points, which we denote $\overline{\alpha}_n^i$ is μ^i .

$$\overline{\alpha}_n^i = \frac{1}{n-1} \sum_{1 \leq z \leq n} \alpha_{n,z}^i = \frac{1}{n-1} u_{n-1,n-1}^i = \frac{1}{n-1} n\mu^i = \mu^i \quad (17)$$

Proof of Theorem 3: *Large- N Limit*

As $n \rightarrow \infty$, there exists a ν_∞^i such that $\alpha^i \rightarrow \nu_\infty^i$ for all finite k .

Suppose $n = \infty$ so that $n = n-1$ and i is pivotal at (n, k) . The equilibrium now reduces to

$$\begin{aligned} \alpha_{n,k}^i + u_{n,k-1}^i &= u_{n,k}^i \\ &= (1 - p_{n,k}) (\nu_{n,k}^i + u_{n,k-1}^i) + p_{n,k} u_{n,k}^i \end{aligned} \quad (18)$$

which, dropping the n subscript, reduces to

$$\begin{aligned} \alpha_k^i &= (1 - p_k) \nu_k^i + p_k (u_k^i - u_{k-1}^i) \\ &= (1 - p_{n,k}) \nu_k^i + p_{n,k} V^i(i + \delta_{i,k}) \\ &= \nu_k^i \end{aligned} \quad (19)$$

Note that ν_k^i is simply a function of α_k , so that the index, k , only appears on the variables

we are solving for in each period. That is, the solution does not depend on k , and we are left with $\alpha^i = \nu_\infty^i$.

Proof of Lemma 3.1: Bounded α^i

$\alpha_{n,k}^i$ is bounded such that

$$\min\{\alpha_{n-1,k}^i, \alpha_{n-1,k-1}^i\} \leq \alpha_{n,k}^i \leq \max\{\alpha_{n-1,k}^i, \alpha_{n-1,k-1}^i\} \quad (20)$$

for $n > k > 2$.

Consider two draws beginning at an arbitrary node $(n+1, k)$ where $n \geq 2$ and $2 \leq k \leq n-1$.

We want to show that $\alpha_{n+1,k}^i$ is weakly bounded by $\{\alpha_{n,k-1}^i, \alpha_{n,k}^i\}$. There are two cases:

1. $\alpha_{n,k-1}^i \geq \alpha_{n,k}^i$
2. $\alpha_{n,k-1}^i \leq \alpha_{n,k}^i$

We prove the Lemma for Case 1. The proof for the second case is symmetric.

Suppose Case 1, the optimal cutpoint $\alpha_{n+1,k}^i > \alpha_{n,k-1}^i$. Then there exists some draw, x_{n+1} , such that $V^i(x_{n+1}) > \alpha_{n,k-1}^i$ such that player i is better off passing on x_{n+1} than she would be by taking x_{n+1} . Now suppose the next draw, x_n yields a payoff of $V^i(x_n)$, and consider three instances:

1. $V^i(x_n) > \alpha_{n,k-1}^i$
2. $V^i(x_n) < \alpha_{n,k}^i$
3. $\alpha_{n,k}^i \leq V^i(x_n) \leq \alpha_{n,k-1}^i$

If $V^i(x_n) \geq \alpha_{n,k-1}^i$, then regardless of whether or not player i takes x_{n+1} , she will accept x_n . So the choice is between $\{take, take\}$ and $\{pass, take\}$. The former yields $V^i(x_{n+1}) +$

$V^i(x_n) + u_{n-1,k-2}^i$ the latter gives $V^i(x_n) + u_{n-1,k-1}^i$. Recall that $u_{n-1,k-1}^i = u_{n-1,k-2}^i + \alpha_{n,k-1}^i$ by definition and $V^i(x_{n+1}) > \alpha_{n,k-1}^i$ by assumption. Thus $V^i(x_{n+1}) + V^i(x_n) + u_{n-1,k-2}^i > V^i(x_n) + u_{n-1,k-2}^i + \alpha_{n,k-1}^i$.

If $V^i(x_n) < \alpha_{n,k}^i$, then the choice is between $\{take, pass\}$ and $\{pass, pass\}$. Taking x_{n+1} then would provide a total payoff of $V^i(x_{n+1}) + u_{n-1,k-1}^i$ whereas passing on both draws leaves $u_{n-1,k}^i$. Again, by definition, $u_{n-1,k}^i = u_{n-1,k-1}^i + \alpha_{n,k}^i$ and by assumption, $\alpha_{n,k}^i \leq \alpha_{n,k-1}^i < V^i(x_{n+1})$. And so $V^i(x_{n+1}) + u_{n-1,k-1}^i > u_{n-1,k}^i$.

If $\alpha_{n,k}^i \leq V^i(x_n) < \alpha_{n,k-1}^i$, the choice is between $\{take, pass\}$ and $\{pass, take\}$. The former offers $V^i(x_{n+1}) + u_{n-1,k-1}^i$ the latter yields $V^i(x_n) + u_{n-1,k-1}^i$. But since by assumption $V^i(x_{n+1}) > \alpha_{n,k-1}^i > V^i(x_n)$, we have $V^i(x_{n+1}) + u_{n-1,k-1}^i > V^i(x_n) + u_{n-1,k-1}^i$.

These arguments show that regardless of the value of the following draw, player i would be better off taking a draw that pays $V^i(x_{n+1})$ if $\alpha_{n,k-1}^i < V^i(x_{n+1}) \leq \alpha_{n+1,k}^i$.

Now suppose $\alpha_{n+1,k}^i < \alpha_{n,k}^i$. Then there would be some draw $V^i(x_{n+1}) < \alpha_{n,k}^i$ such that player i is better off taking x_{n+1} than she would be by passing on it. We again consider the three possible cases for the next draw, x_n .

If $V^i(x_n) \geq \alpha_{n,k-1}^i$, the choice is again between $\{take, take\}$ and $\{pass, take\}$. The former yields $V^i(x_{n+1}) + V^i(x_n) + u_{n-1,k-2}^i$ the latter gives $V^i(x_n) + u_{n-1,k-1}^i$. Recall that $u_{n-1,k-1}^i = u_{n-1,k-2}^i + \alpha_{n,k-1}^i$ by definition, but now $V^i(x_{n+1}) < \alpha_{n,k}^i \leq \alpha_{n,k-1}^i$ by assumption. Thus $V^i(x_{n+1}) + V^i(x_n) + u_{n-1,k-2}^i < V^i(x_n) + u_{n-1,k-2}^i + \alpha_{n,k-1}^i$.

If $V^i(x_n) < \alpha_{n,k}^i$, then the choice is between $\{take, pass\}$ and $\{pass, pass\}$. Taking x_{n+1} then would provide a total payoff of $V^i(x_{n+1}) + u_{n-1,k-1}^i$ whereas passing on both draws leaves $u_{n-1,k}^i$. Again, by definition, $u_{n-1,k}^i = u_{n-1,k-1}^i + \alpha_{n,k}^i$, and by assumption, $V^i(x_{n+1}) < \alpha_{n,k}^i$. So $V^i(x_{n+1}) + u_{n-1,k-1}^i < u_{n-1,k}^i$.

If $\alpha_{n,k}^i \leq V^i(x_n) < \alpha_{n,k-1}^i$, the choice is between $\{take, pass\}$ and $\{pass, take\}$. The former offers $V^i(x_{n+1}) + u_{n-1,k-1}^i$ the latter yields $V^i(x_n) + u_{n-1,k-1}^i$. But since by assumption $V^i(x_{n+1}) < \alpha_{n,k}^i < V^i(x_n)$, we have $V^i(x_{n+1}) + u_{n-1,k-1}^i < V^i(x_n) + u_{n-1,k-1}^i$.

These show that there is no draw $V^i(x_{n+1}) < \alpha_{n,k}^i$ that player i should take. Together these arguments show that the optimal cut-point $\alpha_{n+1,k}^i$ must be situated between $\alpha_{n,k-1}^i$ and $\alpha_{n,k}^i$.

Proof of Lemma 3.2: *Sacrifice Regions*

1. If $\mu^i \leq 0$, then for any $2 < n \leq K + 1$ there is some $k > 0$ such that $\alpha_{n,k}^i \leq 0$, and the last inequality is strict if the first is also strict.
2. If for some node (\bar{n}, \bar{k}) where $\bar{k} > 2$ we have $\alpha_{\bar{n},\bar{k}}^i \leq 0$, then there is a path of connected nodes from (\bar{n}, \bar{k}) to some node $(\tilde{n}, 2)$ such that $\alpha_{n,k}^i \leq 0$ for all $\tilde{n} \leq n \leq \bar{n}$ and $\bar{k} \geq k \geq 2$.

Part (1): Following Theorem 2, the mean value of $\alpha_n^i, \bar{\alpha}_n^i$, must be equal to μ^i for every $2 < n \leq K + 1$. For this to hold when $\mu^i \leq 0$, it must be that for every $2 < n \leq K + 1$, there is at least one k such that $\alpha_{n,k}^i \leq 0$, and this inequality must be strict whenever $\mu^i < 0$.

Part (2): If $\alpha_{\bar{n},\bar{k}}^i \leq 0$, then by Lemma 3.1, either $\alpha_{\bar{n}-1,\bar{k}-1}^i \leq 0$ or $\alpha_{\bar{n}-1,\bar{k}}^i \leq 0$. Thus, there is a path of connected nodes from (\bar{n}, \bar{k}) to either $(\bar{n} - 1, \bar{k} - 1)$ or $(\bar{n} - 1, \bar{k})$. Applying this logic iteratively to the lesser of $\alpha_{\bar{n}-1,\bar{k}-1}^i$ and $\alpha_{\bar{n}-1,\bar{k}}^i$, there must either be a path to $(\tilde{n}, 2)$ or a path to $(\tilde{k} + 1, \tilde{k})$ such that $\alpha_{n,k}^i \leq 0$ for every n and k in the path. Thus, if for some node (\bar{n}, \bar{k}) where $\bar{k} > 2$ we have $\alpha_{\bar{n},\bar{k}}^i \leq 0$, there is a path of connected nodes from (\bar{n}, \bar{k}) to some node $(\tilde{n}, 2)$ such that $\alpha_{n,k}^i \leq 0$ for all $\tilde{n} \leq n \leq \bar{n}$ and $\tilde{k} \geq k \geq 2$, and the inequality on α^i is strict whenever $\alpha_{\bar{n},\bar{k}}^i < 0$.

Proof of Theorem 4: *Optimal Monopoly Agenda*

Let \mathbf{A}_N be the set of all possible agendas of size N , where any element, $A_j \in \mathbf{A}_N$, is an ordered subset of \mathcal{X} . If the committee can accept K draws and player i has monopoly agenda-setting power, there exists some nonempty subset $\mathbf{A}_N^* \subset \mathbf{A}_N$ where every agenda in \mathbf{A}_N^* maximizes the setter's total utility.

For some ordering of \mathbf{A}_N indexed by m , define

$$\mathbf{A}_N^M = \left\{ A_N \mid A_N \in \arg \max_{A_N^m} U_{setter}(A_N^m), m < M \right\} \quad (21)$$

Trivially, $\mathbf{A}_N^1 = \{A_N^1\}$. Now assume that the set, \mathbf{A}_N^M is nonempty for M . At $M + 1$, we must have

$$\mathbf{A}_N^{M+1} = \begin{cases} \{A_N^{M+1}\} & \text{if } U_{setter}(A_N^{M+1}) > U_{setter}(A_N^m) \forall m \in \mathbf{A}_N^M \\ \{A_N^{M+1}\} \cup \mathbf{A}_N^M & \text{if } U_{setter}(A_N^{M+1}) = U_{setter}(A_N^m) \forall m \in \mathbf{A}_N^M \\ \mathbf{A}_N^M & \text{if } U_{setter}(A_N^{M+1}) < U_{setter}(A_N^m) \forall m \in \mathbf{A}_N^M \end{cases} \quad (22)$$

Since this holds for $M = 1$, it holds for all $M \geq 1$. Thus, there is a nonempty set of agendas, $\mathbf{A}_N^* = \mathbf{A}_N^{||\mathbf{A}_N||}$ which maximize the agenda setter's utility.