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1. Introduction

Studies of political economy in recent years have placed emphasis on the operating characteristics of political and economic institutions. The premise of this work is that constitutional features of the political economy provide a structure of institutional incentives inducing equilibrium behavior and practices by optimizing agents. At both the theoretical and empirical levels there are comparisons in the literature of the equilibrium tendencies of classes of political arrangements (see, for example, Persson and Tabellini 2000, 2005, respectively). Political agents behave differently (targeting benefits, producing public goods, regulating the economy, extracting rents), and the effects of their collective choices differ (size and composition of spending, level of debt, productivity and growth of the economy) in presidential and parliamentary regimes, in unicameral and bicameral legislatures, under majoritarian and proportional electoral systems, and more generally in autocratic and democratic political economies. This research has made clear that explanations of collective choice require attention to institutional building blocks in order to anticipate equilibrium performance under

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different configurations. These explanations, in turn, provide a rational basis for ex ante constitutional decisions.

To date, most of the work has entailed comparisons between broad institutional regimes. Empirical work demonstrates that even crude distinctions, like that between majoritarian and proportional electoral arrangements, uncover systematic differences in the form of behavior and the content of outcomes. In the present paper we extend this style of analysis but focus on some micro-institutional differences.

We take a garden-variety instance of distributive politics — a divide-the-cake stage game — and explore dynamic extensions in different institutional contexts. In one institutional setting there is repeated play of the stage game in a unicameral legislative body, where each period of play is separated by an election in which all legislators face renewal. In a second setting the term length for the unicameral body is two periods, the stage game is played once in each of two periods, there is an election at the end of each period (as in the first setting), but with only a subset of legislators facing reelection in that period. The first setting entails *simultaneous* legislator reelection, while the second setting captures the incentives faced by legislators in a *staggered-term* legislature. The analysis of these settings permits us to unpack the "electoral connection" under varying institutional conditions.

We then combine these building blocks into an analysis of bicameralism. We establish the operating characteristics of a dual legislature, each chamber responsible for

dividing half a cake, when both are simultaneous-term bodies, both are staggered-term bodies, and when there is one chamber of each type.[1] These positive results allow us to consider how features of political institutions should initially be arranged at a "constitutional moment." Our basic bicameralism model also permits us to move beyond simple distributive politics tasks like dividing a cake to incorporate consideration of taxation and public goods.

The analysis of bicameralism is of interest in its own right inasmuch as we observe single-period term, multi-period term, simultaneous-election, and staggered-election legislatures, individually and in bicameral combination, empirically. A second virtue of this approach is that it provides a foundation for assessing whether generalizations drawn on the basis of relatively broad institutional distinctions, as is common in the current literature, are robust to finer-grained distinctions. Finally, we are in a position to explore endogenous institutional choice.

2. Bicameralism: Conventional Accounts

There is a wealth of historical material on the emergence and evolution of legislative bodies, principally as advisors to (and later providers of protection from) rulers. We provide a sketch of this history as it pertains to bicameralism below. Following this we review some of the models of bicameral legislative choice. We shall see that there

[1]Empirically, each chamber of a bicameral legislature passes a legislative bill and there is an ex post reconciliation of these proposals. In the United States this resolution occurs in a *conference procedure*. In many distributive politics situations, however, each chamber is effectively given a portion of the cake to divide and their respective proposals are simply added together ex post. See Shepsle, Van Houweling, Abrams, and Hanson (2007).

are a number of models of bicameralism related to our own. The main shortcomings of these models, however, are in not exploring dynamic extensions and in not taking variation in term structure across chambers into account. In effect, bicameralism is modeled as joint choice by two symmetric, essentially identical chambers. Our own approach makes dynamics and term structure central elements, and we trace the consequences of these in succeeding sections. (There are virtually no theoretical papers, though an occasional empirical one, on the distinction between simultaneous-term and staggered-term chambers.)

2.1. **Historical Backdrop.** The historical roots of bicameralism extend back at least as far as the classical societies of Greece and Rome. These were not instances of dual legislative chambers by which we know modern bicameralism, but more like advisory bodies to the ruler. There is evidence of these in Athens, Sparta, Crete, Carthage, and early Rome (Tsebelis and Money, 1997). They did sometimes assume a quasi-representative character, with assemblies representing different classes of citizen. Set next to such "representative" assemblies were smaller councils of advisors to the ruler, thus giving the institutional arrangement the nominal appearance of bicameralism. Early Rome, in fact, had a council of elders to advise the ruler that has given modern upper chambers their name – the Senate. Arrangements such as these appeared in Europe throughout and beyond the first millenium, with religious bodies often overlayed on, or thoroughly integrated with, secular ones.

As the "mother of parliaments," Britain developed some of the earliest institutional practices that came to be imitated throughout the western world. By the ninth century Angles and Saxons had firmly established a presence in England and

governed via quasi-military organizations. Various "courts" were established (courts of law, the hundreds court, the shire court) that different classes of individuals were expected to attend upon a summons from the ruler. In these settings the judicial, the legislative, and the administrative were blended as disputes were resolved, laws enacted, and decisions implemented. Over the next several centuries these sometimes advisory, often military-like bodies morphed into a pair of legislative chambers. One contained geographically based representatives (e.g., two knights from each shire) and the other privileged or entitled individuals (earls, dukes, lords, etc.). By the end of the thirteenth century, an arrangement of two chambers one of which consisted of "(s)elected" local representatives and which met with some regularity was firmly in place. Of great significance for the political importance of a separate powerful legislature was the written commitment by King John in 1215 to seek consent from the parliament to levy taxes above and beyond those to which he was entitled by feudal prerogative. This provided elites a focal venue for coordination to protect themselves from royal exploitation. While we cannot develop the subsequent history in any detail (see Gneist 1886 for a thorough account), we should note that over the next five centuries the British parliament was transformed from an institution summoned into being at the discretion of the ruler to one that met on regular occasions and developed an existence and policy inclinations independent of the ruler's wishes.

By the end of the bloody seventeenth century, following civil war, regicide, experimentation with a republic, restoration of the monarch, and a second deposing, power had permanently shifted from the king to the parliament, the latter now a bicameral body that met regularly. The upper chamber, Lords, consisted of hereditary and life

peers (whose number varied with the disposition of the king to create them). The lower chamber, Commons, represented individuals satisfying a substantial property requirement (essentially the "gentry"). It is estimated that the electorate of mid-seventeenth century England and Wales was 160,000 (Gneist, 285). Thus, a legislature consisting of two chambers that met regularly and whose consent was necessary for most initiatives of the ruler, especially the provision of supply, was firmly in place. At this same time England's North American colonies were crafting institutions of their own. With some exceptions, they produced colonial legislatures that had the look and feel of the mother-country parliament back in London.[2]

The innovation of the United States Constitution late in the eighteenth century was the creation of a bicameral arrangement that replaced a class basis for chamber representation with a modified federal basis. The "great compromise" of the Constitutional Convention of 1787 allowed for lower chamber representation based on population and upper chamber representation based on equality among the states. It also adopted the principal of "partial renewal" for the upper chamber in which, because the term of a senator was six years and that of a representative two, only a fraction of senators would be subject to replacement at the end of each two-year Congress. (The entire House is subject to renewal at the conclusion of a Congress.)

[2]Tsebelis and Money (1997, 27) report the irony that all the North American colonial legislatures began as unicameral. By the time of the American revolution, however, all but Georgia and Pennsylvania had become bicameral. The typical pattern was for the press of business to cause the creation of a subset of the unicameral legislative chamber as a separate "standing council." This was effectively a combined agenda-setting agent and executive committee, but was transformed over time into a second chamber.

Thus the House is a *simultaneous-term (full-renewal) chamber* and the Senate is a *staggered-term (partial-renewal) chamber*.

British class-based bicameralism and American federal-based bicameralism were the two prevailing models that proved influential in the nineteenth century as many continental European countries moved away from absolutism to representative democracy. One pattern, following the British experience, was for some form of Estates General of medieval origin, with a number of privileged classes or categories represented in separate chambers (often serving as no more than consultative to the monarch) to transform itself into dual legislative chambers. The upper chamber served to empower and protect a landed aristocracy or other elite from the potential predations of the popular chamber. Another pattern, following the American example, applied to confederations. Many of these, as reported in Tsebelis and Money (1997, 31-32), actually began as unicameral, its members essentially ambassadors from the territorial units of the confederation. The pressure of republicanism and popular participation in the wake of the French and American revolutions transformed these arrangements into bicameral structures, preserving the representation of local units in one chamber and adding popular representation in the other. In each of these patterns, established centers of power, whether landed elites, the bourgeosie, or local governmental units, protected themselves in a second chamber while extending popular representation in a first chamber. As noted by Lascelles (1952, 202-203), "Of course, no second chamber can stop a revolution but it can check the abuse of power by constitutional means or the use of it in an oppressive manner..."

We conclude this historical tour with some brief observations about the last century and the contemporary scene. Bicameralism, as we have seen, emerged as a medieval development (with traces of more ancient roots) but has been mainly a modern phenomenon associated with the rise (or re-creation) of the state. Important dates are 1215 and 1688 in England, 1787 in the US, 1789 in France, the nineteenth century in the rest of Western Europe, and the last decade of the twentieth century in Eastern Europe. By the end of the twentieth century, bicameralism was mainly associated with large, rich countries. In 183 parliamentary democracies counted by Patterson and Mughan (1999), 122 are unicameral and mostly small; sixty-one are bicameral and mostly large. (They also note that most municipalities around the world have unicameral councils.) In a report posted on the website of the French Senat (2000), it is noted that there has been a near doubling of the number of bicameral legislatures in the last twenty-five years – presumably an effect of the spread of democracy to former communist states in Eastern Europe. It also notes that of the fifteen countries with the highest GDP only two (China and Korea) are unicameral.

2.2. **Rationales for Bicameralism.** We are, of course, not the first to explore the operating characteristics or examine the normative attractions of bicameralism. Why bicameralism? This is really two questions – why more than one legislative chamber? and why no more than two legislative chambers? As we shall see, the literature addresses the first question but not the second.

An early explanation for bicameral legislative arrangements emerged from *realpolitik*. Whether an explicit compromise as developed in the US constitutional convention, or an implicit recognition by existing elites as happened in much of Europe,

the emergence of new sources of political power or the threat of political challenges to the established order induced institutional accommodation. This accommodation often took the form of balancing competing bases for representation. Dual legislative chambers, in effect, provided a more convenient and flexible institutional solution than attempting to house alternative representational considerations under a single institutional roof.[3] In suggesting that *representational diversity* is a force for bicameralism, Patterson and Mughan (1999, 10) point out that, circa 1990, 54 of 66 unitary democracies were unicameral while 18 of 19 federal democracies were bicameral. And, as we noted above, they also suggest that a unicameral structure is associated with smaller, and presumably more homogenous, polities while bicameralism is associated with larger, heterogeneous polities.

The most comprehensive set of claims in favor of bicameralism is the one offered in *Federalist #62* and *#63* [4]. Their first claim is that the upper chamber is a check on popular passions and thus on the possibility of *majority tyranny*.

> "In this point of view, a senate, as a second branch of the legislative assembly, distinct from, and dividing the power with, a first, must be

[3]This fails to account for why there were typically only two chambers. In fact, until reforms in the mid-nineteenth century, the Swedish Riksdag had *four* chambers. Tsebelis and Money, (1997, 29-30) report that from the fifteenth century onward each chamber had a veto over decisions. In the eighteenth century this was relaxed with decisions requiring the assent of three of the four chambers. The 1865-66 creation of a two-chamber parliament is suggested by them to be the result of "the unwieldiness of decision making with four estates rather than by demands for electoral reform."

[4]The author is believed to be either Alexander Hamilton or James Madison, but there is no definitive attribution.

> in all cases a salutary check on the government. It doubles the security to the people, by requiring the concurrence of two distinct bodies in schemes of usurpation or perfidy, where the ambition or corruption of one would otherwise be sufficient" (Federalist #62, 403).

Riker (1992), too, emphasizes the control of majority tyranny, claiming that a bicameral structure is more appropriate than other devices. He concedes, however, that other constitutional features accomplish this purpose – a unitary legislature with a supermajority decision rule, an independent executive, proportional representation (diminishing the likelihood of a single majority party), judicial veto power – but presents deficiencies in each relative to bicameralism (which we take up in the next section).

The second claim for bicameralism from Hamilton and Madison revolves around the virtues of *delay*. Numerous bodies, like most lower chambers, are subject to sudden impulses that less numerous bodies are able to check through deliberation and patience. Members of the lower chamber may, given their short terms, be impulsive and prone to quick fixes to problems that would better yield to a more deliberative and considered treatment. Thus, the combination of smaller size and longer terms provides the Senate with the inclination toward delay. Of course it should be observed that, as advocates for the Constitution, Hamilton and Madison did not balance their analysis with an assessment of the costs of delay, or what today would be called *gridlock*.

Nevertheless, as also emphasized by Riker (1992) and Levmore (1992), bicameralism renders change more difficult than unicameralism. Their argument is that it takes

longer to broker a deal to change the status quo because acceptible changes are harder to find in a bicameral arrangement than in a unicameral one.[5] As a corollary of delaying change by making it more difficult, bicameralism also reduces the prospect of arbitrary change, something that is more problematical for multidimensional decisions in a simple majority-rule institution with no Condorcet winner.[6]

A third rationale for bicameralism offered up by Hamilton and Madison is related to *agent types* on the one hand, and the specific tasks often performed by upper chambers on the other. They observe:

> "It is not possible that an assembly of men called for the most part from pursuits of a private nature, continued in appointment for a short time, and led by no permanent motive to devote the intervals of public occupation to a study of the laws, the affairs, and the comprehensive interests of their country, should, if left wholly to themselves, escape a variety of important errors in the exercise of their legislative trust" (*Federalist #62*, 404).

By contrast, politicians with longer terms are in a position to accumulate substantive expertise and human capital relevant to governing. Thus, it should come as no

[5]Let x^0 be the status quo in a multidimensional policy space. Define $W(x^0)$ as the set of alternatives preferred to x^0 by any decisive coalition in a unitary legislature – the *winset of* x^0. Let $W_i(x^0), i = H, S$ be the chamber-specific winsets of a House and Senate. The claim is: $W_H(x^0) \cap W_S(x^0) \subset W(x^0)$.

[6]Cutrone and McCarty (2006) demonstrate, as a positive claim (with no normative justification), that bicameralism produces a gridlock region that renders the status quo more robust to minor electoral perturbations than is the case in a unicameral arrangement.

surprise that upper chambers frequently have responsibility to review and revise the work of the lower chamber. Indeed, in many upper chambers they may *only* review and revise matters related to the raising of revenue. In effect, the second chamber provides a second opinion. (And, in those political systems where power has shifted dramatically to the lower chamber, the upper chamber is often restricted to a role of review and revision for all legislation.)

Fourth, and related, the authors of *The Federalist* regarded stability in policy and in government as a virtue. "No government, any more than an individual, will long be respected without being truly respectable; nor be truly respectable, without possessing a certain portion of order and stability" (*Federalist #62*, 407). Longer terms for the upper chamber mean more experienced members, a more stable membership, and a greater willingness to think long term.

Fifth, Hamilton and Madison further emphasize time horizon and limited discounting of the future associated with the upper chamber. The lower chamber, given their shorter leash, is bound to be focused on the short term. So, while frequent elections maintain popular control over politicians, they have a dark side. A second chamber, on a different and lengthier electoral calendar, is a partial corrective. They note that "the proper remedy for [a short-term oriented lower chamber] must be an additional body in the legislative department, which, having sufficient permanency to provide for *such objects as require a continued attention,* and a train of measures, may be justly and effectually answerable for the attainment of those objects" (*Federalist #63*, 409, emphasis added).

We have presented the liberal canon of justifications for bicameralism – representational diversity, checks on majority tyranny, the virtues of delay, the need for experienced and knowledgeable legislative politicians while not sacrificing proximity to popular sentiments, the benefits of review and revision, stability of the political class, and longer time horizons and a willingness to devote energy to "such objects as require a continued attention." The justifications are suggestive ... up to a point. They demonstrate why a single legislative chamber may be at a disadvantage, but they justify neither why a second chamber is sufficient nor, in failing to explore alternative remedies, whether it is necessary. We turn to some of the modeling literature for views on these issues.

3. Modeling Literature

3.1. **Bicameralism.** There are many models of legislatures and their internal arrangements, but few take up the issue of bicameralism. Indeed, most political economy models include a legislature that looks either like the US House of Representatives with its elaborate internal structure and nuanced procedures, or like a continental lower chamber with a cabinet supported (typically) by a multiparty coalition. Explicit treatments of bicameralism are rare.

Riker (1992) attempts to provide insights about bicameralism developed from more formal considerations.[7] Riker is obsessed with majority preference cycles. Their very existence means that majority decisions are arbitrary and can only be arrived at by

[7]One of the earliest treatments is Buchanan and Tullock (1962).

contrivance (e.g., agenda manipulation). Since they almost always exist in multidimensional policy spaces, Riker concludes that simple majority decision making is tyrannical, precisely the worry expressed about unicameral legislatures in *The Federalist*. He then explores, mainly via abstract examples, how several institutions might alleviate this condition. If, in a multidimensional set up, the winset of any status quo is non-empty under simple majority rule, the winset for that status quo under a supermajority criterion is nested within the simple majority winset. This, Riker claims, ameliorates majority tyranny and increases the prospects for delay. Likewise, he shows that the intersecting winsets of multiple chambers have a similar effect.[8] However, and this is his "pitch" for bicameralism, unidimensional decisions, in which single-peaked preferences assure the absence of preference cycles and the existence of a majority-rule optimum, are handled more effectively by bicameral arrangements than any of his other proposed institutions.

> "So we have reached the new normative justification of bicameralism. As against unicameralism, bicameralism works to minimize majority tyranny. As against other methods of delay, it allows majority decision when an unequivocal majority choice exists. Thus it captures the advantages and avoids the disadvantages of the method of majority rule" (Riker, 1992, 113).[9]

[8]As a third institution, he suggests that the mulitpartism produced by proportional representation, even in a unicameral chamber, has similarities to both multicameralism and supermajority rule.

[9]Riker makes a number of simplifying assumptions. He assumes, for example, that the distributions of legislative preferences are *identical* in both chambers. As Cutrone and McCarty (2006)

Levmore (1992) is also obsessed by preference cycles under simple majority rule and the opportunities for mischief this affords an agenda setter (or head of a majority party) in a unicameral legislative body. The advantage of bicameralism he identifies has to do with the sequencing of votes when two bodies must concur. An agenda setter is one chamber may well be able to sequence votes to obtain a result he desires. But if that result must then be considered by a second chamber whose agenda setter has objectives of her own, then the first agenda setter's leverage is reduced – "At the very least, if the two chambers consider an issue simultaneously, one chamber's agenda setter will be at the mercy of the order of consideration in the second chamber. Bicameralism can thus be understood as an antidote to the manipulative power of the convenor, or agenda setter, when faced with cycling preferences" (Levmore, 1992, 147-148).

The arguments of Riker and Levmore are casual, driven mainly by example, and seem contrived to some (see Tsebelis and Money, 1997, Chapter 9). They seek to justify bicameralism. Most of the modeling literature, on the other hand, seeks to trace the implications of bicameralism. We will be brief in describing some of these results.

It is well known that the existence of a non-empty majority core in a multidimensional spatial model is a zero-probability event. Hammond and Miller (1987) show conditions that produce a non-empty *bicameral* core – the set of points that cannot

show, even in a unidimensional world, when this assumption is relaxed there is a gridlock region between the medians of the two chambers. So, the advantages attributed by Riker to bicameralism are not terribly robust.

be defeated by concurrent majorities in both chambers.[10] Tsebelis and Money (1997) employ cooperative game theory concepts (core, yolk, uncovered set), like Hammond and Miller, to identify bicameral equilibria under conditions of bargaining between the chambers. They explore Rubinstein-Baron-Ferejohn bargaining between agents of the two chambers (as in a conference or navette procedure). Both moral hazard and impatience figure in this.[11] In a more general framework, Diermeier and Myerson (1999) provide an elegant treatment of "strategic" organizational design. Taking constitutional features as given – unicameral or multicameral legislature, whether there is an independent executive, distribution of agenda and veto power across constitutional players – they examine how a chamber will strategicaly arrange its own internal organization in order to accomplish chamber-specific goals.[12] Their general approach is very appealing for it accommodates a variety of ways in which "hurdles"

[10]In effect, the requirement is that there is clear "separation" between the preference distributions of the two chambers. That is, the majority winsets of the two chambers must have an empty intersection – an implausible condition.

[11]Moral hazard is of interest because bargaining agents need not be "representative" of their parent chamber. Gailmard and Hammond (2006), for example, explore the ways in which intercameral bargaining has *intracameral* organizational consequences – in particular, that a chamber might wish to "tie its hands" by appointing a biased committee to bargain on its behalf. Impatience is of interest because it connects to the differing term structures of the two chambers of a bicameral legislature. In the US, for example, the Senate might be thought the more patient body, since two-thirds of its members do not face their voters at the next election. In models of the Rubinstein variety, patience has its bargaining advantages.

[12]Theirs is a vote-buying model in which politicians shake down interest groups for bribes and campaign contributions. Members of each chamber seek to arrange intracameral structures and procedures, taking other constitutional arrangements as fixed, to enable them to extract as much

may be put in place, ranging from disciplined legislative parties to committee systems to committee chairs with veto power to strong floor leaders. This enables comparisons across nominally different organizational features in terms of the hurdles they imply and thus the extraction capabilities from special interests they constitute.

3.2. **Staggered Terms.** In every treatment of bicameralism with which we are familiar, there is no recognition of the near-universal regularity that membership conditions vary across the chambers. For example, nearly all lower chambers are elected. Of the 72 two-chamber legislatures identified on the French Senat web site in 2000 on the other hand, 36 have fully elected upper chambers, 18 are partially elected, and 18 are fully appointed. Eighteen percent have term lengths of four years, 31% have five years, 24% six years, 7% more than six years, and the remainder are mixed. Lower chambers on the other hand tend to have shorter term lengths (whether fixed or determined endogenously by the discretionary calling of elections). Bicameral chambers, in short, are not copies of each other.

Of special interest to us in the present paper is the fact that many upper chambers not only have longer terms than lower chambers; they also do not "fully renew" themselves at each election occasion. One third of the members of the US Senate, for example, face renewal of their six year terms every two years. This means that while all members of the lower chamber are "in cycle" every election – this is the defining property of a simultaneous-term legislature – only a third of senators are. This, in

as possible. This involves creating intra-institutional hurdles optimally so as to encourage maximum contributions from special interests, making sure the hurdles are not so high to discourage contributions.

turn, means that in intra-chamber politics, senators may condition on each other's location in the electoral cycle, something simultaneous-term lower-chamber members cannot do.

Alas there are virtually no models of bicameralism incorporating differential membership conditions across chambers.[13] The model that we develop in the present paper addresses some of these micro-features.

4. Theoretical Features of the Baseline Model

In order to focus attention initially on some of the core features of our framework and establish a few of our main points in as simple a set-up as possible, we first study a baseline model with two restrictive features, one concerning the economic environment and the other concerning the legislative structure. With respect to the former, we assume that in each period there is an exogenously given, fixed economic surplus, or cake, to be allocated as pork across political districts. Thus, we suppress the underlying, general fiscal policy problem of taxation (that determines the size of the cake) and its allocation between district-specific amounts of pork and national public goods. With respect to the latter, we assume that if there are two (or more) chambers in the legislature, then they are identical except possibly with respect to their term structures. The extensions section considers somewhat richer environments.

[13]There are many empirical papers in the American politics literature that explore legislative voting patterns, campaign practices, time allocations, etc. conditional on where in the electoral cycle a senator is. Shepsle, Van Houweling, Abrams, and Hanson (2006), a study of divide-the-dollar pork barreling activities among senators, cites some of these papers.

4.1. **Term Structure.** We consider an infinitely-lived legislature which is founded in period -1. At that time the "founding fathers" jointly determine and commit to various elements of its institutional structure, as described in section 4.5. At this constitutional moment, there are no legislators present. The legislature starts operating from period 0 onwards. In each period t (where $t = 0, 1, 2, 3, \ldots$) there are two legislators in a chamber (of either a unicameral or a bicameral legislature), each elected from a separate electoral district.[14]

We will begin our analysis with a simultaneous-term unicameral legislature (in which both legislators come up for reelection in the same period), and then compare it to a staggered-term unicameral legislature (in which the two legislators come up for reelection at different dates). In the context of our baseline model, this will prove pretty straightforward to do but it will illustrate some of the calculations at work, and allow us to zero-in on the importance of the determination and allocation of agenda power (formally captured by recognition probabilities). We then study the more interesting case of a bicameral legislature. A main aim in this part of the

[14]There are several restrictive features built into this baseline set-up, which we initially adopt so as to allow us to focus attention on a few core points. In the extensions section we discuss several modifications. We raise the issue of the "optimal" number of chambers when more than two can be selected. It will be argued that frictions of various kinds arise as more chambers are added to the legislature, some of which can create costly gridlock. We explore the robustness of our results when in a bicameral legislature the two chambers are interlocked in the sense that to pass legislation the approval of both chambers (as is the case in many bicameral legislatures) is required. Finally we raise the prospect of allowing for a richer, and more plausible composition of the legislature which would involve chambers having different numbers of legislators and different bases of representation.

analysis is to explore the circumstances, if any, under which a bicameral legislature is preferred (and hence selected by the founding fathers at the constitutional moment) over a unicameral legislature.

Our model of elections is described in subsection 4.2. The policy context in each period concerns the sharing of an economic surplus. We stylize this as the allocation of a cake of unit size between the two districts. In the context of a unicameral legislature, the two legislators negotiate over the partition of this whole cake. But in a bicameral setting each of the two chambers independently divides half of the cake.[15] Note that the legislative task is exclusively one of distribution. There are no public goods in this baseline model, and the surplus is treated as exogenous. The bargaining procedure (which in particular embodies the distribution of proposal power between the legislators within a chamber) is described in subsection 4.3. If an agreement is struck, then the agreed shares of the cake flow to the districts. The legislators receive no direct benefit from any portion of this cake. A legislator simply receives a fixed payoff $b > 0$ in each term he serves in office. Any share of the cake that he negotiates for his district, however, may help his reelection prospects.

4.2. **Elections.** The likelihood of a legislator being reelected depends on a variety of factors. Even when such factors are taken into account, some uncertainty about the

[15]It would be useful to consider alternative procedures through which the unit-size cake is partitioned, including procedures in which one chamber proposes an allocation while the other chamber decides on whether or not to approve it. Such procedures would mean that the two chambers are interlocked and connected, and do not operate independently. The extensions section studies an extended set-up in which some policy (tax rates) are determined "jointly" by the two chambers.

election outcome remains. Let Π therefore denote the probability that an arbitrary legislator (in an arbitrary period) is reelected. We explicitly incorporate a key idea about this probability of being reelected, the notion of *retrospective voting* (Fiorina, 1981). Voters care about the legislator's past performance in office when deciding whether or not to reelect him. We formalize this idea by positing that Π depends on the amounts of cake he obtained for his constituents during his most recent term of office. When that term consists of two periods, then we write this as $\Pi(x_1, x_2)$, where x_1 and x_2 are the amounts of cake obtained by the legislator during the first and second periods, respectively, in his most recent two-period term of office. And when the term of office consists of a single period, then we write this simply as $\Pi(x)$.

It is natural to assume that receiving more cake does not make a voter worse off, and thus does not decrease a legislator's chances of getting reelected. However, it may be that for some increases, the chances are unaffected. Hence:

Assumption 1 (Weak Monotonicity)**.** *The probability* Π *that a legislator is reelected is non-decreasing in its argument(s).*

In summary, our model of elections comes in reduced form and is characterized by the probability-of-reelection function Π satisfying Assumption 1 (A1 henceforth). Thus, the probability-of-reelection function is exogenously given (i.e., in particular the voting rule and voter behaviour are not explicitly modelled).[16]

[16]It may be noted that Π could alternatively be interpreted as the probability of reappointment by, say, a state legislature, as was the case in the nineteenth century US.

4.3. **Bargaining Power.** The procedural rules that influence the determination of the negotiated partition of the cake are a key part of the institutional structure of the legislature, pinning down the allocation of power (proposal power in particular) between the two legislators. Our framework abstracts from many of the details of real institutions through which power is derived (such as membership on committees or floor leadership positions), capturing the allocation of bargaining power in a simple manner.

For each chamber, we posit a random proposer, "take-it-or-leave-it-offer" format. Let $\theta_i \in [0,1]$ denote the probability with which the legislator from district i ($i = 1, 2$) is recognized, and makes an offer of a partition of the cake that the chamber in question has available, where $\theta_1 + \theta_2 = 1$. If the offer is accepted, agreement is struck. But if the offer is rejected, then bargaining terminates, no agreement is reached, and no cake is obtained (in the period in question) by either district from this chamber.

The recognition probabilities can depend on several factors including the following: (i) the population size of the two districts, with the larger-sized district possessing higher recognition probability (which capture the notion that larger-sized districts have a larger number of legislators), (ii) the seniority of the legislators (with for example recognition probability increasing with seniority), and (iii) in the case of a staggered-term chamber, the positions of the legislators in the "electoral cycle" (with recognition probabilities in a period increasing with proximity to the election date).

We adopt the convention that an offer designates the share going to the proposer. It is therefore convenient to use the word "demand" rather than "offer". We adopt the following regularity assumptions:

Assumption 2 (Tie-Breaking)**.** *(i) When indifferent between accepting or rejecting a demand, a legislator accepts it. (ii) When indifferent between making one of several demands, a legislator selects the one which allocates the largest share of the cake to him.*

For future reference, it may be noted that the expected payoff to a legislator who is reelected on each occasion with a constant probability $\pi \in [0, 1)$ equals $b/(1 - \pi)$. Notice that, without much loss of generality, we do not endow legislators with a discount factor.[17]

4.4. **Informational Structure.** How much information does any legislator have in any given period about the history of play? The issue is especially pertinent here since every legislator faces reelection, and with positive probability he is replaced by a newly minted legislator. While the legislature is an infinitely-lived body, operating over an indefinite number of periods, legislators come and go. As such a legislator may not know all of the important or relevant bits of the history of play at any given period. In this chapter, we posit a *default information regime*, one in which legislators have imperfect information about the history of play:

[17]To be precise, there is a potential but minor loss of generality. By not entertaining discounting, we need to assume that the reelection probability never takes the value of one. While such an assumption seems quite plausible, it does however rule out the cut-off voting rules used in the political agency literature (Barro, 1972; Ferejohn, 1986) in which a legislator is reelected with probability one if he performs sufficiently well (and fails to get reelected otherwise). The reelection probability function Π can of course approximate such a cut-off rule. We have chosen to proceed as we have in order to avoid carrying around an extra parameter (a discount factor for the legislators).

Assumption 3 (Imperfect Information)**.** *For any t there exists a finite $T > t$ such that legislators in period T and onwards do not know of the actions taken by the legislators in periods $s \leq t$.*

This formalization of imperfect information is implied by agents with finite memory; the length can vary across legislators. Assumption 3 implies that information about a past action is lost for sure some finite number of periods in the future.[18]

An altogether different kind of information concerns what a legislator knows about the game form, the payoffs and various parameters. Throughout this paper we adopt the *complete information* assumption: i.e., there is common knowledge amongst all legislators about the game itself.

4.5. **Founding Fathers' Problem.** At the constitutional moment in period -1, the founding fathers select the institutional structure of the legislature. In particular, they jointly choose (a) chamber structure (unicameral or bicameral), (b) term structure (simultaneous, staggered, or mixed), and (c) the allocation of proposal power (recognition probabilities in each chamber). These features are institutionalized through appropriate constitutional mechanisms, which determine legislative procedures and rules.

The choices are made so as to optimize over the founding fathers' joint interests. We assume that the founding fathers respectively represent the interests of the two districts, and that for each district, the voters across time have the same preferences. We can therefore identify one infinitely-lived principal per district. Let $u_i(c)$ denote

[18]This formalization of imperfect information is adapted from Bhaskar (1998) who studies a version of Samuelson's OLG model with imperfect information.

the per-period utility obtained by the principal from district i ($i = 1, 2$) when her consumption is c in the period in question, and let $\delta_i < 1$ denote the per-period discount factor used by her to discount future utility. We assume that u_i is strictly increasing and strictly concave in c. The latter feature captures the notion that the principals (voters, citizens) are strictly risk-averse.

4.6. **Comparisons.** Our main objective is to compare and contrast the properties of the equilibrium outcomes in legislatures with one or two chambers consisting of agents serving under a staggered-term or simultaneous-term structure. For a simultaneous-term legislature, a term consists of one period with an election taking place at the end of the period. In contrast, a term of office in a staggered-term body consists of two periods with elections taking place at the end of every period. The important difference is that both simultaneous-term legislators face election each period, whereas only one of the staggered-term legislators faces election each period.

A staggered-term legislator is denoted as EARLY when he is in the first period of his two-period term of office, and LATE when he is in the second (and final) period of his two-period term of office. In each period $t \geq 0$, therefore, one legislator is EARLY and the other LATE, and it is the period-t LATE legislator who comes up for reelection at the end of this period. If reelected, he becomes the period-$(t+1)$ EARLY legislator, while the period-t EARLY legislator becomes the period-$(t+1)$ LATE legislator. If, on the other hand, the period-t LATE legislator loses his election bid, then a new legislator is the period $(t+1)$-EARLY legislator.[19]

[19]The equilibria of this staggered-term legislature have been studied in Muthoo and Shepsle (2006).

It is assumed that in a simultaneous-term chamber proposal power is conditioned only on the name of the district; thus the district i legislator is recognized each period to make a proposal with probability θ_i; in *every* period this is i's recognition probability. Alternatively, in the staggered-term legislature proposal power is conditioned on the district name and the legislator's type: θ_{iE} and θ_{iL} respectively denote the probabilities with which the legislator from district i $(i = 1, 2)$ makes the take-it-or-leave-it offer when he is EARLY and LATE, where $\theta_{iE} + \theta_{jL} = 1$ $(j \neq i)$. Thus, i's recognition probability can possibly alternate from period to period according to his period-specific type. As noted earlier, recognition probabilities will typically depend on other factors such as legislative seniority, with more senior legislators possessing relatively greater agenda power and hence a larger recognition probability. We will discuss below how our results would alter when account is taken of such factors.

This completes the description of the theoretical features of our basic framework. They define a stochastic game with a countably infinite number of agents, but only two agents (per chamber) are active in any one period, and the number of periods for which an agent is active is determined endogenously.[20]

[20]Our stochastic game falls outside of the classes of stochastic games studied in the current literature (see, for example, Friedman 1986, Fudenberg and Tirole 1991, and Dutta 1995). Thus, we cannot appeal to or apply results from that literature. However, some of our main results are derived using methods and ideas borrowed from that literature and from the theory of infinitely-repeated games.

4.7. **Preliminary Results: Sequentially Rational Equilibria.** The imperfect information assumption, A3, implies that there are no proper subgames in our dynamic, stochastic game. As such we cannot use the subgame perfect equilibrium concept. But, as is now well-established, it is desirable to work nonetheless with a solution concept that embodies the general notion of sequential rationality, which is the central element of the subgame perfect equilibrium concept. In the context of our stochastic game, the sequential rationality concept requires that in any period t and for any *observed* history, each legislator's actions are ex-post optimal (i.e., they maximize his expected payoff *from that period onwards*). We define a sequentially rational, symmetric pure strategy equilibrium (henceforth equilibrium) to be a pure-strategy, adopted by all legislators, which is sequentially rational.[21] We now state a main result concerning the structure of equilibria:

Proposition 1 (Structure of Equilibria)**.** *Fix the institutional choices made by the founding fathers in period* -1*. Any pure-strategy equilibrium of the subgame starting from period 0 is a Markov pure strategy.*

Proof. In the appendix. □

[21]To simplify the formal analysis, we assume that the legislators in period t know the amount of cake the period-t LATE legislator obtained in period $t-1$ (which comprises the payoff-relevant bits of the history at the beginning of period t in those cases when legislators have two-period terms of office); note this means that T in A3 is strictly greater than $t+1$. Given this, we do not need to invoke any beliefs regarding past actions in defining and implementing this equilibrium concept. For example, we do not need to employ the relatively more complex sequential equilibrium concept. Our adopted solution concept is essentially the same as used in Bhaskar (1998).

This remarkable and unexpected result implies that with imperfect information about the history of play, there cannot exist equilibria in which a legislator uses a non-Markov (history dependent) pure strategy; that is, any pure strategy in which a legislator conditions his current actions on payoff-irrelevant past actions cannot be part of an equilibrium. This means, for example, that intertemporal cooperation is not sustainable in equilibrium.

We have formalized the notion of imperfect information about history in a particular manner, as defined in A3. As noted earlier, this would be satisfied if, for example, legislators have finite memory. The method of proof of Proposition 1 relies crucially on the implied feature that information about an action in period t is lost for sure after a finite number of periods; this allows us to deploy a backward induction argument to establish that equilibrium actions in any period after $t+1$ cannot be conditioned on period-t actions. While finite memory would seem to be a relatively reasonable assumption, it would be interesting to know whether or not the conclusion of Proposition 1 is robust to alternative formalizations of imperfect information, such as when information is lost gradually and stochastically (for example, because each legislator knows the full history from the point at which he is first elected into the legislature).[22]

[22]It may be noted that any refinement of our equilibrium concept will *not*, by definition, sustain non-Markov equilibria involving intertemporal cooperation. Proposition 1 only requires that players' strategies respect the standard notion of sequential rationality.

Given Proposition 1, the set of pure-strategy equilibria is identical to the set of pure-strategy equilibria in Markov strategies. The following proposition characterizes the unique such equilibrium.

Proposition 2 (Unique Markov Equilibrium, ME)**.** *Fix the institutional choices made by the founding fathers in period* -1*. In the unique pure-strategy ME of the subgame beginning in period 0, a legislator always agrees to any proposed demand, and when controlling the agenda always demands the whole cake.*

Proof. In the appendix. □

Given these equilibrium consequences of any set of institutional choices made by the founding fathers in period -1, we now turn to characterize the payoff consequences to them of each possible set of choices, and then assess the relative merits of each such choice.

5. Unicameral Legislatures: Results

Without loss of generality in what follows, we normalize the utility of principal i, setting $u_i(1) = 1$ and $u_i(0) = 0$. Strict concavity implies that for any $x \in (0, 1)$, $u_i(x) > x$, a fact we use in the analysis below. We begin with unicameral legislatures where in each period the two legislators have the opportunity to partition a unit-size cake.

First, we consider a unicameral, simultaneous-term chamber. Proposition 2 implies that a legislator will demand in any period the entire unit-size cake when recognized to make a proposal, and will accept any proposal made to him when his counterpart

is recognized. Thus, the representative citizen in district i (hereafter, principal i) will receive a sequence of 1s and 0s over time, sometimes securing the entire cake and other times getting none of it. Her Bellman equation is $U_i^S = \theta_i + \delta U_i^S$, and hence,

$$U_i^S = \frac{\theta_i}{1-\delta}, \tag{1}$$

where U_i^S is the equilibrium discounted present value of principal i's payoffs under a unicameral simultaneous-term institutional arrangement. (U is the mnemonic for "unicameral." The superscript identifies the chamber as simultaneous-term.)

Computing the present value for principal i when her representative serves in a staggered-term legislature requires a bit more development as the legislator's recognition probability depends on his district and period-dependent type. Assume that as part of the constitutional determination at $t = -1$, one district is randomly denoted EARLY at $t = 0, 2, 4, \ldots$ and the other as EARLY at $t = 1, 3, 5, \ldots$. We may now compute two Bellman equations for each principal – one for U_{iE}^{St} and another for U_{iL}^{St}. These stand for the ex ante value to principal i at $t = 0$, depending on whether her district begins with the EARLY legislator or the LATE legislator respectively, under the unicameral staggered-term arrangement. From the assumption of random assignment of types, it follows that the present value for each district is simply the arithmetic average of the EARLY and LATE payoffs $U_i^{St} = [U_{iE}^{St} + U_{iL}^{St}]/2$.

Proposition 2 implies that the period-t EARLY principal, say principal i, will enjoy the entire cake with probability θ_{iE} and thus the period-t LATE principal, principal j, will enjoy it with complementary probability, $\theta_{jL} = 1 - \theta_{iE}$. This implies the

following Bellman equations for each principal:

$$U_{iE}^{St} = \theta_{iE} + \delta[\theta_{iL} + \delta U_{iE}^{St}] \rightarrow U_{iE}^{St} = [\theta_{iE} + \delta\theta_{iL}]/(1-\delta^2)$$

$$U_{iL}^{St} = \theta_{iL} + \delta[\theta_{iE} + \delta U_{iL}^{St}] \rightarrow U_{iL}^{St} = [\theta_{iL} + \delta\theta_{iE}]/(1-\delta^2).$$

Random assignment of EARLY and LATE to districts 1 and 2 imply

$$U_i^{St} = \frac{U_{iE}^{St} + U_{iL}^{St}}{2} = \frac{\theta_{iE} + \theta_{iL}}{2(1-\delta)}. \tag{2}$$

Comparing (1) and (2), we note that in the absence of any frictions or constraints on parameter values, the payoff consequences of a unicameral staggered-term legislature can be replicated by a unicameral simultaneous-term legislature, and vice-versa, by setting $\theta_i = (\theta_{iE} + \theta_{iL})/2$. Thus, in the (literal) context of the baseline model, the founding fathers should, in period -1, be indifferent between these two legislative term structures, given that choice is restricted to a unicameral legislature.[23]

But that would be a mistaken conclusion to arrive at in general, as this conclusion has been deduced from a baseline model that contains some restrictive features. This can be illustrated with a substantive extension to the baseline model. Suppose *legislative experience* is explicitly modelled (by for example the numbers of previous terms of office held by an incumbent legislator), and average experience positively affects the size of the cake available to the legislators — since it is plausible that a chamber with more experienced legislators is able to secure a larger-sized cake from the same set of resources ("more bang for the buck"). But how does that affect the conclusion

[23]If the two legislators are treated equally, so that recognition probability depends only on a legislator's location in the electoral cycle, then $\theta_{1E} = \theta_{2E}$. Since $\theta_{iE} + \theta_{jL} = 1$, equation (2) becomes $U_i^{St} = 1/2(1-\delta)$.

that the principals, when restricted to select a unicameral legislature, are indifferent between adopting a simultaneous-term structure and a staggered-term structure?

The fundamental difference between these two term structures is that in one structure all legislators are up for reelection in the same period (simultaneous-term), while in the other structure not all legislators are up for reelection in the same period (staggered-term). This key difference generates (potentially substantive) differences in expected legislative experience in the chamber. In our two-legislators-per-chamber setting, for example, consider the simultaneous-term chamber first. With positive probability both incumbent legislators will be defeated in any given period, and hence both legislators in the subsequent period will be newly minted ones. This implies a complete absence of legislative experience in the chamber. However, such a scenario is impossible in a staggered-term chamber. Consequently, when allowing for the size of the cake to be increasing in legislative experience, a staggered-term unicameral legislature should have an advantage from the principals' perspective over a simultaneous-term unicameral legislature. This, of course, was one of the virtues of a "partially renewed" chamber cited by Hamilton and Madison in *The Federalist*.

Another factor suggests that principals, at the constitutional moment, might prefer a staggered-term unicameral legislature to a simultaneous-term unicameral alternative: the former structure facilitates commitment to probabilistic alternation of agenda-setting powers between the two districts by making recognition likelihood type-dependent, a form of insurance preferred by risk-averse principals. We elaborate on this below.

We state one of the messages of this section informally since we have not elaborated our model in order to prove this as a result:

> If restricted to select a unicameral legislature at the constitutional moment, there are circumstances under which founding fathers would choose one with a staggered-term structure rather than one with a simultaneous-term structure.

6. Bicameral Legislatures: Results

In the baseline model the bicameral setting has two chambers each independently dividing half a cake. The payoff to a district is simply the sum of the chamber decisions. There are three cases to examine: (i) both chambers simultaneous-term; (ii) both chambers staggered-term; (iii) one simultaneous-term chamber and one staggered-term chamber.[24]

6.1. **Two Simultaneous-Term Chambers.** Define B_i^{SS} as the present value to district i of the flow of cake from two simultaneous-term chambers each allocating one half a cake. (B is the mnemonic for "bicameral." The superscript identifies both of the chambers as simultaneous-term.) With probability θ_i^2 principal i's agent will be recognized in both chambers and receive the entire half-cake from each (following from Proposition 2). With probability $(1-\theta_i)^2$ she will receive no cake at all. And

[24]In case (ii) we will assume that the staggers are independently determined at t=-1. Thus, district i's agent begins EARLY in both chambers, LATE in both chambers, EARLY in the first chamber and LATE in the second, and LATE in the first chamber and EARLY in the second with equal probability.

with probability $\theta_i(1-\theta_i)$ she will receive half a cake from one chamber and none from the other (and this can occur in either of two ways). Thus,

$$B_i^{SS} = \theta_i^2 + 2\theta_i(1-\theta_i)u_i(1/2) + \delta B_i^{SS} \rightarrow B_i^{SS} = \frac{\theta_i^2 + 2\theta_i(1-\theta_i)u_i(1/2)}{1-\delta}. \tag{3}$$

A comparison of (1) and (3) verifies for each i that:

$$B_i^{SS} > U_i^S, \tag{4}$$

since u_i is strictly concave.[25] Thus the bicameral legislature with both chambers operating under the simultaneous-term structure Pareto dominates (for the two principals) the unicameral legislature with the simultaneous-term structure. Since, as established above, principals are indifferent between simultaneous- and staggered-term structures when restricted to the choice of a unicameral legislature, we have the following result:

Proposition 3. *In the baseline model, at the constitutional moment the principals will select a bicameral legislature over a unicameral legislature.*

While the Pareto-dominance of the bicameral simultaneous-term legislature over the unicameral legislature of either term structure is established, we cannot yet say which term structures should operate in the bicameral setting until we determine the payoff consequences in the other two possible cases (all staggered and mixed). But before we turn to that, we provide some intuition for the result contained in Proposition 3.

[25]The result also requires that $0 < \theta_i < 1$; that is, we rule out the possibility that either district has *all* the agenda power.

At the heart of the result lies the fact that principals are risk averse, and bicameralism, as modelled in our baseline model, reduces risk because it allows for the possibility that the agenda setters in the two chambers are different. If principal i's legislator in one chamber does not get proposal power in a particular legislative session, maybe her legislator in the other chamber will. This means that bicameralism – with two chambers each controling the distribution of half a cake each period – provides better insurance for principals against getting nothing.[26]

6.2. **Two Staggered-Term Chambers.** Define B_{iEE}^{StSt} as the present value to district i of a two-staggered-term-chamber bicameral arrangement where i's agent is EARLY in both. Define B_{iLL}^{StSt} and $B_{iEL}^{StSt} = B_{iLE}^{StSt}$ in a similar fashion. (The superscript identifies the arrangement as staggered-term in each chamber and the subscript identifies i's agent type in each chamber.) We obtain:

$$\begin{aligned}
B_{iEE}^{StSt} =& \{\theta_{iE}^2 + 2\theta_{iE}(1-\theta_{iE})u_i(1/2) + \delta[\theta_{iL}^2 + 2\theta_{iL}(1-\theta_{iL})u_i(1/2)]\}/(1-\delta^2) \\
B_{iEL}^{StSt} =& B_{iLE}^{StSt} = \left[(1+\delta)\left(\theta_{iE}\theta_{iL} + [\theta_{iE}(1-\theta_{iL}) + (1-\theta_{iE})\theta_{iL}]u_i(1/2)\right)\right]/(1-\delta^2) \\
B_{iLL}^{StSt} =& \{\theta_{iL}^2 + 2\theta_{iL}(1-\theta_{iL})u_i(1/2) + \delta[\theta_{iE}^2 + 2\theta_{iE}(1-\theta_{iE})u_i(1/2)]\}/(1-\delta^2).
\end{aligned}$$

Summing these expressions (the second one twice), simplifying, and dividing by four, we obtain

$$B_i^{StSt} = \frac{\widehat{\theta}_i^2 + 2\widehat{\theta}_i(2-\widehat{\theta}_i)u_i(1/2)}{4(1-\delta)}, \quad \text{where} \tag{5}$$

[26]One might then wonder why we actually observe unicameral legislatures in many circumstances. That is, what weighs against the insurance advantages of bicameralism? We take up this extension in section 7.

$\widehat{\theta}_i = \theta_{iE} + \theta_{iL}$.[27] From (2) and (5) it is easy to verify for each i that (since $u_i(1/2) > 1/2$):

$$B_i^{StSt} > U_i^{St}. \tag{6}$$

Consequently, we have established that principal i prefers the bicameral legislature with both chambers operating under the staggered-term structure over a unicameral staggered-term legislature. By the same argument as the one establishing the Pareto dominance of the bicameral simultaneous-term legislature over unicameral legislatures of either term structure (and hence Proposition 3), it follows that the bicameral staggered-term legislature Pareto dominates unicameral legislatures of either term structure.

Before proceeding further, we would like to note that the extent to which the bicameral staggered-term legislature is preferred by principal i over the unicameral staggered-term legislature strictly increases in her degree of risk aversion. More precisely, the difference $B_i^{StSt} - U_i^{St}$ is directly proportional to the difference $u_i(1/2) - 1/2$. Indeed, the "risk reduction" force is at work here as well.

6.3. **A Simultaneous-Term Chamber and a Staggered-Term Chamber.** Define B_{iE}^{SSt} as the present value to district i of a bicameral arrangement in which i's agent in the staggered-term chamber begins as the EARLY type; B_{iL}^{SSt} is the present

[27]It may be noted that while, by definition, $\widehat{\theta}_1 + \widehat{\theta}_2 = 2$, there is no reason why in general $\widehat{\theta}_i = 1$. For example, it may be the case that LATE legislators receive higher agenda power than EARLY ones, but at the same time agenda power is increasing in population size. It is thus possible that if district i has a much smaller population that while $\theta_{iL} > \theta_{iE}$, it nonetheless is the case that $\widehat{\theta}_i < 1$.

value when i's agent begins as the LATE type. Given equal chances that i's agent will be of either type, $B_i^{SSt} = (B_{iE}^{SSt} + B_{iL}^{SSt})/2$.

From Proposition 2, recognition in a chamber for a district's agent secures for her the entire half-cake from that chamber. Thus, assuming each chamber operates independently, the Bellman equations are

$$B_{iE}^{SSt} = \{\theta_i\theta_{iE} + [\theta_i(1-\theta_{iE}) + (1-\theta_i)\theta_{iE}]u_i(1/2)\} + \delta\{\theta_i\theta_{iL} + [\theta_i(1-\theta_{iL}) + (1-\theta_i)\theta_{iL}]u_i(1/2)\} + \delta^2 B_{iE}^{SSt}.$$

$$B_{iL}^{SSt} = \{\theta_i\theta_{iL} + [\theta_i(1-\theta_{iL}) + (1-\theta_i)\theta_{iL}]u_i(1/2)\} + \delta\{\theta_i\theta_{iE} + [\theta_i(1-\theta_{iE}) + (1-\theta_i)\theta_{iE}]u_i(1/2)\} + \delta^2 B_{iL}^{SSt}.$$

Summing, simplifying, and dividing by two we obtain

$$B_i^{SSt} = \frac{B_{iE}^{SSt} + B_{iL}^{SSt}}{2} = \frac{\theta_i\widehat{\theta}_i + [\theta_i(2-\widehat{\theta}_i) + (1-\theta_i)\widehat{\theta}_i]u_i(1/2)}{2(1-\delta)}. \tag{7}$$

Proposition 3 established the payoff dominance of bicameralism over unicameralism (based on the "risk reduction" argument). Having now completed the derivation of the payoffs to the principals from a bicameral legislature under the various alternative term structures, one can in principle assess the relative merits of the three possible kinds of bicameral legislatures. However, there are no general results to be obtained here, as matters in part depend on exact parameter values.

One interesting set of parameter values are those when $\theta_i = \widehat{\theta}_i/2$ $(i = 1, 2)$; i.e., which capture the notion that agenda power in a staggered-term chamber is on average

the same as in a simultaneous-term chamber. For such parameter values, we obtain (via straightforward computations) for each i that

$$B_i^{StSt} = B_i^{SS} = B_i^{SSt} > U_i^S = U_i^{St},$$

and hence:

Proposition 4. *If the parameters are such that agenda power to legislators from each district in a staggered-term chamber is to be the same on average as in a simultaneous-term chamber, then the principals are indifferent amongst the three possible bicameral legislatures.*

6.4. **Summary and Discussion.** Before we turn to study a few extensions of the baseline model, we provide a summary of the main insights established above. Perhaps the most important insight is the one contained in Proposition 3, namely, that *bicameralism Pareto dominates unicameralism.* This result follows from the fact that on the one hand bicameralism reduces risk and this benefits risk-averse principals, and on the other hand there are no costs of having an additional chamber (in the baseline model). The greater the degree of risk-aversion, the larger is the benefit from bicameralism. However, once costs of having an additional chamber are taken into account (see section 7.2 below), a unicameral legislature can be preferred by the principals. In such circumstances, the principals may choose to operate the single chamber under a staggered-term structure rather than a simultaneous-term one, since, as noted above, that would provide for relatively greater legislative experience in the chamber in every period.

Given Proposition 3, we then established a few results concerning the relative merits of the three possible kinds of bicameral legislature, relating to the term structures of its two chambers. One point to emphasize is that in general it is not possible to pin down which kind of bicameral legislature best serves the joint interests of the principals. It depends on parameter values. However, we showed in Proposition 4 that for a class of parameter values, the principals' are indifferent amongst the three possible kinds of bicameral legislatures.

7. Extensions

7.1. **Risk-Reduction: A Benefit from Dividing Power.** In a unicameral legislature all power is concentrated in the hands of the members of a single chamber. In contrast, in a bicameral legislature power is divided between members of two chambers. What are the costs and benefits of dividing power between two chambers of a single legislature? To put it differently, what are the relative merits of unicameralism versus bicameralism? In the baseline model above, we identified and focused on one source of benefit of bicameralism over unicameralism to the principals, which is as follows. By dividing power between two chambers, there is the possibility of two distinctive agenda-setters coexisting in each period. This, in turn, implies that each district has a relatively greater chance of securing some legislative agenda power, and this reduces the likelihood of receiving no (or little) cake in each period. Given that the principals are risk-averse, the consequent reduction in risk afforded by this division of power is of strict benefit to each principal.

This logic of *risk reduction* extends beyond the comparative advantage of bicameralism over unicameralism, since dividing power further reduces risk further. To illustrate this point consider a legislature composed of three chambers all of which operate under the simultaneous-term structure. We capture the division of power by assuming that each chamber controls, and independently divides, one third of the unit-size cake. Since Proposition 2 carries over to this context, the ex ante expected payoff to principal i under simultaneous-term tricameralism is

$$T_i^{SSS} = \frac{3\theta_i(1-\theta_i)^2 u_i(1/3) + 3\theta_i^2(1-\theta_i)u_i(2/3) + \theta_i^3}{1-\delta_i}. \tag{8}$$

Using (3), we obtain, after some simplification (and assuming that $0 < \theta_i < 1$), that

$$T_i^{SSS} \gtreqless B_i^{SS} \iff G(\theta_i) \equiv (1-\theta_i)u_i(1/3) + \theta_i u(2/3) - \frac{\theta_i}{3} - \frac{2}{3}u_i(1/2) \gtreqless 0.$$

Since u_i is strictly concave, it follows that $G(\theta_i) > 0$ (for all θ_i).[28] Hence, $T_i^{SSS} > B_i^{SS}$. So, in this version of the baseline model, where there are no costs of dividing power (see section 7.2 below for that), tricameralism Pareto-dominates bicameralism because of the risk reduction factor. This point may generalize to some extent, as we now briefly show.

Suppose the legislature is composed of $n \geq 1$ chambers, all of which operate, for the sake of illustration, under the simultaneous-term structure. Furthermore, each chamber controls, and independently divides, $1/n$th of the unit-size cake. Proposition 2 carries over, and it follows that the expected payoff to principal i at the constitutional moment from instituting a legislature with n such chambers is:

[28]This follows from the observations that G is linear, and that u_i strictly concave implies that $G(0) > 0$ and $G(1) > 1$.

$$V_i(n) = \frac{1}{1-\delta} \sum_{k=0}^{k=n} \left[\frac{n!}{(n-k)!k!} \right] (\theta_i)^k (1-\theta_i)^{n-k} u_i(k/n).$$

It is straightforward to show that for any finite n, $V_i(n) < u_i(\theta_i)/(1-\delta)$, and that as $n \to \infty$, $V_i(n) \to u_i(\theta_i)/(1-\delta)$.[29] These properties imply that there does not exist a finite n for which $V_i(n)$ is maximal. While we have not been able to establish whether in general $V_i(n)$ is monotonically increasing, these results imply that for any n there exists an $n' > n$ such that $V_1(n') > V_1(n)$ and $V_2(n') > V_2(n)$. In words, for any n there exists an $n' > n$ such that a legislature with n chambers is Pareto dominated by a legislature with $n' > n$ chambers. Of course, the risk-reduction benefit is at work here without the interference of any costs of increasing the number of chambers, an issue to which we now turn.

7.2. **Excessive Taxation: A Cost from Dividing Power.** There are several possible reasons for why dividing power between two or more chambers can be costly from the principals' perspective, as evaluated at the constitutional moment. The calculus of the optimal number of chambers needs to trade off the benefits of dividing power such as those derived from risk reduction against the possible costs. To illustrate the possibility of such costs, we now extend the baseline model to enable us to see a few

[29]The argument is as follows. $(1-\delta)V_i(n) = \boldsymbol{E}(u_i(k_n/n))$, where $\boldsymbol{E}$ is the expectation and k_n is a random variable with a binomial distribution with parameters n, θ_i. The expectation of k_n equals $n\theta_i$, and hence $\boldsymbol{E}(k_n/n) = \theta_i$. It follows from Jensen's inequality (and since u_i is strictly concave) that for any finite n, $\boldsymbol{E}(u_i(k_n/n)) < u_i(\boldsymbol{E}(k_n/n))$. Hence, for any finite n, $(1-\delta)V_i(n) < u_i(\theta_i)$. To show convergence, take any $\epsilon > 0$ and it is easy to show that as n tends to infinity, $Prob[k_n/n > \theta_i - \epsilon]$ converges to one (given continuity of u_i).

novel aspects of the relative merits of dividing power. To keep matters simple, we restrict attention to the choice between a bicameral legislature and a unicameral one; i.e., we do not consider legislatures with three or more chambers. Furthermore, in this formal structure we will suppress the choice of term structure, and assume that legislators in any chamber operate under a simultaneous term structure.[30]

The core feature of our extension is that the size of the cake is now endogenously determined through the tax rate chosen by the legislature. As in the baseline model, there are two districts, with possibly unequal population sizes, N_1 and N_2, where the income of each citizen in district i is $y_i > 0$.

If the legislature consists of a simultaneous-term single chamber, then the legislator who is recognized to make the take-it-or-leave-it offer proposes a tax rate $\tau \in [0, 1]$ and a partition of the tax revenue (cake) between the two legislators (districts), where the size of the cake equals $\tau(y_1 N_1 + y_2 N_2)$. If the offer is rejected, then the status quo policy remains in force in the period in question, which is that no taxes are levied and no pork is thus available for distribution to the districts. As in the baseline model, the legislator from district i is recognized each period with probability θ_i.

If all that were involved is extracting revenue from citizens via taxes, repackaging it, and then returning it to the districts, then the process would be one of pure redistribution. However, it would then not be possible to improve upon the status quo for both districts; it is purely a money transfer. We are assuming something

[30]We conjecture that some of the main insights concerning the relative merits of bicameralism versus unicameralism established below, in the context of the extended set-up, carry over to staggered term structures. However, this needs to be formally established, and we leave that for future research.

different. The legislature extracts revenues and then transforms these into a package of local public goods. If each district values its local public good more than the tax revenue it loses, then a Pareto improvement is effected. That is, the legislature helps each district alleviate local coordination/collective action difficulties, enabling it to provide itself with public goods.

The probability that a legislator is reelected Π now depends on the amount x of per capita pork (local public goods) he brings to his district during his most recent, one-period term in office, and on the tax rate τ imposed in the period in question. It is natural to assume that Π is increasing in x but decreasing in τ. However, citizens, when deciding whether or not to reelect an incumbent legislator, tend to put relatively more weight on the amount of per capita pork that *he* secured for them (which we assume is observable) than on the tax rate set by the legislature (of which he is *a* member). We capture this by assuming that the marginal impact of x on Π is strictly greater than that due to τ. In summary, we make the following assumptions on this extended probability of reelection function:

Assumption 4. Π *is twice continuously differentiable, increasing in* x *and decreasing in* τ*. Furthermore, for any* x, τ*:* $\|\Pi_1(x,\tau)\| > \|\Pi_2(x,\tau)\|$.

Proposition 1 carries over and hence pure-strategy equilibria will necessarily be Markov. Given that, the following result may be established:

Proposition 5 (Taxation and Pork Allocation under Unicameralism)**.** *In the extension of the baseline model described above, in a unicameral simultaneous-term legislature in which legislators finance pork spending via taxation, there is a unique*

equilibrium. In any period in which legislator i is recognized, his offer (x_i, τ_i), where x_i is the per-capita pork for his district and τ_i is the proposed tax rate, is a solution to the maximization problem stated below, and this offer is accepted by the legislator from district j $(i \neq j)$:

$$\max_{x_i, \tau_i} \ \Pi(x_i, \tau_i) \tag{9}$$

$$s.t.\ 0 \leq \tau_i \leq 1 \tag{10}$$

$$0 \leq x_i \leq \frac{\tau_i(y_1 N_1 + y_2 N_2)}{N_i} \qquad \textit{and} \tag{11}$$

$$\Pi\left(\frac{\tau_i(y_1 N_1 + y_2 N_2) - x_i N_i}{N_j}, \tau_i\right) \geq \Pi(0, 0). \tag{12}$$

Proof. Given that equilibria are necessarily in Markov pure strategies, the formal argument parallels those in the proof of Proposition 2. We thus omit that, but instead provide an informal argument. We first note that it follows from the "one-shot deviation" principle of dynamic programming that in a Markov equilibrium (ME, for short) each legislator's objective boils down to maximizing his current probability of reelection. Now, in any ME, the legislator from district i can always offer the status quo policy in which no taxes are raised and there is no pork available. Any different policy (x_i, τ_i) must thus offer the legislator from district j a probability of reelection that is at least as good as what it would be with the status quo policy. Hence, acceptable policies must satisfy legislator j's individual rationality constraint, inequality (12). Notice that total tax revenue raised is $\tau_i(y_1 N_1 + y_2 N_2)$ and the amount of per capita pork allocated to district j is as stated in the first argument in Π on the lefthand side of (12). Together with the feasibility constraints (10) and (11), the

legislator from district i chooses an offer which maximizes his probability of reelection subject to satisfying these three conditions. □

Since our main objective is to compare and contrast the consequences in this extended set-up of dividing power, we will shortly proceed to deriving the equilibrium solution for the bicameral setting. Once we have done that, we will then undertake a comparative analysis and during that process we will return to Proposition 5 and provide a characterization of the solution of the optimization problem stated in this proposition. But there is one feature of the solution we would like to mention now.

In this extended set-up it is no longer the case that the agenda-setter can allocate all the cake to his district (unlike in the baseline model in which the size of the cake was fixed and exogenously given; cf. Proposition 2). Notice that if, for any $\tau_i > 0$, the legislator from district i sets x_i to its upper bound, then the individual rationality constraint of the legislator from district j, (12), would be violated (since, given Assumption 4, Π is decreasing in the tax rate). Not surprisingly, raising some tax revenue across the two districts but without allocating any pork to a district is worse than the status quo policy from a legislator's perspective. So, in this extended set-up, with multidimensional policy, extremal allocations of pork, which featured in the baseline model, cannot form part of the equilibrium solution. Having said that, at the solution to the maximization problem, the individual rationality constraint (12) binds (for otherwise the agenda-setter could increase his reelection probability by allocating to his district a little more of the cake), and hence the agenda-setter nonetheless extracts most of the surplus.

We now turn to the bicameral legislature, where power is divided between two chambers, which we assume are identical and both operate under the simultaneous-term structure. Here are the main features that are specific to the bicameral legislature. In each period, a legislator is randomly and independently recognized in each chamber. The probability that in each chamber the legislator from district i is recognized is θ_i. The two agenda-setters simultaneously and independently make take-it-or-leave-it offers to their respective chamber partners, who simultaneously and independently decide whether or not to accept the proposals. There is no communication, cooperation or collusion across the chambers. They operate separately.

We want to capture the notion that tax policy is determined "jointly" by the two chambers. We model this as follows. The offer of a legislator in each chamber contains a proposed tax rate. The actual tax rate announced by the legislature will be the average of the two proposed tax rates, which in turn determines the total tax revenue (the total size of the cake), which, like in the baseline model, is to be divided equally between the two chambers. It should be noted that the status quo policy — no taxation and no cake — is changed in any period if and only if in each of the two chambers, the respective offers made are accepted by the respective legislators. Thus, if the offer in either chamber is turned down then the status quo policy remains in force in the period in question.

We assume that, in each period, after legislators from each chamber are recognized, this becomes known to all legislators in both chambers before any actions are taken. Hence, for example, the legislator who is recognized in a chamber can condition his offer on whether his counterpart has also been recognized in the other chamber or not.

Indeed, since the actual tax rate will be the average of the proposed tax rates, the two agenda-setters are in a game-theoretic situation, and we will, unlike in the baseline model, look for a Nash equilibrium in offers across the two chambers. Furthermore, it is assumed that when responding to an offer, a legislator knows the offer made in the other chamber, which thus allows him to calculate the actual tax rate if he and the responder in the other chamber accept their respective offers.

It is straightforward to verify that Proposition 1 carries over here as well, and hence equilibria will necessarily be in Markov pure strategies. Given that, we can establish the following:

Proposition 6 (Taxation and Pork Allocation under Bicameralism)**.** *In the extension of the baseline model described above under a bicameral legislature in which legislators finance pork spending via taxation and power is divided across the two chambers, there is a unique equilibrium in which, in any period, acceptable offers are made, which are as follows. Suppose that the legislators recognized in the two chambers are from districts i and j, where $i, j = 1, 2$. Then the equilibrium offers of legislators i and j, (x_i^j, τ_i^j) and $(\widehat{x}_j^i, \widehat{\tau}_j^i)$, respectively, are solutions to the following pair of (simultaneous) maximization problems:*[31]

[31] (x_i^j, τ_i^j) is legislator i's offer, who is the agenda setter in one of the chambers, say chamber 1, given that legislator j is the agenda-setter in chamber 2. And $(\widehat{x}_j^i, \widehat{\tau}_j^i)$ is legislator j's offer, who is the agenda setter in chamber 2, given that legislator i is the agenda-setter in chamber 1.

Problem 1:

$$\max_{x_i^j,\tau_i^j} \ \Pi\left(x_i^j, \frac{\tau_i^j + \widehat{\tau}_j^i}{2}\right) \quad s.t. \quad 0 \leq \tau_i^j \leq 1, \quad 0 \leq x_i^j \leq \frac{[(\tau_i^j + \widehat{\tau}_j^i)/2](y_1N_1 + y_2N_2)}{2N_i}$$

$$and \quad \Pi\left(\frac{[(\tau_i^j + \widehat{\tau}_j^i)/2](y_1N_1 + y_2N_2) - 2x_i^jN_i}{2N_k}, \frac{\tau_i^j + \widehat{\tau}_j^i}{2}\right) \geq \Pi(0,0), \ \textit{where } k \neq i.$$

Problem 2:

$$\max_{\widehat{x}_j^i,\widehat{\tau}_j^i} \ \Pi\left(\widehat{x}_j^i, \frac{\tau_i^j + \widehat{\tau}_j^i}{2}\right) \quad s.t. \quad 0 \leq \widehat{\tau}_j^i \leq 1, \quad 0 \leq \widehat{x}_j^i \leq \frac{[(\tau_i^j + \widehat{\tau}_j^i)/2](y_1N_1 + y_2N_2)}{2N_j}$$

$$and \quad \Pi\left(\frac{[(\tau_i^j + \widehat{\tau}_j^i)/2](y_1N_1 + y_2N_2) - 2\widehat{x}_j^iN_i}{2N_l}, \frac{\tau_i^j + \widehat{\tau}_j^i}{2}\right) \geq \Pi(0,0), \ \textit{where } l \neq j.$$

Proof. The argument is an extension of the proof of Proposition 5 in which the offers made in each period by the two agenda-setters in the two chambers are in a Nash equilibrium of the appropriate game. In a ME, it follows that each legislator's objective is to maximize their own current reelection probability. The solution to problem 1 defines i's reaction function to an arbitrary offer made by the agenda-setter, j, in the other chamber. Symmetrically, problem 2 gives rise to j's reaction function. A fix point of these reaction functions defines the equilibrium offers. □

Like in the solution to the maximization problem that defines the equilibrium in the unicameral setting (cf. Proposition 5), in each of two maximization problems stated in Proposition 6 that together define a ME in the bicameral setting, the two individual rationality (IR) constraints bind, but the feasibility constraints don't. That is, while each agenda-setter will extract as much of the surplus as possible, he needs to allocate some pork to the district of his chamber partner (for otherwise the status quo policy will be preferred).

Comparing the IR constraint of the maximization problem that defines the unicameral equilibrium with those that define the bicameral equilibrium, notice that, not surprisingly, for any pair of policies (x, τ), it is easier to satisfy the IR constraint in the unicameral setting than in the bicameral setting, because in the former setting there is twice as much pork from which a given x is deducted. This intuitive observation provides the key for the result that the set of acceptable and feasible offers under bicameralism is strictly contained in the corresponding set under unicameralism. This means it is possible that under bicameralism the status quo policy is the only feasible and acceptable policy while that is not the case under unicameralism. Consequently, there is relatively greater scope for gridlock under bicameralism. We summarise this in the following corollary:

Corollary 1 (Gridlock under Bicameralism)**.** *There is relatively greater prospect of gridlock — no change from the status quo policy — under bicameralism than under unicameralism.*

We now consider scenarios in which the set of acceptable and feasible offers under bicameralism contains policy vectors other than the status quo policy. In such cases, the equilibrium tax rates under bicameralism will in general be higher than the equilibrium tax rates under unicameralism. The intuition for this result is straightforward, and can be gleaned by comparing the maximization problems stated in these two propositions. It is this. Under bicameralism, each agenda-setter gets to control and divide only one-half of the total tax revenues raised, and hence each has an incentive to set a higher tax rate than he would under unicameralism. It is "as if" the

agenda-setter in each chamber is being "held-up" by the agenda-setter in the other chamber, in having to relinquish one-half of the tax revenues raised:

Corollary 2 (Higher Taxes under Bicameralism)**.** *Tax rates under bicameralism will tend to be higher than under unicameralism.*

While the equilibrium policy (the tax rate and allocation of pork) will differ under these two alternative legislative structures, which one is preferred by the two principals at the constitutional moment, in period -1, depends on which policy is closer to the one they would jointly select (the first-best). We assume that principals, as before, discount future payoffs with a common discount factor $\delta < 1$, and assume that their instantaneous utility is the sum of net income and utility from pork (as in the baseline model). That is, principal i's utility is $(1-\tau)y_i + u_i(x)$. This implies that aggregate welfare per period is given by

$$(1-\tau)(y_1N_1 + y_2N_2) + u_1(x_1)N_1 + u_2(x_2)N_2 \quad \text{where } x_1N_1 + x_2N_2 = \tau(y_1N_1 + y_2N_2).$$

It may be noted that since u_i is strictly increasing and strictly concave, the first-best tax rate will be strictly positive, and hence different from the status quo policy of a zero tax rate. The risk reduction benefit from bicameralism will continue to arise in this extended baseline model. But now there is a potential cost from bicameralism, which is that the equilibrium policy vectors under a bicameral setting deviate further away from first-best policy than the equilibrium policy vectors arrived at in a unicameral setting. Of course, this need not be case, since this depends on the relative positions of the two sets of equilibrium policies and the first best policy. And

that, in turn, depends on the the utility functions and the probability of reelection functions. But when the cost exists, then the optimal number of chambers (one or two) depends, in effect, on the comparing the costs from excessive taxation against the benefits from risk reduction.

8. Conclusions and Future Directions

The concerns expressed by the authors of *The Federalist* in arguing for bicameral legislative arrangements centered on majority tyranny and delay. The results we have provided do so as well, but from a slightly different perspective. Bicameralism does, indeed, reduce the prospects of majority tyranny in the sense that two chambers provide greater insurance against domination by an agenda-setter agent of one (class of) principal to the exclusion of others. Bicameralism is associated with delay as well in the sense that there are circumstances in which a unicameral legislature will pass new legislation but a bicameral legislature is saddled with the status quo. Interestingly, Hamilton and Madison saw this, like the control of majority tyranny, as an *advantage* of bicameralism. We believe that, in their advocacy for the US constitution, they were not prepared to acknowledge the downside of delay, what modern scholars term *gridlock*. Nor were they prepared to speculate about taxation propensities in a bicameral legislature. So we have concluded that the risk-spreading virtues of multicameralism must be balanced against the prospects of inaction on the one hand, and the possibility of larger government on the other. Empirically, of course, most of the world's democracies have settled on a legislative branch with one or two chambers, though

some have included some (partial) legislative powers in other branches of government (e.g., executive veto, judicial negativing of statutes).

We have had considerably less to say about the circumstances in which democracies choose a single chamber or multiple chambers, partial renewal or full renewal. As noted, such arrangements are ex ante optimal at any given constitutional moment depending upon "parameters," but we haven't offered much insight beyond this. We believe the next research step should be to build in heterogeneity among principals and thus diversity among agent objectives. Bicameralism, as we noted at the outset, is associated empiricially with large states, with rich states, and with federal states – that is, with states that are nominally more complex economically and more layered politically. Unicameralism is found in states with a lower GDP per capita, with a more compact geography, and with more centralized governance. Under what circumstances would such factors induce constitution writers to make one set of institutional choices rather than another? We also believe it desirable to introduce more heterogeneity among agents. Re-elected incumbents are, in important ways, different from newly minted legislators – their human capital in the form of substantive expertise and legislative experience may well have performance effects that should be captured in an extension of the present model. Finally, it would be interesting to explore the possibility (and consequences thereof) of cooperation across space and time: cooperation, in any given session, amongst legislators within a single chamber and/or across chambers, and intertemporal cooperation. In order to sustain cooperative behaviour

in equilibrium one needs to relax the informational assumption (Assumption 3) that has underpinned the analysis in this chapter.[32]

Appendix

PROOF OF PROPOSITION 1. Fix an arbitrary pure-strategy equilibrium, and fix an arbitrary period $t \geq 1$. We will show that the equilibrium actions in period t are conditioned on at most z_t (the amount of cake obtained by the period-t LATE legislator in period $t-1$), but on no other bits of observed history, which then establishes the proposition. The argument involves induction.

First, note that A3 implies that there exists a $T \geq t+2$ such that the equilibrium actions in any period from and including period T onwards cannot be conditioned on the actions taken in any period before and including $t-1$. Second, we establish the following inductive step:

Fix an arbitrary period s, where $s \geq t+1$. If the equilibrium actions in any period from and including period $s+1$ onwards are not conditioned on the actions taken in any period before and including period $t-1$, then the same is true of the equilibrium actions in period s.

Proof of inductive step. Since $s \geq t+1$, none of the actions in any period before and including period $t-1$ directly affects the payoffs of any legislator in period s. Given this and the hypothesis of the inductive step, it follows that the equilibrium expected payoff to a legislator from period s onwards does not depend on the actions in any

[32] In Muthoo and Shepsle (2006) — where we develop an analysis of intertemporal cooperative equilibria in staggered-term, unicameral legislatures — the role of information is assessed in some greater detail.

period before and including $t-1$. Let h_{t-1} and h'_{t-1} denote two different histories till the end of period $t-1$ that are observable to an arbitrary legislator in period s. Furthermore, let h denote a history of actions observed by the arbitrary legislator between and including periods t and $s-1$. Hence, two different observed histories at the beginning of period s are (h_{t-1}, h) and (h'_{t-1}, h). The equilibrium expected payoffs to this arbitrary legislator from period s onwards will be the same following either observed history (for any set of period s actions and given the equilibrium pure-strategy). Hence, given Assumption 2, the legislator's equilibrium actions in period s following these two observed histories are the same. The completes the proof of the inductive step.

Hence, it now follows from the principle of mathematical induction that the equilibrium actions in any period from and including period $t+1$ are not conditioned on the actions taken in any period before and including period $t-1$. The desired conclusion follows immediately.

PROOF OF PROPOSITION 2. We first show that the strategy described in the proposition, when adopted by all legislators is the unique stationary Markov equilibrium, and then we establish the non-existence of non-stationary Markov equilibria. This then establishes the proposition.

Since in the baseline model there is no payoff-relevant link between two chambers in a bicameral legislature, this means that a stationary Markov pure strategy of a legislator in a chamber is not conditioned on events or actions of legislators in the other chamber. Hence, it suffices to establish the result for a unicameral legislature.

We do so below in the context of a unicameral staggered-term chamber; the argument for a unicameral simultaneous-term chamber is similar and hence omitted.

A stationary Markov pure strategy for a legislator from district i ($i = 1, 2$) in a unicameral, staggered-term chamber is made up of two numbers, k_{iE} and k_{iL}, and two functions, f_{iE} and f_{iL}: k_{in} denotes the legislator's demand when he is type n, and $f_{in} : [0, 1] \to \{\text{“Accept”}, \text{“Reject”}\}$ such that $f_{in}(x)$ denotes whether the legislator accepts or rejects the demand x when he is type n, where $n = E, L$ (E stands for EARLY and L stands for LATE). Fix an arbitrary stationary Markov equilibrium, and let W_i denote the expected payoff associated with this equilibrium to the legislator when he is EARLY at the beginning of any period (before the proposer is randomly selected). We first establish the following result:

Claim 1. If the probability of reelection Π *satisfies Assumption 1, then a legislator accepts any offer when EARLY and any offer when LATE.*

Proof of Claim 1. To establish this claim, we need to show that the legislator, when EARLY and when LATE, respectively, accepts any demand $x \in [0, 1]$ made by the proposer. It follows from the *One-Shot Deviation* Principle that the legislator, when EARLY, accepts a demand $x \in [0, 1]$ if and only if $H_{iE}(x) \geq H_{iE}(1)$, where $H_{iE}(x) = b + [\theta_{jE}\Pi(1 - x, y_{iE}) + (\theta_{iL})\Pi(1 - x, y_{iL})]W_i$, where

$$y_{iE} = \begin{cases} 1 - k_{jE} & \text{if } f_{iL}(k_{jE}) = \text{“Accept”} \\ 0 & \text{if } f_{iL}(k_{jE}) = \text{“Reject”} \end{cases} \quad \text{and} \quad y_{iL} = \begin{cases} k_{iL} & \text{if } f_{jE}(k_{iL}) = \text{“Accept”} \\ 0 & \text{if } f_{jE}(k_{iL}) = \text{“Reject”}. \end{cases}$$

Assumption 1 implies that for any $x \in [0, 1]$, $H_{iE}(x) \geq H_{iE}(1)$. Hence, this means that $f_{iE}(x) =$“Accept” for all $x \in [0, 1]$. A legislator, when LATE, accepts an offer

$x \in [0,1]$ if and only if $H_{iL}(x) \geq H_{iL}(1)$, where $H_{iL}(x) = b + \Pi(z, 1-x)W_i$, and z is the amount of cake received by LATE in the previous period. Assumption 1 implies that for any $x \in [0,1]$, $H_{iL}(x) \geq H_{iL}(1)$. Hence, this means that $f_{iL}(x) =$"Accept" for all $x \in [0,1]$. This completes the proof of Claim 1.

Given Claim 1, it follows from the One-Shot Deviation Principle that the pair (k_{iE}, k_{iL}) satisfy the following conditions:

$$k_{iE} \in \arg\max_{x\in[0,1]} \Big[b + [\theta_{jE}\Pi(x, 1-k_{jE}) + \theta_{iL}\Pi(x, k_{iL})]W_i \Big] \quad \text{and} \quad k_{iL} \in \arg\max_{x\in[0,1]} \Big[b + \Pi(z,x)W_i \Big],$$

where z is the amount of cake earned by the LATE legislator a period earlier. That is,

$$k_{iE} \in \arg\max_{x\in[0,1]} \Big[\theta_{jE}\Pi(x, 1-k_{jE}) + \theta_{iL}\Pi(x, k_{iL}) \Big] \quad \text{and} \quad k_{iL} \in \arg\max_{x\in[0,1]} \Big[\Pi(z,x) \Big].$$

Assumptions 1 and 2 thus imply that $(k_{iE}, k_{iL}) = (1,1)$ is the unique solution.

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