AGENDA-SETTING POWER IN ORGANIZATIONS WITH OVERLAPPING GENERATIONS OF PLAYERS

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ABSTRACT. This paper presents an analysis of the allocation of agenda-setting (or bargaining) power in organizations with overlapping generations of players. Such powers are typically institutionalized within an organization's structure, and, given the focus of this paper, we identify the former with the latter. Our analysis concerns organizations (such as the US Senate) in which the number of periods each player participates is endogenously determined by his or her past performance. We derive several results and insights concerning (i) optimal organizational structure and (ii) conditions under which the unique, dynamically optimal outcome can be sustained (in equilibrium) in organizations with suboptimal structures. For example, we show that under a broad set of conditions, the optimal organizational structure should involve a seniority system, in which most of the agenda-setting power is allocated to the oldest generation of players.

"The future is purchased by the present; it is not possible to secure distant or permanent happiness but by the forbearance of some immediate gratification." SAMUEL JOHNSON

1. INTRODUCTION

Most organizations are long-lived, while the players who participate in them are not. Moreover, in some of these organizations players of different generations overlap. The US Senate in which legislators have staggered terms of office is a case in point.[1] It is perhaps intuitive that in such organizations the incentives of players of different generations will differ. This, in turn, may have implications for *optimal* organizational structure.

An important feature of some of these organizations is that the number of periods any particular player participates is *endogenously* determined by his or her past performance. This is often the case when the

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[1]In this legislative body a generation is a cohort of politicians who share a common re-election date.

player is an agent for an external principal who exercises the power to retain the agent's services or fire her, depending upon agent performance during her previous "contract". For example, in the US Senate the likelihood that a legislator is re-elected on any particular occasion depends on the benefits the member managed to bring to the constituency during his or her term of office. Indeed, in this circumstance it is plausible to suggest that the intertemporal flow of benefits affects the re-election probability, with the electorate placing greater weight on more recently delivered benefits than on those delivered earlier in the legislator's term. We call this the "What Have You Done For Me Lately" (or *WHYDFML*) Principle, a principle which lies at the heart of our model, analysis and results.

A fundamental aspect of any such organization is the allocation of agenda-setting (or bargaining) power amongst players. Such powers, which crucially determine and shape the outcome and performance of the organization in question, are typically institutionalized within the organization's structure. Although, of course, the organizational structure deals with other issues as well, given the focus of this paper it is convenient to identify the organizational structure with the allocation of such powers. There are two central questions that we aim to address in this paper. First, what are the properties of the *optimal* organizational structure, and how does it depend on the underlying parameters? Second, under what conditions, if any, can the dynamically optimal outcome be sustained (in equilibrium) in organizations with suboptimal structures? The latter question is important due to the persistence (in the real world) of such suboptimal structures in some organizations.[2] We develop our answers to these questions in the context of a simple model with assumptions deliberately chosen in order to develop our main results and insights in a simplified and focused manner.

Our model considers an organization which operates over an infinite number of periods with overlapping generations of players, where the number of periods each player participates in it is endogenously determined (along the lines indicated above). In each period, players from different generations encounter a "bargaining situation", which is a situation in which they have a common interest to co-operate, but conflicting interests over exactly how to do so. They thus engage in

[2]In his classic treatise, North (1990), Douglass North develops the thesis that the persistence of inefficient institutions may be explained by the presence of various kinds of "transactions costs". This is the thrust of Coase's argument — namely, that the presence of transactions costs weakens the tendency toward otherwise efficient adaptations.

negotiations according to a procedure that is institutionalized within the framework of the organization's structure.

Given our assumption that players have symmetric information about the parameters of the bargaining situation, it is not surprising that in equilibrium the players strike an agreement. However, the equilibrium distribution of the gains from co-operation — which is determined by the players' relative bargaining powers (which, in turn, are determined in part by the bargaining procedure) — may not be optimal (or efficient) from a dynamic perspective. Indeed, static efficiency need not imply dynamic efficiency. While the former is achieved because players in each period strike an agreement, the latter requires them to strike a particular agreement, one which is "optimal" from an intertemporal perspective. This is because of the *WHYDFML* Principle.

Given the above observation, we then characterize the optimal allocation of bargaining (or agenda-setting) power amongst players of different generations (i.e., the optimal organizational structure), one which does sustain, in equilibrium, the (unique) dynamically optimal distribution of the gains from co-operation. Our analysis unearths a close and deep connection between optimal organizational structure and what we call the *probability-of-survival* function, a function which formalizes the *WHYDFML* Principle. We show that under some conditions on this function, all the bargaining power should optimally reside with the oldest generation of players. Thus, it is optimal to design the organization's structure in such a way that all the agenda-setting power is vested in the oldest generation of players. To put it differently, it is optimal to institute a *seniority* system. If, on the other hand, those conditions are not met, then it is optimal for each generation of players to have some agenda-setting power. However, even in that case, most of the power should optimally reside with the oldest generation of players, which may be interpreted as a weak form of a seniority system, but a seniority system nevertheless.

As noted above, in some organizations with a suboptimal structure, it might not be possible to replace it with the optimal one. The persistence of inefficient (or suboptimal) institutions is commonplace. One explanation for this is based on the notion that powerful players may have a vested interest in maintaining a suboptimal organizational structure; for further discussion and analysis of this point, see, for example, Bardhan (2001) and Busch and Muthoo (2002). Given the importance of this issue, we thus explore whether or not the dynamically optimal outcome can be sustained (in equilibrium) in organizations with suboptimal structures. We show that under some conditions, it is possible to do so. These conditions entail, in particular, the presence of a disinterested "third party" within the organization's structure, who has the ability and the incentive to honestly communicate key information about the (recent) history of the organization to new generations of players. This is because in such an organization with a suboptimal structure, a dynamically optimal outcome can be sustained only via an equilibrium in which the players' equilibrium actions are conditioned on some aspects of the history. As such one requires the presence of a disinterested "third party" because the new generations of players cannot (by definition) have observed the actions taken before their birth into the organization — that is, they don't have, what may be called, perfect observability about the history of the organization — and at the same time, the old generations of players may have an incentive to lie to them about those actions.

Indeed, to put it differently, we show that in an organization with a suboptimal structure, the dynamically optimal outcome is sustainable via the mechanism of inter-generational co-operation, but this is possible only when the organization has a disinterested "third party" who acts as a surrogate for perfect observability. It should be noted that, in contrast, dynamic optimality is sustainable in organizations with the optimal structure by definition, and is not based on any form of inter-generational co-operation.

The remainder of our paper is organized as follows. Section 2 discusses the related literature. Section 3 lays down our model, and presents a preliminary result. Section 4 studies the issue of the optimal allocation of agenda-setting (or bargaining) power. Section 5 studies the issue of sustaining the unique, dynamically optimal outcome in organizations with suboptimal structures. Section 6 studies a simple extension of our model in which the size of the gains from co-operation in any period is randomly realized at the beginning of the period in question. Section 7 concludes.

2. Related Literature

To the best of our knowledge, this is the first paper that studies the issue of the optimal allocation of agenda-setting (or bargaining) power in organizations with overlapping generations. That such power matters is of course well recognized by scholars from a variety of disciplines including economics, politics, sociology and business administration. Indeed, the role of such power in a wide variety of situations has been analyzed and studied in a vast number of models; for instance, see Muthoo (1999) and Doron and Sened (2001) (and references therein) for examples of a small selection of these studies in economics and politics, respectively. These studies have obtained many important results and insights concerning the impact of the players' relative bargaining powers on various economic and political outcomes, but have taken such powers as given (often because it makes sense to do so in the context under consideration).

There is a small, but recently growing literature on repeated games with overlapping generations of players. The first example of this kind of dynamic game was studied in Samuelson (1958); see also Hammond (1975). For a discussion of the recent literature, see Bhaskar (1998) and Lagunoff and Matsui (2001). Our model may be differentiated from this class of games, however, in that OLG repeated games involve players who live for a finite and exogenously given number of periods, whereas a key feature of our model is the endogenous determination of the number of periods a player lives as a consequence of his or her past performance.[3]

There are two papers in the political science literature which are somewhat related to ours (in terms of some ideas, some aspects of the analysis and some results), namely, McKelvey and Riezman (1992) and Shepsle, Dickson and Van Houweling (2000).[4]

McKelvey and Riezman (1992) study a stochastic game model of a legislature with a fixed number (greater than or equal to three) of infinitely lived players (or legislators). In each period, the three or more legislators bargain over the partition of a unit-size cake according to a version of the bargaining model studied in Baron and Ferejohn (1989).[5] The authors construct a stationary equilibrium in which voters in each period choose to re-elect their incumbent legislator (instead of replacing him or her with a new representative) and legislators then agree among themselves to institute a "seniority system" (one which

[3]Both our model and those in the repeated-game literature, however, share a focus on sustaining dynamically efficient equilibria via inter-generational cooperation. Formally speaking, our model is a stochastic game, though the literature on stochastic games has not studied environments with overlapping generations of players. It has studied fairly general classes of stochastic games, but all with a fixed number of infinitely lived players.

[4]We should also like to draw attention to the paper by Diermeier (1995), who shows — in the context of a multistage game involving an overlapping generations of legislators who employ a majoritarian decision rule — how various legislative institutional norms and arrangements (committee specialization and floor deference) can be sustained in equilibrium.

[5]Baron and Ferejohn's bargaining model extends Rubinstein's (alternating-offers) bargaining model to three or more players, but with the proviso that agreement does not require unanimity.

privileges legislators with previous terms of service over newly elected legislators by giving the former greater agenda power). A game of divide-the-cake (as in Baron-Ferejohn, 1989) then commences, and the period ends. The "incumbency effect" in the electoral game (re-electing incumbents) occurs because the "seniority effect" (is anticipated to) occur(s) in the legislature.

Out-of-equilibrium there may exist in some period some junior legislators — that is, those whom voters chose instead of re-electing their incumbent legislators. This would then give real substance to a seniority system (by differentially privileging seniors over these junior legislators in terms of agenda power). In contrast, in the stationary equilibrium that is constructed in the McKelvey-Riezman paper, all legislators are senior (i.e., incumbents) and the seniority system has no effect on final distribution (since all legislators now have symmetric agenda power). Observationally, the concept of "seniority" has bite only when there are both seniors and juniors. (Of course, the seniority system nevertheless does make a difference, even if it is observationally invisible, because it sustains the propensity of voters to re-elect incumbents.)

While there are many differences between our model and analysis and that of McKelvey and Riezman (1992), four are fundamental and worth emphasizing. First, they are not concerned with optimal organizational structure, but with the equilibrium consequences of a *particular* organizational structure. Second, in their model each player is infinitely lived and, moreover, *every* legislator faces his voters in each period. In our model, on the other hand, it is only the oldest generation of players who face re-election at the end of each period. Third, in their model whether or not an incumbent is re-elected at the end of any period depends essentially on cake that would be obtained in the future (i.e, in the next period). In contrast, in our model, success in re-elections depends on a retrospective assessment by voters of cake obtained in the past, with the *WHYDFML* Principle lying at the heart of this matter. Fourth and finally, in the equilibrium of the McKelvey-Riezman model there are only re-elected "old" legislators, whereas in the equilibrium of our model there is a mix of experienced and inexperienced legislators.

Shepsle, Dickson and Van Houweling (2000) study a dynamic model of bargaining in the US Senate over the allocation of pork-barrel projects that involves three generations of legislators — just (re)elected senators, those in the middle two years of their (six-year) term, and those in the two years preceding an election. Like McKelvey and Riezman (1992), their analysis concerns the equilibrium consequences of a particular organizational structure — they use a version of the bargaining model studied in Baron and Ferejohn (1989). Although they don't address the issue of the optimal organizational structure, some of the key ideas underlying their model (such as the *WHYDFML* Principle) underlie ours as well.

In some respects our model is a generalization of theirs. But, in order to conduct an analysis of such a model in a tractable manner (especially in connection with the issue of the optimal organizational structure), we restrict attention to organizations in which in any period there are two generations of players. Although there are some examples where this assumption is appropriate, in some organizations there are three (or more) generations of players present in any given period (such as in the US Senate, the case studied in their paper). Moving from the two generations case to the three (or more) generations case introduces a conceptually new dimension to the problem, namely, that of "coalition formation" amongst players of different generations. In order to focus attention on the other strategic elements present in the kind of dynamic situation studied here, and derive a deeper understanding of them, it is theoretically productive to first analyze the two generations case. Besides being of independent interest, this should make the analysis and understanding of the three generations case easier.

3. The Model

3.1. **Framework.**

We consider a strategic environment which operates over an infinite number of periods with overlapping generations of players. In each period $t \in \{\ldots, -1, 0, 1, \ldots\}$, two players bargain over the partition of a unit-size "cake" (or surplus) according to a procedure specified below, in section 3.3. The two players belong to different generations: one player is "young" while the other is "old". The period-t young player is the period-$(t + 1)$ old player.

At the end of period t, the period-t old player faces the possibility of "death": if he dies then a new player is immediately born who is the period-$(t + 1)$ young player, but if he does not die then he is the period-$(t+1)$ young player.[6] The probability that a period-t old player survives death depends on the amounts of cake he obtained in periods t and $t - 1$. More precisely, this probability is $\Pi(x_y, x_o)$, where x_y and x_o are respectively the amounts of cake he obtained when he was young

[6] The concepts of "young" and "old" are period specific. It should therefore be noted that the "date of birth" of the period-t young player can be *any* time $s \in \{t, t - 2, t - 4, \ldots\}$. Indeed, when we refer to a player as the period-t young player, it means that the player in question will be alive in periods t and $t + 1$ for sure, and then, at the end of period $t + 1$, the player faces the possibility of death.

(in period $t-1$) and when he was old (in period t). The assumptions that we adopt on this *probability-of-survival* function Π are stated and discussed below, in section 3.2.

The payoff per period for a player is $b > 0$. It may thus be noted that x_y and x_o are pure instruments of "survival", and provide no direct utility.[7] Each player's objective is to maximize the expected present value of his payoffs, where $\delta \in (0, 1)$ is his time discount factor. For notational convenience, in what follows we sometimes call a young player, "player y", and an old player, "player o".

3.2. **Assumptions on the Probability-of-Survival Function.** We make two assumptions about each agent's probability of survival, which we maintain throughout our analysis. First, we assume that Π is strictly increasing in each of its two arguments, which means that the probability of survival is higher the more cake the player obtains either when young or when old. A formal statement of this assumption is as follows:

Assumption 1 (Π is strictly increasing in each of its two arguments)**.** *For any arbitrary pairs* $x^1 = (x^1_y, x^1_o)$ *and* $x^2 = (x^2_y, x^2_o)$ *such that* $x^1_y \geq x^2_y$, $x^1_o \geq x^2_o$, *and either* $x^1_y > x^2_y$ *or* $x^1_o > x^2_o$, *it is the case that* $\Pi(x^1) > \Pi(x^2)$.

Assumption 1 could be stated in a relatively more straightforward manner if we were to assume that Π is differentiable. With such an additional assumption, Assumption 1 could be stated as follows: for any pair $x = (x_y, x_o)$, $\Pi_i(x) > 0$ $(i = y, o)$, where Π_i denotes the derivative of Π *w.r.t.* x_i. However, our analysis and results do not require that Π be differentiable. As such there is no need to make this assumption. In fact, we will not even require that Π be continuous. This allows us to explore the implications of a richer class of probability-of-survival functions. For example, we can analyze the potential impact of the assumption that the probability of survival jumps (upwards, of course) at some critical values of x_y and/or x_o.

While Assumption 1 is an obvious assumption to make, our next assumption is not. This second assumption concerns the "What Have You Done For Me Lately"(or *WHYDFML*) Principle. As we indicated above in section 1, this principle requires that the probability-of-survival function place relatively greater weight on cake obtained when

[7]In effect, they provide utility to the player's principal, in that way influencing the player's probability of survival.

old than that obtained when young.[8] There is some choice in how one formally encapsulates this principle in terms of properties on the Π function. Although our formulation (stated below in Assumption 2) might be considered to be somewhat "weaker" than what is implied by the *WHYDFML* Principle, it captures the main thrust of this principle. We first state our assumption, and then discuss it.

Assumption 2 (The *WHYDFML* Principle)**.** *For any arbitrary pair $x = (x_y, x_o)$, and for an arbitrarily small $\Delta > 0$, $\Pi(x_y, x_o + \Delta) > \Pi(x_y + \Delta, x_o)$.*

It is perhaps instructive to note first that if we were to assume that Π is differentiable, then Assumption 2 could alternatively be stated as follows: for any pair $x = (x_y, x_o)$, $\Pi_2(x) > \Pi_1(x)$, where Π_i denotes the derivative of Π *w.r.t.* x_i $(i = y, o)$. In words, this states that the marginal probability of survival from cake obtained when old is strictly greater than the marginal probability of survival from cake obtained when young.

It is straightforward to verify that Assumption 2 implies that for any arbitrary pair $x = (x_y, x_o)$, and for any arbitrarily small $\Delta > 0$, $\Pi(x_y - \Delta, x_o + \Delta) > \Pi(x_y, x_o)$.[9] Using this observation recursively, it immediately follows that for any pair (x_y, x_o), $\Pi(0, x_y + x_o) > \Pi(x_y, x_o)$. This result establishes that the *WHYDFML* Principle, as formulated in Assumption 2, implies that in terms of maximizing his or her survival probability, a player prefers, ceteris paribus, to have all of the cake that he obtains when young given to him when old.

3.3. **Bargaining Procedure.** Our central objective is to explore the impact of alternative allocations of agenda-setting (or bargaining) power on equilibrium outcomes, and thus be able to characterize the optimal allocation of such power (which, in this paper, we identify with the optimal organizational structure). In order to achieve this objective in a simplified manner, we adopt the following well-known procedure of bargaining.

[8]We take this "recency bias" as given exogenously, and make no claims as to its optimality for the principal. As a behavioral matter, recency biases are often in evidence and we seek to trace their consequences here. However, it would be fruitful to extend our analysis by modeling the principal (voters) explicitly in order to endogenize the properties of Π.

[9]Here is a formal proof. Fix an arbitrary pair $x = (x_y, x_o)$, and an arbitrarily small $\Delta > 0$. Now define $x'_y = x_y - \Delta$ and $x'_o = x_o$. Assumption 2 implies that $\Pi(x'_y, x'_o + \Delta) > \Pi(x'_y + \Delta, x'_o)$. The desired conclusion follows after substituting for the (defined) values of x'_y and x'_o.

With probability θ, where $\theta \in [0, 1]$, the young player makes a "take-it-or-leave-it" offer to the old player, and with probability $1-\theta$ it is the old player who makes a "take-it-or-leave-it" offer to the young player.

By a "take-it-or-it-leave-it" offer, it is meant that one player makes an offer which the other player either accepts or rejects. In the former case agreement is struck. In the latter case no agreement is reached, and moreover, no counteroffers can be made; it is "as if" the cake for the period in question "disappears" after the offer is rejected. Or, alternatively, the rejection of an offer means that an (inefficient) status quo remains in place during the period in question.[10] Having provided two possible interpretations of the consequences of rejecting the single offer, we argue that in fact this procedure need not (and should not) be given a literal interpretation. It can be interpreted as a "reduced form" of more complex procedures which allow for offers and counteroffers; on this point, see Muthoo (1999).[11] The great advantage of this simple procedure is that it captures in a tractable manner the full range of allocations of bargaining (or agenda-setting) powers.

Notice that θ parameterizes the allocation of such power. If $\theta = 0$ then the old player has all the power, while the exact opposite is the case if $\theta = 1$. Furthermore, if $0 < \theta < 1$ then each generation has some power. The greater the value of θ the more power is vested in the young player. It seems appropriate, indeed convenient, to treat θ as a characterization of seniority in which $\theta = 0$ describes a *pure* seniority system and $\theta < 0.5$ as a seniority system more generally.[12]

3.4. **Informational Assumptions.** We plausibly assume that each player does not and/or cannot have knowledge of the entire history of the organization; for that would require knowledge, in particular, of all the actions taken before his birth into the organization (which includes actions taken by players who, at the time of his birth, would be long dead). At best, a player might learn of actions that were taken some finite number of periods before his birth. As such we adopt the plausible

[10]Where the amount of cake obtained by each player in such a status quo is normalized to zero.

[11]We specify the bargaining procedure in our model as of the take-it-or-leave-it variety and treat this procedure as exogenously given. An extension of the argument developed below suggests that this is the procedure that optimizing agents would arrive at if a procedure were not specified exogneously. It is part of an "optimal organization."

[12]It should however be observed that in other contexts seniority is taken as a measure of the number of terms served in office, and not tenure within any single term.

assumption that, in any period, each player has limited observability (or imperfect information) about the history of the game.

Furthermore, we adopt the complete information assumption, which is an informational assumption about the game itself: the structure and the payoffs that define our game are assumed to be common knowledge amongst all players. Thus, in particular, the values of all the parameters — which include b, δ, Π and θ — are common knowledge amongst all players.

3.5. **Preliminary Result.** Bhaskar (1998) studies a class of repeated games with overlapping generations of players in which the number of periods each player lives is finite and exogenously given. He shows that if players have limited observability about the history of the game, then in any equilibrium players must be using stationary strategies. Subject to some minor alterations, the argument in Bhaskar (1998) carries over to our stochastic game model in which the number of periods a player lives is endogenously determined as part of the equilibrium. As such we have the following preliminary result which informs our analysis:

Lemma 1. *The limited observability assumption implies that in any subgame perfect equilibrium, players must be using stationary strategies.*

The intuition behind this result is as follows.[13] The limited observability assumption implies that for any player in any period t, there will exist some player in some future period $s > t$ such that the period-s player has no information about the history of the game before period t that the period-t player does have. But this means that the period-s player cannot condition his action in period s on that part of the history. Now, the only reason that the period-t player would condition his action in period t on that part of the history is if players in the future would as well. Hence, history-dependant behaviour cannot be sustained in equilibrium — because players in different time periods have asymmetric (or differential) information about the history of game.[14]

[13]A formal proof of this lemma, which is available upon request from the authors, is based on an inductive argument on the degree of player observability of history (formally, on the number of periods of player memory). The argument is an adaptation of the argument in Bhaskar (1998).

[14]To further illustrate this intuition, suppose, for example, that each player in any period t knows the history of play in the preceding m periods, where m is large but finite. And suppose, contrary to Lemma 1, that there exists an equilibrium in which in some period t two players condition their respective period-t actions on the actions taken in the previous period, $t-1$, which they in principle can (since

4. Optimal Organizational Structure

Given Lemma 1, we restrict attention to stationary subgame perfect equilibria. In any such equilibrium the players' bargaining behaviour in any period (and hence the outcome of the negotiations in any period) is independent of the history of the game up until that period. It is therefore intuitive that in a stationary subgame perfect equilibrium (in which current actions have no affect on future equilibrium play), the player who is (randomly) chosen to make the "take-it-or-leave-it" offer would demand and receive all the cake. Thus, the result stated in the following proposition is intuitive (and straightforward to formally establish, which is done in the Appendix):

Lemma 2. *Fix* $\theta \in [0, 1]$. *There exists a unique subgame perfect equilibrium in which in each period all of the unit-size cake is obtained by the player who makes the "take-it-or-leave-it" offer. The equilibrium expected payoff to a young player is*

$$W(\theta) = \frac{b(1+\delta)}{1-\delta^2\pi(\theta)}, \quad \textit{where}$$

$$\pi(\theta) = \theta^2\Pi(1,0) + \theta(1-\theta)\Pi(1,1) + (1-\theta)\theta\Pi(0,0) + (1-\theta)^2\Pi(0,1).$$

Proof. In the Appendix. □

The equilibrium expected probability of survival, $\pi(\theta)$, depends on whether or not a player gets to make the offer when young and whether or not he gets to make the offer when old. As such there are four possible outcomes, as is reflected in the expression for $\pi(\theta)$. Notice that not surprisingly, a young player's equilibrium expected payoff — which is identical to the equilibrium expected payoff of a newly born player — depends on the value of θ.

The optimal organizational structure is defined to be the value of $\theta \in [0, 1]$ that maximizes the equilibrium expected payoff $W(\theta)$. This maximization problem is solved in the Appendix, and we obtain our first main result:

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they both can observe the actions taken in the preceding period). Now consider some distant future period s, which is larger than $t + m$. The newly born, young period-s player will not know the actions take in period $t - 1$, since he will only know the history of play in the preceding m periods. Hence, in period s, he will not know the state in which play is, which is a contradiction (i.e., it contradicts the supposition that such an equilibrium can exist in which some players use non-stationary strategies).

Proposition 1. *Define the following inequality:*

$$\frac{1}{2}\Pi(1,1) + \frac{1}{2}\Pi(0,0) > \Pi(0,1). \tag{1}$$

(i) If Π *satisfies inequality 1, then there exists a* $\theta^* \in (0,1)$ *such that* $W(.)$ *is maximized at* $\theta = \theta^*$*, where*

$$\theta^* = \frac{\Pi(1,1) + \Pi(0,0) - 2\Pi(0,1)}{2[\Pi(1,1) + \Pi(0,0) - \Pi(0,1) - \Pi(1,0)]}.$$

(ii) If Π *does not satisfy inequality 1, then* $W(.)$ *is maximized at* $\theta = 0$*.*

Proof. In the Appendix. □

The (large) class of probability-of-survival functions satisfying Assumptions 1 and 2 can be divided in two, mutually exclusive (and exhaustive) subclasses: functions in one subclass satisfy inequality 1, while functions in the other subclass don't. Each of these subclasses will contain a large number of probability-of-survival functions. It is of course not possible to argue in the abstract that one or the other of these two subclasses contains the most plausible and/or the most relevant probability-of-survival functions. In some real-life situations inequality 1 will be satisfied, while in other situations it will not, depending in particular on the degree of importance attached to cake obtained when young. For instance, in the context of the US Senate, if voters attach much signficance to cake obtained in both periods (to the extent, for example, that $\Pi(1,1) > 2\Pi(0,1)$) then inequality 1 would be satisfied.[15]

Proposition 1(ii) has established that if the probability-of-survival function does not satisfy inequality 1, e.g., Π concave, then the optimal organizational structure involves allocating all the agenda-setting (or bargaining) power to the old player. That is, as defined in section 3.3, a seniority system should optimally be instituted within the organization's structure. This holds for any arbitrarily small amount of

[15]We re-emphasize that our results, including Proposition 1, do not require that Π be continuous. Indeed, in some real-life situations, Π may jump (upwards, of course) at some critical values of x_y and x_o. For instance, this might be the case in situations where the probability-of-survival function is derived from some equilibrium models of electoral competition. It may also be worth noting that if Π is concave — which might be the case in some situations (and which, of course, implies that Π is differentiable almost everywhere, hence continuous) — then inequality 1 is not satisfied; since if Π is concave then the LHS of inequality 1 is less than or equal to $\Pi(1/2, 1/2)$, which, by Assumption 2, is strictly less than the RHS of inequality 1. However, if, for example, Π is sufficiently convex then inequality 1 would be satisfied.

recency bias as specified in Assumption 2. We state this result in the following corollary:

Corollary 1. *If the probability-of-survival function does not satisfy inequality 1, then the optimal organizational structure involves allocating all the agenda-setting (or bargaining) power to the old player; that is, to institute a seniority system.*

Proposition 1(i) establishes that the equilibrium expected payoff $W(.)$ is higher when both the young and the old players have some bargaining power than when all the power is allocated to either generation of players. When both players have some agenda-setting power, then, in equilibrium, with positive probability a player obtains the whole unit-size cake both when he is young and when he is old. When Π satisfies inequality 1, this prospect is sufficiently attractive to compensate for the fact that with positive probability he will obtain no cake when young and no cake when old, and with positive probability the whole cake when young but no cake when old.

It is easy to verify that θ^* is strictly less than 0.5; and that is the case because of Assumption 2 (the *WHYDFML* Principle). This result indicates that even when it is optimal to allocate some bargaining power to the young player, most of it should reside with the old player. This could be interpreted as a weak form of the seniority system, but a seniority system nevertheless, in which the old generation of players have most, if not all, of the agenda setting powers. It can also be verified that $0.5 - \theta^*$ is proportional to $\Pi(0,1) - \Pi(1,0)$, which (by Assumption 2) is strictly positive. This observation can be interpreted as follows: the greater the weight placed on cake obtained when old compared to that obtained when young, the closer is the optimal organizational structure to the idealized seniority system (in which the old have literally all the agenda-setting powers). We summarize these results in the following corollary:

Corollary 2. *If the probability-of-survival function satisfies inequality 1, then the optimal organizational structure involves allocating some agenda-setting (or bargaining) power to each player, but with the old player receiving a bigger share of that power.*

5. Third Parties and Suboptimal Structures

We now turn our attention to organizations with suboptimal organizational structures; that is, in which the allocation of agenda-setting (or bargaining) power differs from the optimal allocation derived in the previous section.

5.1. **Transactions Costs and Equilibrium Structures.** An application of Coase's Theorem would imply that in the absence of transactions costs (or frictions), the players within the organization should be able to (and would) negotiate amongst themselves to institute the optimal organizational structure. This conclusion can be explicitly derived as the unique equilibrium of an extended version of our model in which in each period the two players first negotiate over the value of θ, and then negotiate over the partition of the unit-size cake. Hence, in the absence of "transactions costs", one can establish that the equilibrium organizational structure is the optimal one.

However, in the presence of certain kinds of transactions costs, the above conclusion may not hold; the equilibrium organizational structure can be suboptimal. We don't propose, in this paper, to formally derive such a result.[16] Instead, we turn to the conditions (if any) under which the dynamically optimal *outcome* can be sustained, in equilibrium, in an organization with a suboptimal *structure*. We take as our starting point the conclusion that the presence of certain transactions costs imply that this suboptimal organizational structure is the equilibrium organizational structure.

5.2. **Dynamic Efficiency and Suboptimal Structures.** By definition, and given Lemma 1, unless the value of θ is the one stated in Proposition 1, the unique subgame perfect equilibrium of our model is dynamically inefficient (or suboptimal). In order to sustain the dynamically optimal outcome, it is necessary to employ the mechanism of inter-generational co-operation, which requires the use of non-stationary (or history-dependent) strategies. But Lemma 1 rules them out, since players have limited observability about the history of the game. One mechanism through which players can be provided with the information about the relevant bits of history is for the organization

[16]That would entail extending our model in a non-trivial manner. However, we refer the reader to Busch and Muthoo (2002), who provide an explanation (for the persistence of inefficient institutions) that may be used as the basis for appropriately extending our model and formally deriving the desired conclusion. A key ingredient of their explanation, interpreted in our context, is the notion that a re-allocation of agenda-setting power, while beneficial on one issue (the one we have modelled here), may adversely and strategically affect the power of at least one player on a second issue (which is not modelled here); and thus the player in question may well have an incentive to maintain the inefficient organizational structure.

to have a disinterested third party. Such a party has to be disinterested in the sense that he or she should have an incentive to provide the information truthfully. It should be noted that the old generation of players may also have the relevant information, but, since they are active players in the game, they would have an incentive to lie about it to the new generation of players. The (disinterested) third party acts as a surrogate for perfect observability. In this section we assume the existence of such a third party in the organization, and thus, Lemma 1 does not apply.[17]

In order to illustrate our main insights in a simplified manner, we analyze the special case in which $\theta = 1$ (i.e., the case in which all the agenda-setting power is vested in the young player). As can be seen from Proposition 1, under no circumstances can this be the optimal organizational structure. Furthermore, we assume that the probability-of-survival function Π does not satisfy inequality 1, which implies (from Proposition 1) that the optimal allocation of bargaining power is when $\theta = 0$ (i.e., when all the power is vested in the old player). So, we have laid down a case in which the optimal organizational structure is the "polar opposite" of the equilibrium organizational structure. The results of this case can be interpreted as a "test" case of the general issue of the extent to which dynamic optimality is sustainable, in equilibrium, in organizations with suboptimal organizational structures.

It follows from Lemma 2 that when $\theta = 1$, in the unique stationary subgame perfect equilibrium, the young player obtains all of the unit-size cake in each period, and the equilibrium expected payoff to the young player is

$$W(1) = \frac{b(1+\delta)}{1 - \delta^2 \Pi(1,0)}.$$

However, it follows from Lemma 2 that when $\theta = 0$, in the unique stationary subgame perfect equilibrium, the old player obtains all of the unit-size cake in each period, and the equilibrium expected payoff to the young player is

$$W(0) = \frac{b(1+\delta)}{1 - \delta^2 \Pi(0,1)}.$$

As we expect, $W(0) > W(1)$ — which is the case since (by Assumption 2) $\Pi(0,1) > \Pi(1,0)$. So, our objective here is to see whether or not it

[17]In some organizations, like the US Congress, there are officials — the parliamentarians of the respective chambers — who perform precisely this kind of function. As disinterested officials who maintain the "official record" and keep track of precedent, they provide members with information and official interpretation on the appropriateness of alternative procedural maneuvers.

		state s_1	state s_2
Young Player	offer	$x = 0$	$x = 1$
Old Player	response	accept $x = 0$	accept any offer
	transitions	switch to state s_2 if young player offers $x > 0$	switch to state s_1 immediately after one offer is made and is responded to

TABLE 1. A non-stationary equilibrium when $\theta = 1$. Notice that an offer x is a share of the cake to the young player; and thus $1 - x$ is the old player's share.

is possible to construct a necessarily non-stationary subgame perfect equilibrium of our model when $\theta = 1$ such that, in equilibrium in each period the young player offers all of the unit-size cake to the old player; that is, which sustains, in equilibrium, the dynamically optimal *outcome.*

Consider the strategy profile described in Table 1, using the language of "states" and "transitions" between such states (which is a compact way to describe simple non-stationary equilibria).[18] Play begins in (the dynamically optimal) state s_1. The young player makes the dynamically optimal offer $x = 0$ (where x is the share of the cake going to the young player). Play stays in this state unless an inappropriate action is taken (as described under "transitions"). Deviation from this state by a young player, who asks for some positive share of the cake ($x > 0$), moves play immediately from state s_1 to (the punishment) state s_2. His offer is accepted by the old player, but then in the next period, when the young player himself is old, he receives no cake (the punishment); that is, the then young player's offer, $x = 1$, means that the deviator receives nothing when old. Play then reverts back to state s_1. Thus this strategy profile has the property that only "deviants" are punished, where a deviant is defined as a young player who fails to offer the whole cake to the old player.

We now show that the strategy profile described in Table 1 is in a subgame perfect equilibrium for any parameter values satisfying Assumptions 1 and 2. The main issue is to check that when play is in state s_1, the young player has no incentive to conduct a one-shot (unilateral) deviation by asking for some positive share of the cake. His payoff from conforming (i.e., from offering the whole cake to the old

[18]For further discussion and illustration of this way of describing simple non-stationary equilibria, see Muthoo (1999).

player) is

$$b(1+\delta) + \delta^2 \Pi(0,1) W(0). \tag{2}$$

His payoff from not conforming (i.e., from offering $x > 0$) is

$$b(1+\delta) + \delta^2 \Pi(x,0) W(0), \tag{3}$$

since (as can be seen from Table 1 under "transitions") by deviating to $x > 0$ the state immediately switches to state s_2, where he is punished for one period (receiving no cake when he is old), and then, subsequently, play reverts back to the dynamically optimal state.

The only difference between the expressions in (2) and (3) is in the survival probability. When the young player conforms he receives no cake when young and the whole cake when old, and thus his survival probability is $\Pi(0,1)$. But when he deviates by asking for a share $x > 0$ of the cake when young he obtains no cake when old, and thus, in that case, his survival probability is $\Pi(x,0)$. Notice that his equilibrium continuation payoffs (in the eventuality he survives death) are identical and equal to $W(0)$ whether or not he conforms; this is because play reverts back to the dynamically optimal path (after the one period punishment).

Since (by Assumption 1) $\Pi(x,0)$ is strictly increasing in x, the best possible deviation is to set $x = 1$ (i.e., to ask for the whole cake when young). Hence, a young player will not deviate to any $x > 0$ if and only if

$$\Pi(0,1) > \Pi(1,0). \tag{4}$$

This condition is the young player's *incentive-compatibility* condition, which is required to be satisfied in order for the dynamically optimal outcome to be sustainable in equilibrium by the strategy profile described in Table 1. Assumption 2, the *WHYDFML* Principle, implies that inequality 4 is satisfied. Hence, we have established the following (desired) result:

Proposition 2. *Assume that $\theta = 1$ and that Π does not satisfy inequality 1. Then, for any parameter values satisfying Assumptions 1 and 2, the non-stationary strategy profile described in Table 1 is in a subgame perfect equilibrium. In equilibrium, in each period all of the unit-size cake is obtained by the old player. The equilibrium payoff in this (one-period punishment) equilibrium to a young player is $W(0)$.*

It is worth emphasizing that for any parameter values satisfying Assumptions 1 and 2, the young player has no incentive to deviate from the dynamically optimal path of play. So, although some punishment is required to provide the young player with incentives not to deviate from the dynamically optimal path, incentives can be provided for any values of δ, b and Π provided that Π satisfies Assumptions 1 and 2. This conclusion is to be contrasted with the analogous results in the literature on dynamic games (with and without overlapping generations). The various "folk theorems" in this literature establish that dynamically efficient equilibria require players to be sufficiently patient. If players don't care enough about their future payoffs, then they will have an incentive to deviate, and co-operation becomes unsustainable in equilibrium. In our model, in contrast, the maximal possible gains that a young player obtains from deviation are relatively easy to wipe out given the *WHYDFML* Principle.

We now explain, as it is instructive to do so, why Proposition 2 cannot hold without the presence of a disinterested "third party" to act as a surrogate for perfect observability. The (history-dependent) equilibrium strategies described in Table 1 are fairly simple. In terms of the "informational requirements" for the existence of this equilibrium, it might appear that all that is required is for the players to have one period memory (a very limited degree of observability). The following informal argument shows that such a presumption is misplaced. Indeed, as should be clear, the argument can easily be generalized to show that, irrespective of the number m of periods of memory that players have, this simple, non-stationary equilibrium cannot exist if m is finite; it is necessary that $m = \infty$ (which is the perfect observability assumption).

We argue by contradiction. Thus suppose, to the contrary, that players have one period memory and the strategies described in Table 1 are in a subgame perfect equilibrium. Consider the following situation. In some period t, when play is in state s_1, the period-t young player deviates from the proposed equilibrium action by asking for the whole cake, which (according to the proposed equilibrium) he obtains. Given the one period memory assumption, the period-$(t+1)$ young player knows of this deviation in period t, and hence knows that play in period $t+1$ is in state s_2. He is meant to (according to the proposed equilibrium) ask for the whole cake for himself. We now argue that he will not carry out that equilibrium action, which contradicts our initial supposition. The period-$(t+1)$ young player knows that the period-$(t+2)$ young player will not know of the deviation that took place in period t (given the one period memory assumption). This means that if the period-$(t+1)$ young player does follow the equilibrium action and ask for the whole cake for himself, then the period-$(t+2)$ young player may reasonably conclude that, in fact, the period-$(t+1)$ young player deviated, and hence, that play in period $t+2$ is in state s_2. The desired conclusion is thus an immediate consequence of Assumption 2.

We conclude this analysis by drawing attention to an interesting empirical implication of our results. If one observes the dynamically optimal outcome in any particular organization — which is that in each period all of the unit-size cake is obtained by the old player — then it will not be evident (without an examination of the allocation of agenda-setting power) whether this has arisen because players have instituted the optimal organizational structure ($\theta = 0$) or that a sub-optimal organizational structure is actually in place ($\theta = 1$), but that the dynamically optimal outcome is being sustained in equilibrium by the credible threat of an out-of-equilibrium punishment regime. That is, these two explanations are *observationally equivalent* (on the equilibrium path).

6. An Extension: Booms and Busts

We now extend our model by introducing the possibility of "booms" and "busts". Besides addressing the issue of the robustness of our main results and insights obtained above to this extension, we also obtain some new results and insights that inform the two central questions under study.

The economic environment underlying our model is stable and stationary: the size of the cake (or surplus) in any period is known with certainty at any preceding period, and moreover, its size is the same across all periods. We now enrich the underlying economy just a little bit by assuming that the size of the surplus in any period t is not known with certainty in any preceding period; its size is determined at the beginning of period t (before the proposer is randomly chosen). It can be one of two sizes: small (of size 1), or large (of size $\rho > 1$). With probability τ (where $\tau \in [0, 1]$) the size of the cake is small; and thus with probability $1 - \tau$ it is large.

It may be noted that we have therefore assumed that the size of the cakes in any two periods is identically and independently distributed. Thus, for example, we rule out any correlation between them. We do so mainly in order to be able to develop in the simplest possible manner some implications of the implied symmetric uncertainty. We leave it for future research to address the interesting cases where some form of correlation exists such as when the probability of having the large surplus is relatively higher if the size of the cake in the previous period was large.

6.1. **Optimal Organizational Structure.** We first derive the optimal organizational structure (in the absence of a disinterested "third party"), and thus in particular explore the extent to which the results and insights of section 4 are robust to this simple extension.

It is straightforward to see — and in fact easy to formally establish by adapting the proof of Lemma 2 — that the result contained in Lemma 2 carries over to this extended model except that a young player's equilibrium expected probability of survival is no longer $\pi(\theta)$; instead it is

$$\widehat{\pi}(\theta) = \theta^2\eta_1 + \theta(1-\theta)\eta_2 + (1-\theta)\theta\Pi(0,0) + (1-\theta)^2\eta_3, \quad \text{where}$$

$$\begin{aligned}
\eta_1 &= \tau\Pi(1,0) + (1-\tau)\Pi(\rho,0)\\
\eta_2 &= \tau^2\Pi(1,1) + \tau(1-\tau)\Pi(1,\rho) + (1-\tau)\tau\Pi(\rho,1) + (1-\tau)^2\Pi(\rho,\rho)\\
\eta_3 &= \tau\Pi(0,1) + (1-\tau)\Pi(0,\rho).
\end{aligned}$$

It is worth noting — especially in order to relate (and interpret) the results we obtain here with those obtained above in section 4 — that although $\pi(\theta)$ and $\widehat{\pi}(\theta)$ are quantitatively different, they are qualitatively identical since η_1, η_2 and η_3 are the expected probabilities of survival of a young player in (the same) three different circumstances, respectively: (i) when he obtains no cake when old and all the cake when young, (ii) when he obtains all the cake both when young and when old, and (iii) when he obtains no cake when young and all the cake when old. Indeed, when $\tau = 1$ or $\rho = 1$ then $\pi(\theta) = \widehat{\pi}(\theta)$.

The optimal organizational structure is defined to be the value of $\theta \in [0,1]$ that maximizes the equilibrium expected payoff

$$\widehat{W}(\theta) = \frac{b(1+\delta)}{1-\delta^2\widehat{\pi}(\theta)}.$$

It is easy to appropriately amend the argument in the proof of Proposition 1, and establish the following result (which extends Proposition 1 to the case in which the size of the cake in any period is randomly determined at the beginning of the period in question):

Proposition 3. *Fix $\tau \in [0,1]$ and $\rho > 1$. Now, define the following inequality:*

$$\frac{1}{2}\eta_2 + \frac{1}{2}\Pi(0,0) > \eta_3. \tag{5}$$

(i) If Π *satisfies inequality 5, then there exists a* $\widehat{\theta} \in (0,1)$ *such that* $\widehat{W}(.)$ *is maximized at* $\theta = \widehat{\theta}$*, where*

$$\widehat{\theta} = \frac{\eta_2 + \Pi(0,0) - 2\eta_3}{2[\eta_2 + \Pi(0,0) - \eta_3 - \eta_1]}.$$

(ii) If Π *does not satisfy inequality 5, then* $\widehat{W}(.)$ *is maximized at* $\theta = 0$*.*

As can be seen, the result contained in Proposition 3 is qualitatively identical to the result contained in Proposition 1. In particular, the results contained in Corollaries 1 and 2 carry over (but, of course, with inequality 1 being replaced by inequality 5). As such, our main qualitative insights about optimal organizational structure — in particular, that it involves allocating most (if not all) of the agenda-setting powers to the old player — are robust to symmetric uncertainty about the size of the surplus, or, what may be called, *booms* and *busts.*

There are however some novel insights that are implied by Proposition 3 concerning the role of the size of the boom on optimal organization structure. It is easy to verify that for any $\tau \in [0,1)$ there exists a $\widehat{\rho}$ such that for any $\rho > \widehat{\rho}$ inequality 5 holds. Notice that $\widehat{\rho}$ is strictly increasing in τ, and morever, $\widehat{\rho} \to \infty$ as $\tau \to 1$. This implies (from Proposition 3) that if the size of the boom (relative to the bust) in any period is sufficiently large, then it is optimal to allocate some of the agenda-setting power to the young player. Of course, as noted above, the conclusion of Corollary 2 is applicable, and hence the bigger share of that power should optimally be vested in the old player (i.e., $\widehat{\theta} < 0.5$). However, it can be verified that the larger is the size of the boom, the more power should optimally be allocated to the young player (i.e., $\widehat{\theta}$ is strictly increasing in ρ). In particular, in the limit as the size of the boom becomes infinite, agenda power should be spilt equally between the two players (i.e., $\widehat{\theta} \to 0.5$ as $\rho \to \infty$)

These results make intuitive sense. For after all, for any given positive likelihood of a boom in any period, if the size of that boom is sufficiently large then it is optimal (maximizing the equilibrium survival probability, and hence the equilibrium payoff) that each player has some positive chance to get "two bites at the cherry", once when young and once when old.

6.2. **Dynamic Optimality in a Suboptimal Structure.** We now turn to a positive analysis of this extended model, like we did in section 5.2, on the presumption that the organization has a disinterested "third party" who acts as a surrogate for perfect observability.

Exactly like we did in section 5.2, consider the case in which the equilibrium organizational structure is such that the young player has all the agenda power ($\theta = 1$), but (since, by assumption, inequality 5 does not hold) the optimal organizational structure is one in which the old player possesses all the power ($\theta = 0$). This means that, like in section 5.2, the dynamically optimal outcome is such that in each period the young player offers the old player all of the cake (whatever its size turns out to be). Our aim, as before, is to derive the conditions (if any) under which the dynamically optimal outcome can be sustained in a necessarily non-stationary equilibrium of the extended model with $\theta = 1$.

We consider the strategy profile described in Table 1, but this time we need to interpret x as the fraction of the cake, whatever its size, to the young player; and thus $1 - x$ being the fraction of the cake to the old player. By adapting the argument leading to Proposition 2, it is easy to establish that a young player will not deviate in any period from the proposed equilibrium action (in state s_1) of offering the whole cake to the old player, given that the realized size of the cake in the period in question is ξ (where $\xi = 1, \rho$) if and only if his payoff from conforming, which equals

$$b(1+\delta) + \delta^2[\tau\Pi(0,1) + (1-\tau)\Pi(0,\rho)]\widehat{W}(0)$$

is greater than his payoff from not conforming, which equals

$$b(1+\delta) + \delta^2[\tau\Pi(\xi,0) + (1-\tau)\Pi(\xi,0)]\widehat{W}(0).$$

Since, as is intuitive, the latter payoff is larger when $\xi = \rho$ than when $\xi = 1$, it follows that the young player's *incentive-compatibility* condition — which is required to be satisfied in order for the dynamically optimal outcome to be sustainable in equilibrium by the (appropriately re-interpreted) strategy profile described in Table 1 — is:

$$\Pi(0,\rho) - \Pi(\rho,0) > \tau[\Pi(0,\rho) - \Pi(0,1)].$$

Notice, not surprisingly, that in the degenerate case of $\rho = 1$, this latter condition would collapse to condition 4. Returning to the non-degenerate case of $\rho > 1$, this incentive-compatibility condition may be fruitfully re-written as follows:

$$\tau < \widehat{\tau} \quad \text{where} \quad \widehat{\tau} \equiv \frac{\Pi(0,\rho) - \Pi(\rho,0)}{\Pi(0,\rho) - \Pi(0,1)}. \tag{6}$$

Assumptions 1 and 2 imply that $\widehat{\tau} > 0$. Hence, for any parameter values such that τ is sufficiently small (more precisely less than $\widehat{\tau}$), the incentive-constraint (6) is satisfied. But the question now is whether or not $\widehat{\tau}$ is less than one. For if it is, then this means that for any parameter values such that $\tau > \widehat{\tau}$, this incentive constraint is not satisfied, which means that the dynamically optimal outcome cannot be sustained in equilibrium in this organization with a suboptimal structure. It is easy to see that

$$\widehat{\tau} \gtreqless 1 \Longleftrightarrow \Pi(0,1) \gtreqless \Pi(\rho, 0).$$

It follows from Assumption 2 (the *WHYDFML* Principle) that there exists a $\rho^* > 1$ such that $\Pi(0,1) = \Pi(\rho^*, 0)$. Hence, it follows from Assumption 1 that

$$\widehat{\tau} \gtreqless 1 \Longleftrightarrow \rho^* \gtreqless \rho.$$

This analysis implies the following result:

Proposition 4. *Assume that there exists a disinterested "third party" in the organization who acts as a surrogate for perfect observability about the history of the organization. Furthermore, assume that* $\theta = 1$ *and that* Π *does not satisfy inequality 5. If the size of the boom is sufficiently small, then, for any parameter values satisfying Assumptions 1 and 2, the dynamically optimal outcome can be sustained (via a non-stationary equilibrium) in the organization with the suboptimal structure. But if the size of the boom is sufficiently large, then this latter conclusion holds if and only if the likelihood of a bust occurring in any period is sufficiently small.*

The intuition for these insights comes partly from the following, key observation. If the likelihood of a boom occuring in any period is sufficiently small (is a rare event) and the size of the boom is large, then the young player has an incentive to deviate from the dynamically optimal path, and take all the cake for himself when a (large, by hypotheses) boom does occur — for after all, a boom is a rare event (by hypotheses).

7. Concluding Remarks

Within the context of a simple model, we have developed some answers to two central questions concerning the allocation of agenda-setting power in organizations with overlapping generations of players, where the number of periods a player participates is endogenously determined by his or her past performance.

First, we have derived results and insights concerning the optimal allocation of such power between the two generations of players. A main result obtained is that under a broad set of conditions, most (if not all) of this agenda power should optimally be vested in the old generation of players (rather than the young generation). That is, it is optimal to institute a seniority system within the framework of the organization's structure. We have, however, also identified conditions under which the young should optimally be allocated substantial power (although less than that allocated to the old). This should be the case, for instance, when the underlying economic environment is subject to shocks and exhibits very large booms. A key explanatory factor behind all our results is the *WHYDFML* Principle, an arrangement in which a player's probability of survival in the organization is more sensitive to benefits (cake) accruing to him when old than when young — in effect, a "contract renewal" process exhibiting a recency bias.

Second, we have derived results and insights concerning the conditions under which the dynamically optimal outcome is sustainable in organizations with suboptimal structures in equilibrium (owing to the presence of transactions costs). One important condition is for the organization in question to have a disinterested "third party" who acts as a surrogate for perfect observability about the history of the organization. Under a broad set of conditions, we showed (by appealing in particular to the *WHYDFML* Principle) that dynamic efficiency is sustainable in such an organization via the mechanism of inter-generational co-operation. However, under some conditions, dynamic optimality is unsustainable. This is the case, for instance, when the economic environment is subject to shocks, and exhibits large and rare booms.

Several extensions and generalizations suggest themselves, some of which are the subject of a sequel to the present paper.

• We have seen how perturbations — "booms and busts" as we called them — affect the robustness of intertemporal deals. In deriving our results we assumed, more for convenience than for any substantive reason, that perturbations were uncorrelated. It would be of great interest, however, to determine the effect on equilibrium of alternative correlated structures.

• An organization containing two generations is the simplest OLG setting in which to examine agenda power and multi-period bargaining. Additional generations introduces accounting complexity, but also less-than-unanimous decision rules and the possibility of coalitions among generations. Related to this, multiple agents per generation adds richness and complexity. Each of these extensions would add realism to our model.

• We regard a period t old agent who is re-appointed in period $t+1$ as identical to a newly minted period $t+1$ young agent. It would be enlightening to consider a role for *experience*, for example one in which the probability of reappointment is affected by the number of previous "terms" served. This amounts to introducing an *incumbency effect* as a proxy for "competence". The competence of agents, in turn, will effect the size of the cake available for distribution. It would be of interest to derive the ways in which such an effect impacts the allocation of agenda power and outcomes in equilibrium.

• In many applications the "cake" that is bargained over by agents can be consumed by the principals only with a lag. A public project, for example, may be secured by a legislator, but is only realized and then enjoyed by his or her constituents some years later. In effect, the probability-of-reappointment function impounds a "credit-claiming" technology. We have explicitly recognized monotonicity and a recency bias (*WHYDFML*), but otherwise have assumed that cake produced in period t is also consumed in that period. It would be of interest to determine the effect on equilibrium bargaining of time lags, and the ways they interact with the *WHYDFML* Principle.

• Finally, as noted earlier (see footnote 11), endogenizing the bargaining procedure would extend our argument to "constitutional moments" and provide some insight about the conditions under which take-it-or-leave-it bargaining emerges. In some settings this would be facilitated by bringing the principals into the analysis as strategic players. In such settings there may well be other features of agent interactions on which principals might contract such as agent compensation b and agent re-selection Π.

In sum, agenda power matters. Its allocation amongst the key players in any (economic, political or social) organization has a crucial impact not only on the economic distribution of the benefits amongst the players, but also on the extent to which the organization is able to sustain the dynamically optimal outcome.

Appendix

Proof of Lemma 2. Fix $\theta \in [0, 1]$. Given Lemma 1, we need to derive the set of all stationary subgame perfect equilibria (SSPE). A SSPE is characterized in particular by a pair of numbers, which we denote by k_y and k_o, where (for each $i = y, o$) k_i and $1-k_i$ are respectively the equilibrium shares of the cake to the young and old players offered by player i (in any period and for any history of the game up until that period) if he is chosen to make the "take-it-or-leave-it" offer. It is straightforward to verify that in any SSPE, player i's equilibrium offer k_i is accepted by player j ($j \neq i$). Given this result, we now proceed to characterize the unique SSPE.

Fix an arbitrary SSPE. Letting V denote the expected payoff in this SSPE to a young player (at the beginning of any period, before the proposer is randomly chosen), it follows that V satisfies the following (recursive) equation:

$$V = b(1+\delta) + \delta^2 \gamma V, \quad \text{where}$$

$$\gamma = \theta^2 \Pi(k_y, 1-k_y) + \theta(1-\theta)\Pi(k_y, 1-k_o) + (1-\theta)\theta\Pi(k_o, 1-k_y) + (1-\theta)^2 \Pi(k_o, 1-k_o).$$

Hence,

$$V = \frac{b(1+\delta)}{1-\delta^2\gamma}.$$

From the *One-Shot Deviation* Principle[19], it follows that player i ($i = y, o$) has no incentive to deviate by making an offer that differs from the equilibrium offer k_i if and only if k_i maximizes $P_i(x)$ over $x \in [0,1]$ subject to $P_j(x) \geq D_j$ ($j \neq i$), where

$$\begin{aligned} P_y(x) &= b(1+\delta) + \delta^2[\theta\Pi(x, 1-k_y) + (1-\theta)\Pi(x, 1-k_o)]V \\ P_o(x) &= b + \delta\Pi(z, 1-x)V \\ D_y &= b(1+\delta) + \delta^2[\theta\Pi(0, 1-k_y) + (1-\theta)\Pi(0, 1-k_o)]V \\ D_o &= b + \delta\Pi(z, 0)V, \end{aligned}$$

where z denotes the amount of cake obtained by the old player in the previous period (when he was young). Since $P_y(x)$ is increasing in x and $P_o(x)$ is decreasing in x, it immediately follows that there exists a unique SSPE, namely, $k_y = 1$ and $k_o = 0$.

Proof of Proposition 1. Maximizing W over θ is, of course, equivalent to maximizing π over θ. Differentiating π *w.r.t.* θ, we obtain:

$$\frac{\partial \pi}{\partial \theta} = 2\alpha\theta + \beta, \quad \text{where}$$

$$\begin{aligned} \alpha &= \Pi(1,0) + \Pi(0,1) - \Pi(1,1) - \Pi(0,0) \\ \beta &= \Pi(1,1) + \Pi(0,0) - 2\Pi(0,1). \end{aligned}$$

First, we consider the case in which $\beta > 0$ (i.e., inequality 1 holds). Then since

$$\alpha + \beta = \Pi(1,0) - \Pi(0,1)$$

is strictly negative (by Assumption 2), it follows that $\alpha < 0$. Now note that

$$2\alpha + \beta = -\beta + 2[\Pi(1,0) - \Pi(0,1)],$$

which is strictly negative (by Assumption 2 and since, by hypothesis, $\beta > 0$). Finally note that since $\alpha < 0$, it follows that π is strictly concave in θ. Putting these results together, it follows that we have established that π is increasing in θ over the interval $[0, \theta^*)$, decreasing over the interval $(\theta^*, 1]$

[19]The *One-Shot Deviation* Principle, which is also known by other terms, is essentially the principle of optimality for discounted dynamic programming. A strategy profile is in a subgame perfect equilibrium if and only if each player's strategy is immune to profitable one-shot (unilateral) deviations.

and achieves a maximum at $\theta = \theta^*$, where $\theta^* = -\beta/2\alpha$. Hence, we have established the first part of the proposition.

Now consider the case in which $\beta < 0$ (i.e., inequality 1 does not hold). We break our argument into three cases. First suppose that $\alpha < 0$. This immediately implies that π is maximized at $\theta = 0$ (since π is in this case decreasing and strictly concave in θ). Now suppose that $0 < \alpha < -\beta/2$. In this case π is also maximized at $\theta = 0$ (since π in this case is decreasing but strictly convex in θ). Finally suppose that $\alpha > -\beta/2$. In this case π is strictly convex in θ, decreasing in θ over some interval $(0, \theta')$, achieves a minimum at θ' and is increasing over the interval $(\theta', 1)$. This implies that π achieves a maximum either at $\theta = 0$ or at $\theta = 1$. The desired conclusion follows immediately, since (by Assumption 2) $\pi(0) > \pi(1)$.

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