Distribution of surplus in sequential bargaining with endogenous recognition

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Abstract

I examine a sequential bargaining situation in which agents contest the right to propose an allocation. The contest can either take place at a pre-bargaining stage, yielding "persistent recognition" to propose, or recur throughout the bargaining, yielding "transitory recognition". Equilibrium analysis reveals that surplus is distributed more unequally under persistent recognition; social cost is higher under persistent recognition if and only if it attracts a sufficient number of "active" bargainers; and individual's incentive to propose under transitory recognition may actually increase in the number of agents, while this incentive always diminishes under persistent recognition.

Keywords: Sequential bargaining; Persistent recognition; Transitory recognition; Distribution of surplus; Rent-seeking contests

JEL Classifications: C70; D72

1 Introduction

Beginning with the seminal paper by Rubinstein 1982, the sequential bargaining literature has identified two key sources of bargaining power: the ability to propose an allocation and the ability to wait for a consensus. Hence, it predicts that agents are likely to engage in costly activities to be the proposer so long as it is feasible. Yet, with few exceptions discussed below, the literature has assumed an exogenous "recognition" process[1] by which the proposer is selected.

In this paper, I examine situations in which agents can influence the recognition process via costly actions. Examples abound. In the U.S. Congress, after making formal requests, congressmen often lobby their party's "Committee on Committees", or CC, to be assigned to powerful committees and/or to a higher rank in their current ones.[2]The power of a congressional committee arises from its ability to set the agenda, which is negotiated over by its members.[3] In organizations such as a university and a company, many strategic decisions can be put forward only by an executive committee whose members are elected based on their services and contributions to the organization.[4] In international negotiations, nations in conflict frequently lobby others to garner support for their proposals. And, in legal proceedings, litigants present evidence to the court by hiring lawyers and experts, to promote their settlement offers.[5] Notice that an important feature of influence activities in these examples, and a main component of my ensuing investigation, is their timing: potential committee members need to exert most, if not all, of their efforts before being assigned to the committee setting the agenda; in contrast, nations, in the face of frequently changing governments, need to renew their lobbying activities until negotiations conclude.

My model builds on Binmore's 1987 bargaining framework with random proposers, in which a group of agents wants to divide a dollar and agreement on a division requires unanimous approval. Unlike Binmore, I allow agents to expend efforts –as in the rent-seeking literature– to increase their chances of proposing. In order to establish the endogenous link between their incentives to propose and their ability to wait, I assume that agents are heterogenous only in their discount factors, and in light of the examples above, consider two types of recognition: persistent and transitory. Whereas persistent recognition exhibits a pre-bargaining struggle as in the case of committee assignments, transitory recognition entails a constant struggle throughout the bargaining as in the case of international negotiations and legal battles. I solve for the stationary subgame perfect equilibria of both games and show that such an equilibrium uniquely exists in each.

My analysis reveals that when recognition is persistent, it is the more patient agent who has a stronger incentive to propose, lending him a "double" advantage in the distribution of surplus. Thus, compared to the benchmark bargaining in which agents exogenously are endowed with equal probabilities of proposing, persistent recognition generates a *more unequal* distribution of surplus in the sense of Lorenz dominance defined below. The reason for a stronger incentive to propose is that a more patient agent can protect his investment in recognition more effectively by being able to reject unfavorable offers at a lower waiting cost. A similar line of reasoning suggests that agents' incentives to propose should be more aligned under transitory recognition, because their investments have no long-term impact. This is indeed the case. Under transitory recognition, agents choose equal efforts in equilibrium, *regardless* of their patience levels, and thus propose with equal probabilities, as with the benchmark. Nevertheless, transitory recognition leads to a *less unequal* distribution of surplus than the benchmark, because patient agents are willing to accept relatively small shares to avoid costly struggles in the future. From these two observations, my main finding emerges: the distribution of surplus is more unequal under persistent recognition than under transitory recognition.

My analysis also reveals insights into the social cost created by influence activities as well as the effect of group size on individual's incentive to propose. It shows that persistent recognition produces a greater social cost than transitory recognition, if the former attracts a sufficient number of "active" bargainers, who exert a positive effort to propose. Note that having the same incentive to propose, all agents are active bargainers under transitory recognition. Counteracting this effect in terms of social cost is the prize from proposing, which is likely to be higher under persistent recognition, owing to the long-term impact of efforts on recognition.

As for the effect of group size on the incentive to propose, the intuition suggests that all else being equal, agents should be less eager to expend effort in a larger group due to a diminished chance of proposing. While this intuition holds for the case with persistent recognition, agents may actually increase their efforts under transitory recognition. The latter occurs because, anticipating a more intense struggle in a larger group, agents are willing to settle for little, which raises the (endogenous) prize from proposing and, in turn, encourages each to propose.

My findings suggest that all else equal, bargaining through committees is likely to result in a more unequal distribution of surplus than decentralized bargaining where no member has a strict right to propose. But the former is also likely to be a more effective mechanism for reducing influence activities, especially when agents are heterogenous in their time preferences.

My paper lies at the intersection of two large literatures: sequential bargaining, e.g., Osborne and Rubinstein 1990, and rent-seeking contests, e.g., Konrad 2009. The intersection, however, is almost empty. To my knowledge, Evans 1997 is the first to let players expend (unproductive) efforts to propose, though in a coalitional bargaining setup, to show that the pure strategy subgame perfect payoff set coincides with the core. Board and Zwiebel 2005 investigate a bargaining game in which two agents bid for the right to propose, but their focus is on agents' budget differences, rather than on their patience.[6]

The closest paper to the present work is Yildirim 2007, in which I study the role of voting rules on agents' incentives to propose under transitory recognition. Here, the role of timing of efforts on these incentives and the distribution of surplus by fixing the voting rule at unanimity is highlighted. The insights complement each other. For instance, consistent with the finding here, Yildirim 2007 also predicts a more patient agent to have a greater incentive to propose, but only when the voting rule is less than unanimity so that such an agent fears being left out of others' offers.

Finally, my work also is related to a relatively small number of papers, e.g., McKelvey and Palfrey 1997, Perry and Reny 1993, that endogenize the bargaining procedure by means of strategies other than costly efforts.

2 Model

There are $n \geq 2$ risk-neutral agents who want to divide one dollar among themselves. They negotiate according to Binmore's 1987 sequential bargaining with random proposers. At the beginning of period $t = 1, 2, ...,$ agent i is recognized with probability $p_{i,t}$ to make an offer as to how to allocate the dollar. His offer is accepted if it is feasible *and* receives unanimous approval. Let $s_{k,t} \in [0, 1]$ denote agent k's share, and $S_t = \{(s_{1,t}, ..., s_{n,t}) | \sum_k s_{k,t} \leq 1\}$ represent the set of all feasible offers. If i's offer is accepted, then the bargaining concludes, whereby each agent receives the proposed share. Otherwise, it proceeds to period $t + 1$, whereby agent k (possibly, $k = i$) is selected to propose with probability $p_{k,t+1}$. Agent i discounts the future by $\delta_i \in [0, 1)$, and has an outside option of 0.

As alluded to in the Introduction, my bargaining setup differs from Binmore's in that recognition probabilities are endogenously determined by agents' (wasteful) efforts, much like in the rent-seeking contests. Let $x_{i,t} \geq 0$ be the effort exerted by agent i at the beginning of period t, costing him, $C(x_{i,t}) = cx_{i,t}$, where $c > 0$. Given effort profile $\mathbf{x}_t = (x_{1,t}, ..., x_{n,t})$, agent i proposes with probability:

$$p_i(\mathbf{x}_t) = \begin{cases} \frac{f(x_{i,t})}{\sum_k f(x_{k,t})} & \text{if} \quad \mathbf{x}_t \neq 0 \\ \frac{1}{n} & \text{if} \quad \mathbf{x}_t = 0, \end{cases} \tag{1}$$

where the "production" function, f satisfies: $f(0) = 0$, $f' > 0$, and $f'' \leq 0$.

Two remarks about the setup are in order. First, agents in my model are heterogenous only in their time preferences, because I aim to highlight the impact of patience on the endogenous incentives to propose. Second, the functional form I impose on the recognition process is widely employed in rent-seeking contests as "contest success functions". Aside from being tractable, this so-called Tullock 1980 form has some axiomatic foundations,[7] and it exhibits several basic properties of a recognition process. In particular, the likelihood of one's recognition increases in his own effort and decreases in others', both at a diminishing rate. Furthermore, this form will allow me to obtain a unique pure-strategy equilibrium at the effort stage.

As mentioned in the Introduction, understanding the consequences of timing of efforts on bargaining outcomes will constitute the central part of my investigation. To this end, I consider two polar timings for recognition: persistent and transitory. Under persistent recognition, agents exert efforts *once-and-for-all* before the bargaining, and these efforts fix their recognition probabilities in the subsequent bargaining. Under transitory recognition, on the other hand, agents need to renew their efforts to propose at the beginning of each period following no agreement. Note that when agents are all short-sighted, i.e., $\delta_i = 0$ for all i, bargaining with either type of recognition reduces to a one-shot rent-seeking contest. Note also that the ex-post observability of efforts is immaterial for either case, as players will perfectly infer them in equilibrium.

In terms of the solution concept, I focus on Stationary Subgame Perfect Equilibria (SSPE) with pure strategies in effort. Loosely speaking, in an SSPE, players can base their bargaining strategies only on the current state of (non)agreement. In particular, they are expected to adopt the same strategies until an agreement is reached. As is customary in the literature on multilateral sequential bargaining, aside from its analytical tractability, there are two main reasons why I impose stationarity. First, with more than two players, any allocation can be supported as an SPE in the bargaining where players use history-dependent strategies to punish deviators [see, e.g., Baron and Ferejohn 1989]. The stationarity restriction often reduces the equilibrium set dramatically, and therefore it is widely adopted in the literature [e.g., Baron and Ferejohn 1989, Eraslan 2002, and Merlo and Wilson 1995]. Second, an SSPE may involve the least "complexity" in certain bargaining games similar to the one analyzed here [Baron and Kalai 1993].

I start my analysis with the case of persistent recognition, and then turn to the case of transitory recognition.

3 Bargaining with persistent recognition

Bargaining with persistent recognition is intended to capture the applications that demonstrate a pre-bargaining struggle as in the case of committee assignments where potential members earn their committee positions through initial lobbying. Formally, suppose agents simultaneously exert efforts once-and-for-all at the beginning of period 1, and these efforts determine their (stationary) recognition probabilities $\mathbf{p}(\mathbf{x}) = (p_1(\mathbf{x}), ..., p_n(\mathbf{x}))$ according to (1) for the subsequent bargaining, where, without loss of generality, I drop the time index. By backwards induction, I first solve for bargaining equilibrium for a fixed $\mathbf{x}$. Let $\overline{s}_i(\mathbf{p}(\mathbf{x}))$ be agent i's expected share.

Lemma 1. *Fix* $\mathbf{x}$*. Then, in the unique SSPE of the bargaining stage, agreement is immediate, and agent* i *expects to receive*

$$\overline{s}_i(\mathbf{p}(\mathbf{x})) = \frac{\frac{p_i(\mathbf{x})}{1-\delta_i}}{\sum_k \frac{p_k(\mathbf{x})}{1-\delta_k}}. \tag{2}$$

PROOF. Let $\mathbf{p}(\mathbf{x}) = (p_1(\mathbf{x}), ..., p_n(\mathbf{x}))$ be the recognition vector for a fixed $\mathbf{x}$. Note that in any stationary equilibrium, there is immediate agreement in the bargaining, because, given a costly delay, i.e., $\delta_i < 1$, it is optimal for each proposer i to pay others their continuation values, $\delta_k \overline{s}_k(\mathbf{p}(\mathbf{x}))$ for $k \neq i$, to induce acceptance of his proposal and keep the rest, $1 - \sum_{k \neq i} \delta_k \overline{s}_k(\mathbf{p}(\mathbf{x}))$.[8] This means that equilibrium payoff for player i must satisfy the following recursive equation (where I suppress $\mathbf{x}$):

$$\overline{s}_i = p_i(1 - \sum_{k \neq i} \delta_k \overline{s}_k) + (1 - p_i)\delta_i \overline{s}_i$$

or, equivalently

$$\overline{s}_i = \frac{p_i}{1 - \delta_i}(1 - \sum_k \delta_k \overline{s}_k) \tag{3}$$

Multiplying both sides of (3) by δ_i, and summing over all i's yields $\sum_k \delta_k \overline{s}_k = \frac{\sum_k \frac{\delta_k}{1-\delta_k} p_k}{1+\sum_k \frac{\delta_k}{1-\delta_k} p_k}$. Inserting this fact into (3) and noting $\sum_k \frac{\delta_k}{1-\delta_k} p_k = \left(\sum_k \frac{p_k}{1-\delta_k}\right) - 1$, I obtain (2). ■

Eq. (2) clearly identifies the two key sources of bargaining power: the ability to propose, p_i, and the patience level, δ_i. An agent who is more likely to propose, is more patient, or both is expected to receive a larger share in the bargaining. Perhaps more importantly, eq. (2) reveals that the only reason why an agent ever obtains a positive share is his ability to propose; otherwise $p_i = 0$ implies $\overline{s}_i = 0$, irrespective of δ_i. For $p_i > 0$ however, the agent's bargaining power through proposing is compounded by his patience, because a more patient agent could (off-equilibrium) reject an unfavorable offer and wait to propose.

Armed with the characterization of the bargaining stage, I now solve for equilibrium efforts. Let $v_i(\mathbf{x}) \equiv \overline{s}_i(\mathbf{p}(\mathbf{x})) - cx_i$ be agent i's expected net payoff at the effort stage. Then, an effort profile, $\mathbf{x}^*$ is part of an equilibrium if and only if the following holds for all i:

$$x_i^* = \arg\max_{x_i} v_i(x_1^*, ..., x_i, ..., x_n^*). \tag{4}$$

LEMMA 2. *There exists a unique* $\mathbf{x}^*$, *and* $\mathbf{x}^* \neq \mathbf{0}$.

PROOF. First note that $\mathbf{x}^* \neq \mathbf{0}$. Otherwise, given $\mathbf{x}_{-i}^* = \mathbf{0}$, agent i could be strictly better off by expending a sufficiently small effort, and receiving the whole pie with probability 1 in return. Second, restricting attention to $\mathbf{x} \neq \mathbf{0}$ and using (1), $v_i(\mathbf{x})$ reduces to $v_i(\mathbf{x}) = \frac{\frac{f(x_i)}{1-\delta_i}}{\sum_k \frac{f(x_k)}{1-\delta_k}} - cx_i$. Now, let $z_i \equiv \frac{f(x_i)}{1-\delta_i}$ and $\widehat{C}_i(z_i) = cf^{-1}((1-\delta_i)z_i)$. Then, $v_i(\mathbf{x}) = \widehat{v}_i(\mathbf{z}) = \frac{z_i}{\sum_k z_k} - \widehat{C}_i(z_i)$. Hence, finding $\mathbf{x}^*$ with payoffs $v_i(\mathbf{x})$ amounts to finding $\mathbf{z}^*$ with payoffs $\widehat{v}_i(\mathbf{z})$. The latter is equivalent to a one-shot rent-seeking game, in which player i wins a prize of 1 with probability $\widetilde{p}_i(\mathbf{z}) = \frac{z_i}{\sum_k z_k}$, and his cost function is $\widehat{C}_i(z_i)$, with $\widehat{C}_i' > 0$ and $\widehat{C}_i'' \geq 0$. From Szidarovszky and Okuguchi (1997), such a game has a unique equilibrium $\mathbf{z}^*$, which implies the existence of a unique $\mathbf{x}^*$. ■

I begin my equilibrium analysis with a stark observation when there are only two agents – a case often assumed in the bargaining literature.

PROPOSITION 1. *For $n = 2$,*

- $x_1^* = x_2^* = x^* > 0$.
- $p_1^* = p_2^* = \frac{1}{2}$.
- $(\overline{s}_1^*, \overline{s}_2^*) = (\frac{1-\delta_2}{2-\delta_1-\delta_2}, \frac{1-\delta_1}{2-\delta_1-\delta_2})$.

PROOF. By Lemma 2, $\mathbf{x}^* \neq \mathbf{0}$. For $n = 2$, I further have $x_1^* > 0$ and $x_2^* > 0$: otherwise if $x_i^* = 0$ for some i, then agent $j \neq i$ would have a strict incentive slightly to reduce his effort to $x_j^* - \varepsilon > 0$; because, by doing so, j could still receive the whole pie, while strictly saving on effort costs.

Given $x_1^* > 0$ and $x_2^* > 0$, the FOCs of (4) require $\frac{\partial}{\partial x_1} v_1(\mathbf{x}^*) = 0 = \frac{\partial}{\partial x_2} v_2(\mathbf{x}^*)$, where, by simple differentiation and (2),

$$\frac{\partial}{\partial x_i} v_i(\mathbf{x}^*) = \frac{f'(x_i^*)}{f(x_i^*)} \overline{s}_i^* \overline{s}_j^* - c. \tag{5}$$

Now suppose, without loss of generality, that $x_1^* < x_2^*$. Since $\frac{f'(x_i)}{f(x_i)}$ is strictly decreasing in x_i, $\frac{f'(x_1^*)}{f(x_1^*)} > \frac{f'(x_2^*)}{f(x_2^*)}$. Moreover, since $\overline{s}_i^* = 1 - \overline{s}_j^*$ by (2), $\overline{s}_1^* \overline{s}_2^* = \overline{s}_2^* \overline{s}_1^*$. Together these two facts imply $\frac{\partial}{\partial x_1} v_1(\mathbf{x}^*) > \frac{\partial}{\partial x_2} v_2(\mathbf{x}^*)$, yielding a contradiction. Hence, $x_1^* = x_2^*$, and thus $p_1^* = p_2^* = \frac{1}{2}$. From (2), I then have $(\overline{s}_1^*, \overline{s}_2^*) = (\frac{1-\delta_2}{2-\delta_1-\delta_2}, \frac{1-\delta_1}{2-\delta_1-\delta_2})$. ■

That is, in a bilateral bargaining, each agent expends the same amount of effort and thus proposes with equal probability. To understand why, note from (5) that agent i's marginal return to effort is proportional to both his own expected share, $\overline{s}_i^*$, and the expected share of the other player, $\overline{s}_j^*$, which is, by (2), equal to $1 - \overline{s}_i^*$. Hence, an increase in i's expected share has two opposing effects on his marginal return to effort: on the one hand, he needs to give less to the other player when he is the proposer, increasing the marginal return; but, on the other hand, he would be offered a larger share, when he is not the proposer, reducing the marginal return. In a two-player bargaining, these two effects enter into players' marginal returns in a symmetric way, since what player i receives exactly equals what j doesn't, and as a result, they are equal for both, *irrespective* of players' patience.

With more than two players, the forces that drive effort decisions are similar to those for the two-player bargaining, but the "neutrality" result regarding equilibrium efforts is unlikely to hold in the presence additional players, as I show in

PROPOSITION 2. *Let, without loss of generality,* $\delta_1 \geq \delta_2 \geq ... \geq \delta_n$. *Then,*

- $x_1^* \geq x_2^* \geq ... \geq x_n^*$,

where $x_1^* \geq x_2^* > 0$*; and* $x_i^* > x_j^*$ *whenever* $\delta_i > \delta_j$, $x_i^* > 0$, *and* $j \geq 3$.

- $p_1^* \geq p_2^* \geq ... \geq p_n^*$.

- $\overline{s}_1^* \geq \overline{s}_2^* \geq ... \geq \overline{s}_n^*$,

where $\overline{s}_i^* > \overline{s}_j^*$ *whenever* $\delta_i > \delta_j$ *and* $\overline{s}_i^* > 0$.

PROOF. Let, without loss of generality, $\delta_1 \geq \delta_2 \geq ... \geq \delta_n$. Clearly, if $\delta_i = \delta_j$, then, by the uniqueness of equilibrium from Lemma 2, $x_i^* = x_j^*$, $p_i^* = p_j^*$, and $\overline{s}_i^* = \overline{s}_j^*$, satisfying Proposition 2. Now, let $\delta_i > \delta_j$ for some $i > j$. I first show that $\frac{p_i^*}{1-\delta_i} \geq \frac{p_j^*}{1-\delta_j}$. Suppose, on the contrary, that $\frac{p_i^*}{1-\delta_i} < \frac{p_j^*}{1-\delta_j}$. Using the change of variables in the proof of Lemma 2, this means that $z_i^* < z_j^*$, which implies $\widetilde{p}_i(\mathbf{z}^*) < \widetilde{p}_j(\mathbf{z}^*)$ and $\frac{\partial}{\partial z_j}\widehat{v}_j(\mathbf{z}^*) = 0 \geq \frac{\partial}{\partial z_i}\widehat{v}_i(\mathbf{z}^*)$, where $\frac{\partial}{\partial z_l}\widehat{v}_l(\mathbf{z}^*) = \frac{\partial \widetilde{p}_l(\mathbf{z}^*)}{\partial z_l} - \widehat{C}_l'(z_l^*)$, for $l = i, j$. Since $\frac{\partial \widetilde{p}_l(\mathbf{z}^*)}{\partial z_l} = \frac{1-\widetilde{p}_l(\mathbf{z}^*)}{\sum_k z_k^*}$, $\widetilde{p}_i(\mathbf{z}^*) < \widetilde{p}_j(\mathbf{z}^*)$ implies $\frac{\partial \widetilde{p}_j(\mathbf{z}^*)}{\partial z_j} < \frac{\partial \widetilde{p}_i(\mathbf{z}^*)}{\partial z_i}$. Next, by definition,

$\widehat{C}_l'(z_l) = c(1-\delta_l)f^{-1\prime}((1-\delta_l)z_l)$. Given $\delta_i > \delta_j$ and $z_i^* < z_j^*$, it follows that $f^{-1}((1-\delta_j)z_j^*) > f^{-1}((1-\delta_i)z_i^*)$ and $(1-\delta_j)\ f^{-1\prime}((1-\delta_j)z_j) > (1-\delta_i)f^{-1\prime}((1-\delta_i)z_i)$, which means that $\widehat{C}_j'(z_j^*) \geq \widehat{C}_i'(z_i^*)$. But then, $\frac{\partial}{\partial z_j}\widehat{v}_j(\mathbf{z}^*) < \frac{\partial}{\partial z_i}\widehat{v}_i(\mathbf{z}^*)$, yielding a contradiction. Hence, $\frac{p_i^*}{1-\delta_i} \geq \frac{p_j^*}{1-\delta_j}$. By (2), this implies that $\overline{s}_i^* \geq \overline{s}_j^*$. A similar line of argument also implies that if $p_i^* > 0$, then $\overline{s}_i^* > \overline{s}_j^*$, completing the proof of the last part. To prove the first part, suppose, on the contrary, that $x_i^* < x_j^*$. Then, $\frac{\partial}{\partial x_j}v_j(\mathbf{x}^*) = 0 \geq \frac{\partial}{\partial x_i}v_i(\mathbf{x}^*)$. Using (2) and the facts: $\frac{\partial p_l(\mathbf{x})}{\partial x_k} = -\frac{f'(x_k)}{f(x_k)}p_l(\mathbf{x})p_k(\mathbf{x})$ for $k \neq l$ and $\frac{\partial p_l(\mathbf{x})}{\partial x_l} = \frac{f'(x_l)}{f(x_l)}p_l(\mathbf{x})(1-p_l(\mathbf{x}))$, note that

$$\frac{\partial}{\partial x_l}v_l(\mathbf{x}^*) = \frac{f'(x_l^*)}{f(x_l^*)}\overline{s}_l^* \sum_{k \neq l} \overline{s}_k^* - c \text{ for } l = i, j. \tag{6}$$

As in the proof of Proposition 1, I make two observations: First, since $\frac{f'(x_l)}{f(x_l)}$ is strictly decreasing in x_l, $\frac{f'(x_j^*)}{f(x_j^*)} < \frac{f'(x_i^*)}{f(x_i^*)}$. Second, from the first part, $\delta_i > \delta_j$ implies that $\overline{s}_i^* \geq \overline{s}_j^*$, which, in turn, implies that $\overline{s}_i^* \sum_{k \neq i} \overline{s}_k^* \geq \overline{s}_j^* \sum_{k \neq j} \overline{s}_k^*$. Together these two facts require $\frac{\partial}{\partial x_j}v(\mathbf{x}^*) < \frac{\partial}{\partial x_i}v(\mathbf{x}^*)$, yielding a contradiction. Hence, $x_i^* \geq x_j^*$; and $p_i^* \geq p_j^*$ as a result. The exact arguments also reveal that $x_i^* > x_j^*$, and $p_i^* > p_j^*$, whenever $x_i^* > 0$ and $j \geq 3$. Finally, similar to the proof of Proposition 1, it must be that $x_k^* > 0$ for at least two agents, which means $x_1^* \geq x_2^* > 0$. ■

Proposition 2 indicates that it is the more patient agent who has a greater incentive to propose, even though he could simply reject an unfavorable offer and wait until he is the proposer. The intuition is similar to that with two-players: the marginal return to player i's effort is proportional to both his expected share and those of others (refer to eq.(6)). However, the two factors now affect players' marginal returns in an asymmetric manner, because in the presence of additional players, what player i gets in the bargaining no longer equals what j doesn't. Another way of interpreting this result is to recall from Lemma 1 that the two sources of bargaining power are complements. Hence, knowing that he can better protect his investment in being the proposer, a more patient agent has a stronger incentive to invest.[9]Since a more patient agent is also more likely to propose in the bargaining, it is then not surprising that he is expected to grab a larger share of the surplus. It is also important to note that while the two most patient agents always exert positive efforts, some less patient ones may drop out of competition (see Example 1 below).

In light of Proposition 2, it seems intuitive that the equilibrium distribution of surplus under persistent recognition should exhibit a greater inequality than the one under exogenous recognition where $\mathbf{x} = \mathbf{0}$, because a more patient agent holds both sources of bargaining power in hand under the former. To confirm this intuition, I utilize the concept of Lorenz dominance, which is often used for measuring income inequality.[10]

Definition 1. (Lorenz inequality) *Let* $\overline{\mathbf{s}} = (\overline{s}_1, \overline{s}_2, ..., \overline{s}_n)$ *be a vector of surplus distribution, whose elements are indexed in an ascending order, and define* $L_i(\overline{\mathbf{s}}) = \sum_{k=1}^{i} \overline{s}_k$. *It is said that* $\overline{\mathbf{s}}'$ *is more unequal than* $\overline{\mathbf{s}}''$ *if* $\overline{\mathbf{s}}''$ *Lorenz dominates* $\overline{\mathbf{s}}'$, *i.e.,* $L_i(\overline{\mathbf{s}}'') \geq L_i(\overline{\mathbf{s}}')$ *for all* i.

Loosely speaking, a surplus distribution, $\overline{\mathbf{s}}'$ is more unequal than $\overline{\mathbf{s}}''$ if the majority of surplus is in the hands of the few. Denoting the allocation under an exogenous rule by $\overline{\mathbf{s}}^0 \equiv \overline{\mathbf{s}}(\mathbf{p}(\mathbf{0}))$, I record

Proposition 3. *The surplus distribution under persistent recognition,* $\overline{\mathbf{s}}^*$, *is more unequal than the one under exogenous recognition,* $\overline{\mathbf{s}}^0$, *in the sense of Lorenz.*

Proof. Let, without loss of generality, the elements of $\overline{\mathbf{s}}^* = (\overline{s}_1^*, \overline{s}_2^*, ..., \overline{s}_n^*)$ be indexed in an ascending order. Then, by Proposition 2, $\delta_1 \leq \delta_2 \leq ... \leq \delta_n$, which means that the elements of $\overline{\mathbf{s}}^0 = (s_1^0, s_2^0, ..., s_n^0)$ are also in ascending order. Note that for $n = 2$, Proposition 1 implies that $\overline{\mathbf{s}}^* = \overline{\mathbf{s}}^0$, which trivially satisfies Proposition 3. Now, let $n > 2$. Then, eq.(2) reveals that $\overline{s}_i^* \geq \overline{s}_i^0$ if and only if $p_i^* \geq p^c$, where $p^c \equiv \sum_k \frac{p_k^*}{1-\delta_k} / \sum_k \frac{1}{1-\delta_k}$. This means that there is some $i_c \in \{2, ..., n-1\}$ such that $\overline{s}_i^* \geq \overline{s}_i^0$ for all $i \geq i_c$ and $\overline{s}_i^* \leq \overline{s}_i^0$ for all $i < i_c$. Next, suppose, by way of contradiction, that $L_j(\overline{\mathbf{s}}^0) < L_j(\overline{\mathbf{s}}^*)$ for some j. Clearly $j \geq i_c$ and $j < n$. The latter follows because, by definition, $L_n(\overline{\mathbf{s}}^0) = L_n(\overline{\mathbf{s}}^*) = 1$. Then, $\sum_{k=j+1}^{n} \overline{s}_k^0 \leq \sum_{k=j+1}^{n} \overline{s}_k^*$. Moreover, since $L_j(\overline{\mathbf{s}}^0) < L_j(\overline{\mathbf{s}}^*)$, it must be that $L_n(\overline{\mathbf{s}}^0) = L_j(\overline{\mathbf{s}}^0) + \sum_{k=j+1}^{n} \overline{s}_k^0 < L_n(\overline{\mathbf{s}}^*) = L_j(\overline{\mathbf{s}}^*) + \sum_{k=j+1}^{n} \overline{s}_k^*$, contradicting $L_n(\overline{\mathbf{s}}^0) = L_n(\overline{\mathbf{s}}^*) = 1$. Hence, $L_j(\overline{\mathbf{s}}^0) \geq L_j(\overline{\mathbf{s}}^*)$ for all j, or equivalently $\overline{\mathbf{s}}^*$ is Lorenz dominated by $\overline{\mathbf{s}}^0$, and thus more unequal by Definition 1. ■

Hence, when the recognition process is influenced by agents' initial efforts, the subsequent bargaining is likely to result in a *more unequal* distribution of surplus. In fact, some impatient agents who find the expected share too little may instead drop out of competition to propose and obtain zero surplus – a point I illustrate by an example.

EXAMPLE 1. (Active and Passive Bargainers) *Let* $f(x_i) = x_i$ *so that* $p_i = \frac{x_i}{\sum_k x_k}$. *Moreover, let, without loss of generality,* $\delta_1 \geq \delta_2 \geq ... \geq \delta_n$. *Defining the last active player as* $\overline{k} \equiv \max\{k$ *such that* $\sum_{i=1}^{k}(1-\delta_i) - (k-1)(1-\delta_k) > 0\}$, *I find player* j*'s equilibrium share and effort to be*

$$\overline{s}_j^* = \begin{cases} 1 - \frac{(\overline{k}-1)(1-\delta_j)}{\sum_{i=1}^{\overline{k}}(1-\delta_i)}, & if \quad j \leq \overline{k} \\ 0, & if \quad j > \overline{k} \end{cases}, \text{ and } x_j^* = \frac{1}{c}\overline{s}_j^*(1-\overline{s}_j^*). \tag{7}$$

According to Example 1, the set of "active" players in the bargaining, who expend a positive effort, can be much smaller than the actual set. By Proposition 2, the two most patient players, namely 1 and 2, will always be active. Eq.(7) reveals that they are the only ones whenever $\delta_j \leq \delta_1 + \delta_2 - 1$ for all $j \neq 1, 2$. To draw further insight, Figure 1a plots expected surplus for a group of ten agents whose $\delta_i \in \{.5, .52, .55, .57, .6, .62, .65, .67, .7, .72\}$. Note that whereas all agents receive a positive surplus under exogenous recognition, the four least patient agents receive no surplus under persistent recognition. Note also that the surplus distribution is much more skewed toward the most patient agents under the latter.

4 Bargaining with transitory recognition

I now turn my attention to bargaining with transitory recognition in which, unlike with persistent recognition, proposing each period requires a renewed effort. This scenario approximates well international negotiations where the involved nations repeatedly lobby others with frequently changing governments for the recognition of their proposals as well as legal battles where litigants repeatedly supply evidence through lawyers and experts to tip settlements in their favor. To capture these, I assume that players simultaneously choose efforts at the beginning of period t, which then determine $p_{i,t}$ according to (1). If the offer in period t is rejected, then the bargaining proceeds to period $t+1$, whereby players choose efforts again.

As in the previous section, let v_i^{**} be agent i's expected payoff from the bargaining net of his effort costs, where (**) denotes equilibrium with transitory recognition, and given stationarity, I drop the time index. When deciding on his effort in each period, agent i considers two possibilities: First, with probability p_i he is the proposer, in which case he pays each player $k \neq i$ his continuation payoff, $\delta_k v_k^{**}$, and retains the rest of the surplus, $1 - \sum_{k \neq i} \delta_k v_k^{**}$. Second, with probability $1 - p_i$ someone else is the proposer, in which case agent i is offered his continuation payoff, $\delta_i v_i^{**}$. Together with the fact that there is no delay in equilibrium, agent i solves the following dynamic program:

$$v_i^{**} = \max_{x_i} \{p_i(x_i, \mathbf{x}_{-i}^{**})(1 - \sum_{k \neq i} \delta_k v_k^{**}) + [1 - p_i(x_i, \mathbf{x}_{-i}^{**})]\delta_i v_i^{**} - cx_i\}. \tag{8}$$

Re-arranging terms, I rewrite (8) as

$$v_i^{**} = \frac{1}{1 - \delta_i} \max_{x_i} \{p_i(x_i, \mathbf{x}_{-i}^{**})\underbrace{(1 - \sum\nolimits_k \delta_k v_k^{**})}_{\pi^{**}} - cx_i\}. \tag{9}$$

From (9), it is clear that the effort stage reduces to a one-shot rent-seeking game, in which the winner receives the (endogenous) prize $\pi^{**} \equiv 1 - \sum_k \delta_k v_k^{**}$. By Szidarovszky and Okuguchi 1997, there is a unique pure strategy equilibrium to this effort game. Moreover, given the symmetry of recognition and cost functions, equilibrium efforts must be equal and positive for all agents, i.e., $x_1^{**} = x_2^{**} = ... = x_n^{**} = x^{**} > 0$. Comparing with Proposition 2, this implies that unlike the bargaining with persistent recognition, all agents propose with an equal probability, and all are active, *irrespective* of their discount factors and number.

The reason for this discrepancy lies in the fact that when recognition is transitory, each agent expects to receive the same prize, π^{**}, from proposing. Specifically, by proposing, agent i obtains the residual surplus, $1 - \sum_{k \neq i} \delta_k v_k^{**}$, but sacrifices his continuation value, $\delta_i v_i^{**}$, which becomes his opportunity cost of proposing, and leads to a net prize, π^{**}, independent of his identity. A second line of intuition as to why efforts under transitory recognition are equal is that agent i cannot protect his investment in recognition by being patient, as upon rejection of an offer, efforts need to be renewed. I record the observations up to now in

Proposition 4. *There is a unique equilibrium under transitory recognition, and it has the following properties:*

- $x_1^{**} = x_2^{**} = ... = x_n^{**} = x^{**} > 0$, *with* x^{**} *being the unique solution to:*

$$\frac{\partial}{\partial x_i} p_i(x, x, ..., x)\pi - c = 0, \tag{10}$$

where $\pi = n\left[cx + \frac{1-ncx}{\sum_k \frac{1}{1-\delta_k}}\right]$.

- $p_1^{**} = p_2^{**} = ... = p_n^{**} = \frac{1}{n}$.
- $(1-\delta_1)v_1^{**} = (1-\delta_2)v_2^{**} = ... = (1-\delta_n)v_n^{**} = \frac{1-ncx^{**}}{\sum_k \frac{1}{1-\delta_k}}$.

Proof. As alluded to in the text, let $\widehat{x}(\pi) > 0$ be the equilibrium effort for a fixed $\pi \in [0, 1]$, which uniquely solves the FOC from (9): $\frac{\partial}{\partial x_i} p_i(x, x, ..., x)\pi - c = 0$, or equivalently

$$\frac{f'(x)}{f(x)} \frac{1}{n}(1 - \frac{1}{n})\pi - c = 0, \tag{11}$$

where I utilize the facts: $p_i(x, x, ..., x) = \frac{1}{n}$ and $\frac{\partial}{\partial x_i} p_i(\mathbf{x}) = \frac{f'(x)}{f(x)} p_i(1-p_i)$. From (11), it follows that $\frac{d}{d\pi}\widehat{x}(\pi) > 0$ and $\frac{d}{d\pi}[\frac{1}{n}\pi - c\widehat{x}(\pi)] > 0$. Next, using (9), I obtain

$$v_i = \frac{1}{1-\delta_i}[\frac{1}{n}\pi - c\widehat{x}(\pi)]. \tag{12}$$

Since $\pi \equiv 1 - \sum_k \delta_k v_k$, summing (12) over all i and arranging terms, I find that π^{**} is part of an equilibrium if and only if it solves $\Phi(\pi) = 0$, where

$$\Phi(\pi) \equiv 1 - \pi - \left[\frac{1}{n}\pi - c\widehat{x}(\pi)\right] \sum_k \frac{\delta_k}{1-\delta_k}.$$

Note that $\Phi'(\pi) < 0$ because $\frac{d}{d\pi}[\frac{1}{n}\pi - c\widehat{x}(\pi)] > 0$. Moreover, $\Phi(0) > 0$ and $\Phi(1) < 0$. Hence, there is a unique $\pi^{**} \in (0, 1)$, which by $\frac{d}{d\pi}\widehat{x}(\pi) > 0$, implies a unique $x^{**} = \widehat{x}(\pi^{**})$, and by (12), a unique v_i^{**}. Solving $\Phi(\pi^{**}) = 0$, I further find $\pi^{**} = n\left[cx^{**} + \frac{1-ncx^{**}}{\sum_k \frac{1}{1-\delta_k}}\right]$, which, by substituting into (11) and (12) yields (10) and $(1-\delta_i)v_i^{**} = \frac{1-ncx^{**}}{\sum_k \frac{1}{1-\delta_k}}$, respectively. ■

The last part of Proposition 4 indicates that the net payoff, v_i^{**}, is higher, the more patient agent i is, as one would expect. To investigate the role of transitory recognition on the distribution of surplus, note that the expected share of player i is

$$\overline{s}_i^{**} = p_i^{**}(1 - \sum_{k \neq i} \delta_k v_k^{**}) + (1 - p_i^{**})\delta_i v_i^{**},$$

which, by (8), reduces to $\overline{s}_i^{**} = v_i^{**} + cx^{**}$. Thus, a more patient agent –not surprisingly– obtains a larger share. To see how $\overline{s}_i^{**}$ compares with $\overline{s}_i^0$, received under the exogenous rule, I substitute for v_i^{**} from Proposition 4:

$$\overline{s}_i^{**} = \overline{s}_i^0 + (\frac{1}{n} - \overline{s}_i^0)ncx^{**}. \tag{13}$$

Evidently, $\overline{s}_i^{**} \geq \overline{s}_i^0$ if and only if $\overline{s}_i^0 \leq \frac{1}{n}$. In other words, an agent who receives less than the average surplus under the exogenous rule will *increase* his share under the transitory rule, and vice versa. Hence, $\overline{s}_i^{**}$ should exhibit a less unequal distribution of surplus than $\overline{s}_i^0$. Eq.(13) also reveals that as agents anticipate a more intense struggle to propose, i.e., a higher ncx^{**}, the distribution of surplus will be even less unequal. This is so despite the fact that each agent is equally likely to propose under both transitory and exogenous recognition. The reason is that while waiting is less costly for a more patient agent, transitory recognition requires additional effort to propose in the next bargaining round, leading him to be less demanding than if recognition were exogenous and costless. I now formally state the findings in this paragraph in

Proposition 5.

- *The surplus distribution under transitory recognition,* $\overline{\mathbf{s}}^{**}$, *is less unequal than the one under the exogenous recognition,* $\overline{\mathbf{s}}^0$, *in the sense of Lorenz.*
- $\overline{s}_1^{**} \geq \overline{s}_2^{**} \geq ... \geq \overline{s}_n^{**} > 0$ *for* $\delta_1 \geq \delta_2 \geq ... \geq \delta_n$.

Proof. Together with (13), the exact arguments employed in the proof of Proposition 3 shows the first part. The second part follows from the text. ■

Continuing with the numerical example in Figure 1a, Figure 1b compares surplus distributions for transitory and exogenous recognition rules. The noteworthy observation here is how flat the distribution is under transitory recognition despite significant heterogeneity in discounting.

5 Persistent versus transitory recognition

Armed with equilibrium characterizations of bargaining under persistent and transitory recognition rules, I now compare their outcomes.

5.1 Distribution of surplus

Using Propositions 3 and 5, I have

PROPOSITION 6. *All else equal, bargaining with persistent recognition results in a more unequal distribution of surplus than the one with transitory recognition. Formally,* $\bar{\mathbf{s}}^{**}$ *Lorenz dominates* $\bar{\mathbf{s}}^{*}$.

PROOF. Since $\bar{\mathbf{s}}^{**}$ Lorenz dominates $\bar{\mathbf{s}}^{0}$ by Proposition 5, and $\bar{\mathbf{s}}^{0}$ Lorenz dominates $\bar{\mathbf{s}}^{*}$ by Proposition 3, the result follows by transitivity. ■

Knowing that his initial investment in recognition has a long-lasting impact, a more patient agent has a greater incentive to invest and propose with a higher probability under persistent recognition, lending him a "double" advantage at the bargaining stage. His investment incentive is, however, curbed under transitory recognition, because investment in this case cannot be protected beyond the current period. As a result, the distribution of surplus is more skewed toward patient agents under persistent recognition than under the transitory one. This finding is demonstrated in Figure 1c, which combines Figures 1a and 1b.

An implication of Proposition 6 is that bargaining through committees is likely to produce a more unequal distribution of surplus than a decentralized one where all members – including those outside the committee– can promote their proposals.[11]

5.2 Social cost

A distinctive feature of my bargaining model is that agents' investments in being the proposer are pure social cost, which is simply the sum of individual costs:[12] $SC \equiv \sum_k cx_k$. Hence, it is necessary to determine the extent of this cost and how it compares across the two types of recognition. The insight from the rent-seeking literature seems to suggest that bargaining under transitory recognition should result in a greater social cost, because at the effort stage, players are completely symmetric, i.e., all compete for the same prize, π^{**}, and possess the same cost function.[13] This intuition, however, is incomplete here owing to the endogeneity of π^{**}. To compare social costs in a simple way, I assume that $f(x_i) = x_i$ (as in Example 1) so that $p_i = \frac{x_i}{\sum_k x_k}$.

PROPOSITION 7. *Let $f(x_i) = x_i$. And suppose that for a fixed $\overline{k} \in \{2, 3, ..., n\}$,*

$$\delta_k = \begin{cases} \delta_H & for \quad k \leq \overline{k} \\ \delta_L & for \quad k > \overline{k} \end{cases}$$

such that $\delta_L \leq \delta_H$ and $(\overline{k}-1)a_H < \overline{k}a_L$ where $a_L \equiv \frac{1}{1-\delta_L}$ and $a_H \equiv \frac{1}{1-\delta_H}$. Then,

- *$SC^{**} > SC^*$ if and only if $n > \underline{n}$, where*

$$\underline{n} \equiv \frac{1}{2}\left[(\overline{k}-1)a_L + 1 + \sqrt{[(\overline{k}-1)a_L - 1]^2 + 4(\overline{k}-1)(\overline{k}a_H - (\overline{k}-1)a_L)}\right].$$

- *$\underline{n}$ strictly increases in $\overline{k}$, and $\underline{n} > n$ for $\overline{k} = n$.*

PROOF. Let $f(x_i) = x_i$. From (7), $SC^* = \sum_{k=1}^{\overline{k}} cx_k^* = \sum_{k=1}^{\overline{k}} \overline{s}_k^*(1-\overline{s}_k^*)$, which, by arranging terms, reduces to

$$SC^* = (\overline{k}-1)\left[1 - (\overline{k}-1)\sum_{k=1}^{\overline{k}}\left(\frac{1-\delta_k}{\sum_{k=1}^{\overline{k}}(1-\delta_k)}\right)^2\right]. \qquad (14)$$

The condition $(\overline{k}-1)a_H < \overline{k}a_L$ implies, by Example 1, that only the agents $k \leq \overline{k}$ are active, i.e., $x_1^* = x_2^* = ... = x_{\overline{k}}^* > 0 = x_{\overline{k}+1}^* = ... = x_n^*$. Inserting this fact into (14), I find $SC^* = \frac{\overline{k}-1}{\overline{k}}$.

To compute social cost under transitory recognition, I substitute for $\pi = n\left[cx + \frac{1-ncx}{\sum_k \frac{1}{1-\delta_k}}\right]$ in (11), and solve for $x = x^{**}$. It then follows that

$$SC^{**} = ncx^{**} = \frac{n-1}{n-1+\frac{1}{n}\sum_k \frac{1}{1-\delta_k}},$$

which, given $a_L \equiv \frac{1}{1-\delta_L}$ and $a_H \equiv \frac{1}{1-\delta_H}$, simplifies to $SC^{**} = \frac{n-1}{n-1+\frac{1}{n}[\overline{k}a_H+(n-\overline{k})a_L]}$. Comparing SC^* and SC^{**}, the desired result in the first part of the proposition obtains. Since $a_H \geq a_L$, $\underline{n}$ clearly increases in $\overline{k}$. Finally, computing $\underline{n}$ at $\overline{k} = n$ shows that $\underline{n} > n$. ■

Proposition 7 says that social cost under transitory recognition is higher than it is under persistent recognition if group size is sufficiently large, and vice versa. The size threshold increases in the number of active bargainers under persistent recognition, which, in turn, increases as agents become symmetric. This makes sense. As more agents actively participate in the bargaining, their competition to propose an allocation intensifies, making persistent recognition more likely to generate a higher social cost. Hence, the reason why persistent recognition may save on social cost is because it may induce some bargainers to stay passive, i.e., choose $x_i = 0$, which is *never* the case under transitory recognition. Indeed, if all agents are symmetric, i.e., $\delta_L = \delta_H$ so that $\overline{k} = n$, then they are all active bargainers under persistent recognition. By Proposition 7, this means that persistent recognition generates a higher social cost because $\underline{n} > n$ for $\overline{k} = n$.

Proposition 7 may offer a rent-seeking explanation for the prevalence of executive committees in organizations. It implies that if an organization is composed of members who are sufficiently heterogenous in their discounting,[14] then bargaining through executive committees is a more effective institution for reducing rent-seeking activities than a decentralized bargaining where all members are eligible to make proposals.

5.3 Incentives to propose and group size

In addition to social cost, it is also important to understand the individual effort to propose; and a key factor for individual effort is group size. Specifically, do additional participants in the bargaining encourage or discourage an existing individual to propose? To answer this question in a meaningful way, here I assume agents to be identical and note the main finding in this subsection in

Proposition 8. *Let $\delta_i = \delta$ for all i. Then,*

- x_i^* *decreases in* n.
- *For* $f(x_i) = x_i^\alpha$, *with* $\alpha \in (0,1]$, x_i^{**} *increases in* n *if* $n < 1 + \frac{1}{\sqrt{1-\delta\alpha}}$ *and decreases in* n *if* $n \geq 1 + \frac{1}{\sqrt{1-\delta\alpha}}$.

Proof. Let $\delta_i = \delta$ for all i. Then, there is a unique and symmetric equilibrium under persistent recognition. Hence, $x_i^* = x^* > 0$ and $\overline{s}_i^* = \frac{1}{n}$. From the FOC (6), $\frac{f'(x^*)}{f(x^*)} \frac{n-1}{n^2} - c = 0$, or equivalently $\frac{f'(x^*)}{f(x^*)} = c\frac{n^2}{n-1}$. Since $\frac{f'(x^*)}{f(x^*)}$ is decreasing in x^*, and $\frac{n^2}{n-1}$ is increasing in n, x^* must decrease in n. To prove the second part, let $f(x_i) = x_i^\alpha$, with $\alpha \in (0,1]$. By Proposition 4, $\pi^{**} = 1 - \delta + \delta n c x^{**}$. Inserting this into (10) and solving for x^{**}, it follows that

$$x^{**} = \frac{(1-\delta)\alpha(n-1)}{cn[\delta\alpha + (1-\delta\alpha)n]}.$$

Slightly abusing algebra and differentiating x^{**} with respect to (integer) n, the desired result obtains. ■

To understand Proposition 8, note that an increase in the number of agents has both a recognition and a prize effect on individual incentives to propose. Under persistent recognition, both are negative; because with more participants in the bargaining, each agent's recognition probability and expected prize from proposing diminish. Under transitory recognition, while the recognition effect is still negative, the prize effect is positive. Inserting x^{**} from the proof into π^{**}, it follows that agents compete for a prize of $\pi^{**} = \frac{1-\delta}{1-\delta\alpha+\frac{\delta\alpha}{n}}$, which grows with n. The intuition is that anticipating a costly recognition process upon a disagreement, agents are willing to accept a smaller compensation for their votes, leaving a larger surplus to the proposer.[15] Hence, under transitory recognition, the overall impact of group size on individual incentives is ambiguous, as recorded in the second part of Proposition 8. Note that the source of this ambiguity is found in the dynamics of bargaining, as for $\delta = 0$, the model reduces to a one-shot rent-seeking contest where the winner receives a prize $\pi^{**} = 1$, and thus x^{**} is decreasing in n everywhere. Note also that the interval of

n in which an individual's incentive to propose increases widens as agents care more about the future, i.e., possess a higher δ, and competition to propose becomes more sensitive to effort, i.e., a higher α.

6 Conclusion

In this paper, I have examined situations featuring elements of both sequential bargaining and rent-seeking contests. The main finding of my investigation is that the distribution of surplus is more unequal when efforts are chosen once-and-for-all before the bargaining, as in committee assignments, than when they need to be renewed until an agreement, as in international negotiations and legal battles.

My analysis can be fruitfully extended in several dimensions. Perhaps the most important one is to consider voting rules other than the unanimity. It would also be interesting to let part of agents' efforts be productive as opposed to being pure social waste. Finally, it would be useful to allow agents' current efforts in recognition to have both persistent and transitory components.

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Notes

[1]For instance, whereas agents take turns in making offers in Rubinstein 1982, they are assigned fixed probabilities in Binmore's 1987 extension to random proposers.

[2]A classic work on Congressional committee assignments is due to Shepsle 1978. He emphasizes the significance of lobbying by congressmen in the form of writing letters, paying personal visits to members of their CC, and soliciting letters of recommendation from party leaders and state delegations in these assignments. More recent work on this subject includes Frisch and Kelly 2006, and Lee 2008.

[3]Baron and Ferejohn's 1989 seminal paper formalizes such legislative bargaining. See Knight 2005 for empirical evidence of committee power for the members of Congressional transportation committees.

[4]See Fairholm 1993 and Pfeffer 1994.

[5]See, for example, Farmer and Pecorino 1999, and Hirshleifer and Osborne 2001, who model a legal battle as a static rent-seeking contest, but ignore its dynamic bargaining nature.

[6]See also Anbarci, Skaperdas and Syropoulos 2002, who investigate efficiency under various bargaining solutions when agents can expend effort to influence their threat points.

[7]See, e.g., Clark and Riis 1998, and Skaperdas 1996.

[8]As is common in the literature, I assume that an agent accepts the offer whenever indifferent.

[9]Indeed, using (1) and canceling the term $\sum_k f(x_k)$ in $\overline{s}_i$, note that $v_i(\mathbf{e}) = \overline{p}_i(\mathbf{e}) - C(e_i)$, where $\overline{p}_i(\mathbf{e}) \equiv \frac{f(x_i)/(1-\delta_i)}{\sum_k f(x_k)/(1-\delta_k)}$. Hence, given the equilibrium of the bargaining stage, the effort stage of persistent recognition is strategically equivalent to a one-shot rent-seeking game, in which agent i wins with probability $\overline{p}_i(\mathbf{e})$ and the prize is 1. In this interpretation, the coefficient, $\frac{1}{1-\delta_i}$ is simply a productivity parameter for player i's effort, which is larger the more patient he is.

[10]See, for example, Lambert 2002.

[11]Consider, for instance, negotiations in an organization over the budget allocation. In one mode of bargaining, the organization designates an executive committee to make pro-

posals, where its members and their ranks are determined by an initial competition. In an alternative mode of bargaining, there is no such committee so that all members are allowed to promote their proposals.

[12]The fact that social cost is equal to the sum of one-time individual costs is by definition for persistent recognition, but it is so for transitory recognition due to immediate agreement at bargaining equilibrium.

[13]In a one-shot rent-seeking game with an exogenous prize, several researchers, e.g., Che and Gale 1998, have established that social cost increases as players become more symmetric.

[14]Such heterogeneity may be linked to members' ranks in the organization.

[15]In general, note from Proposition 4 that $\pi^{**} = 1 - \delta + \delta ncx^{**}$ for symmetric players, and clearly π^{**} increases with the social cost ncx^{**}.

References

Anbarci, N., Skaperdas, S. & Syropoulos, C. (2002). Comparing bargaining solutions in the shadow of conflict: how norms against threats can have real effects. *Journal of Economic Theory*, 106, 1-16.

Baron, D. & Ferejohn, J. (1989). Bargaining in legislatures. *American Political Science Review*, 83, 1181–1206.

Baron, D. & Kalai, E. (1993). The simplest equilibrium of a majority-rule division game. *Journal Economic Theory*, 61, 290–301.

Binmore, K. (1987). Perfect equilibria in bargaining models. In K. Binmore, P. Dasgupta (Eds.), *The economics of bargaining*, Basil Blackwell, Oxford, 77–105.

Board, S. & J. Zwiebel, J. (2005). Endogenous competitive bargaining. mimeo.

Che, Y.K. & Gale, I. (1998). Caps on political lobbying. *American Economic Review*, 88, 643–651.

Clark, D. & Riis, C. Contest success functions: an extension. *Economic Theory*, 11, 201-204.

Eraslan, H. (2002). Uniqueness of stationary equilibrium payoffs in the Baron–Ferejohn model. *Journal Economic Theory*, 103, 11–30.

Evans, R. (1997). Coalitional bargaining with competition to make offers. *Games and Economic Behavior*, 19, 211–220.

Fairholm, G. W. (1993). Organizational power politics: tactics in organizational leadership. Praeger, Westport, CT.

Farmer, A & Pecorino, P. (1999). Legal expenditure as a rent-seeking game. *Public Choice*, 100, 271-288.

Frisch, S. A. & Kelly, S. Q. (2006). Committee assignment politics in the U.S. house of representatives. University of Oklahoma Press.

Hirshleifer, J. & Osborne, E. (2001). Truth, effort, and the legal battle. *Public Choice*, 108, 169-195.

Knight, B. (2005). Estimating the value of proposal power. *American Economic Review*, 95, 1639-1652.

Konrad, K. (2009). Strategy and dynamics in contests. Oxford University Press.

Lambert, P. (2002). The distribution and redistribution of income. Manchester University Press.

Lee, D. (2008). Going once, going twice, sold! the committee assignment process as an all-pay auction. *Public Choice*, 135, 237-255.

McKelvey, R. & Palfrey, T. (1997). Endogeneity of alternating offers in a bargaining game. *Journal of Economic Theory*, 73, 425-437.

Merlo, A. & Wilson, C. (1995). A stochastic model of sequential bargaining with complete information. *Econometrica*, 63, 371-399.

Osborne, M. & Rubinstein, A. (1990). Bargaining and markets. Academic Press, San Diego, CA.

Perry, M. & Reny, P. (1993). A non-cooperative bargaining model with strategically timed offers. *Journal of Economic Theory*, 59, 50-77.

Pfeffer, J. (1994). Managing with power: politics and influence in organizations. Pittman, Marshfield, MA.

Rubinstein, A. (1982). Perfect equilibrium in a bargaining model. *Econometrica,* 50, 97–109.

Shepsle, K. (1978). The giant jigsaw puzzle: democratic committee assignments in the modern house. University of Chicago Press.

Skaperdas, S. (1996). Contest success functions. *Economic Theory*, 7, 283–290.

Szidarovski, F. & Okuguchi, K. (1997). On the existence and uniqueness of pure Nash equilibrium in rent-seeking games. *Games and Economic Behavior*, 18, 135–140.

Tullock, G. (1980). Efficient rent seeking. In Buchanan, J., Tollison, R., Tullock, G. (Eds.), *Toward a Theory of the Rent Seeking Society.* Texas A&M Univ. Press, College Station, TX, 97–112.

Yildirim, H. (2007). Proposal power and majority rule in multilateral bargaining with costly recognition. *Journal of Economic Theory*, 136, 167-196.

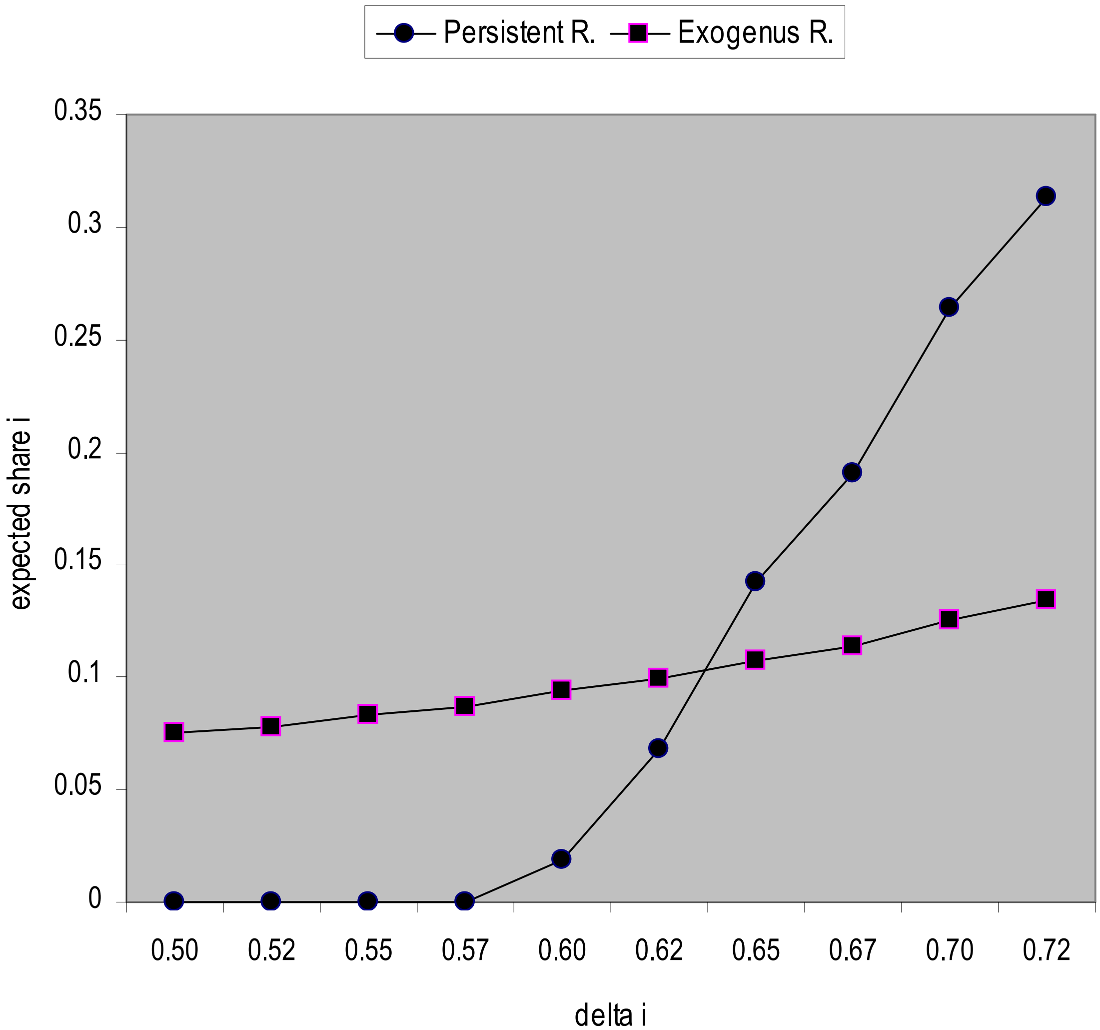

Fig. 1a Persistent versus exogenous recognition

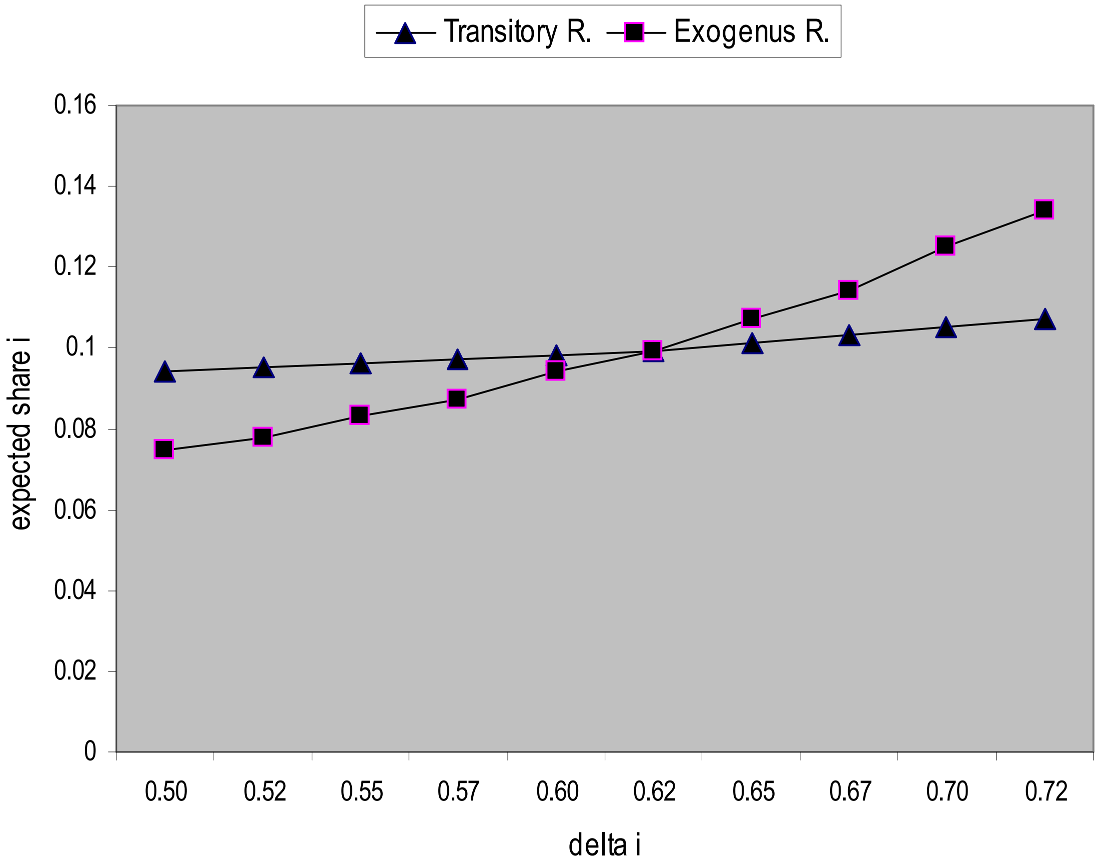

Fig. 1b Transitory versus exogenous recognition

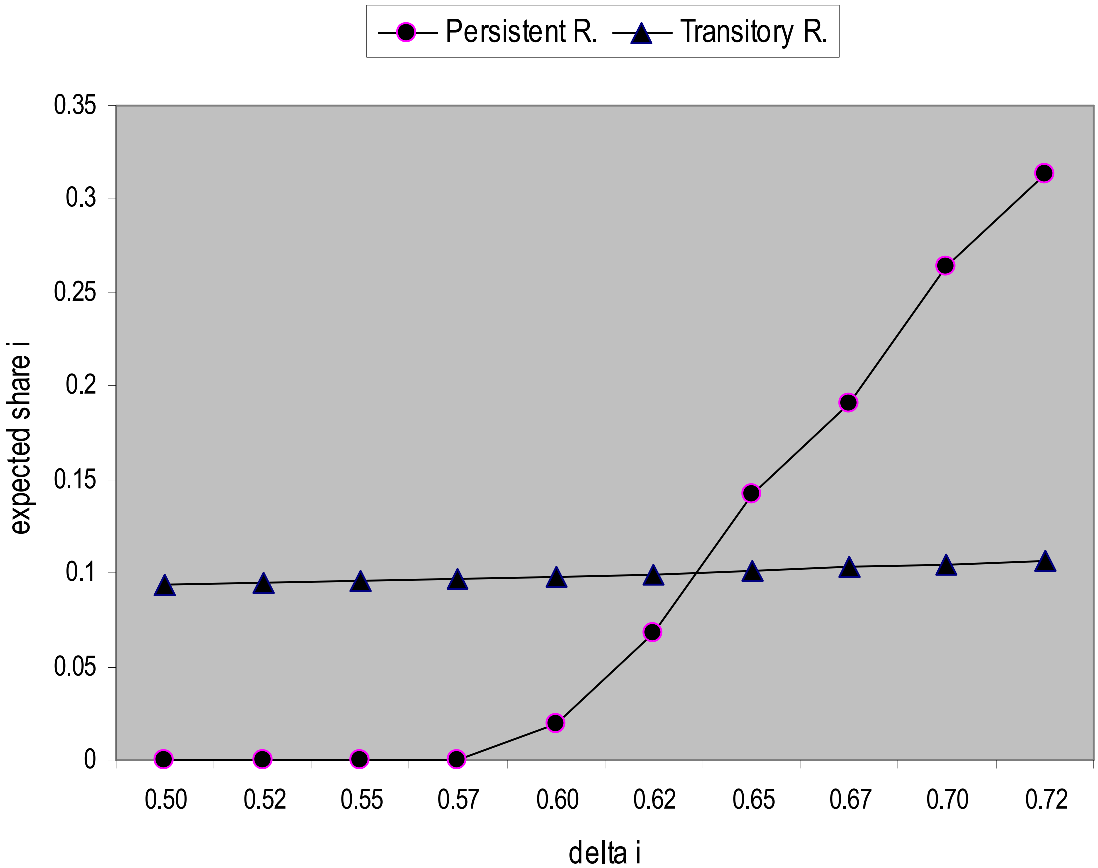

Fig. 1c Persistent versus transitory recognition