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CONSTITUTIONAL SECESSION CLAUSES*

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Taking the view that constitutions are devices whereby people coordinate to specific equilibria in circumstances that allow multiple equilibria, we show that a constitutional secession clause can serve as such a device and, therefore, that such a clause is more than an empty promise or an ineffectual threat. Employing a simple three-person recursive game, we establish that under certain conditions, this game possesses two equilibria—one in which a disadvantaged federal unit secedes and is not punished by the other units in the federation, and a second equilibrium in which this unit does not secede but is punished if it chooses to do so.

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I. Constitutional Commitment

Of all the provisions that might be part of federation's constitution, perhaps none are more controversial than those that implicitly or explicitly deal with secession. The conventional wisdom is that allowing secession weakens a state. As Cuss Sunstein (1991:634) argues, a constitutional right to secede "would increase the risks of ethnic and factional struggle; reduce the prospects for compromise and deliberation in government; raise dramatically the stakes of day-to-day political decisions; introduce irrelevant and illegitimate considerations into these decisions; create dangers of blackmail, strategic behavior, and exploitation; and, most generally, endanger the prospects for long-terms self-governance." As alternative ways to accommodate the demands of political subunits that might not otherwise agree to form or join a federation, we should not be surprised, then, to see instead arguments that defend nullification or veto clauses (Calhoun 1853, Buchanan and Tullock 1962) or, as with Yeltsin's initial proposal for a Russian constitution, over-representation of specific federal units in the legislature (*Izevstia*, 30

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April 1993). Just as the adoption of an implementable provision allowing secession is credited with hastening the demise of the Soviet Union (by way of encouraging the Baltic Republics to resist Moscow), a liberal constitutional secession clause would seem to promote a union destined for disintegration.

Defending such suppositions, though, takes us to the core of a theory of constitutions. Just as we might ask how a constitution or any of its provisions is enforced, we can ask: How would setting any prohibition or admission of secession to paper influence behavior? If a federal unit chooses whether or not to secede strictly on the basis of self-interest, how can a constitutional clause influence that interest? If that choice is itself a response to beliefs about the responses of others in the federation, who also act out of self-interest, then why would a secession clause influence their self-interest? Another way to formulate these questions is to consider Sunstein's (1991) argument that a constitutional provision prohibiting secession is best interpreted as an agreement whereby federal units pre-commit to strategies that preclude secession and that require punishing those who defect. The unanswered question here is: How are such agreements maintained, how can pre-commitments be binding, and why would a "parchment barrier" influence anything?

Game theory provides a partial answer to these questions. Specifically, agreements such as those embodied in a constitution are maintained if and only if the strategies implied by them are in equilibrium—if and only if no one has a unilateral incentive to defect from those strategies so as to make choices other than the ones prescribed by the agreements. Complications can be added by allowing coordinated defections or by allowing players to renegotiate agreements as a situation unfolds, but the essential idea is this: Constitutional provisions are self-enforcing if and only if abiding by them, including punishing those who defect, is in the self-interest of each participant when each participant assumes that everyone else will do the same.

However, even if agreeing to refrain from secession or agreeing to punish those who secede is sustainable as an equilibrium, we cannot say that setting such an agreement to paper influences anything. If such an agreement corresponds to a situation's unique equilibrium, then presumably that outcome would be realized regardless of the words a constitution contains. In this event, aside from arguing that a constitutional provision might reduce the likelihood of misperception and error, we would be unable to reject the hypothesis that a federation survives or fails merely as a product of self-interest and that the constitution is mere window dressing.

Suppose, on the other hand, that there is more than one equilibrium. The problem, now, is that unless the individual members of society somehow coordinate their actions, there is no guarantee that society will achieve any equilibrium or it will achieve an equilibrium other than one that everyone or nearly everyone prefers to avoid. What society requires, then, is a "device" that coordinates society by making a particular equilibrium a focal point—a device that establishes individual beliefs about the strategies that the different members of society will choose such that those beliefs and strategies become self-fulfilling prophesies.

Coordination to render a particular agreement a focal point need not be terribly difficult since the very act of negotiating an agreement can serve that purpose. However, if an issue is of lasting significance—if it concerns, say, the basic structure and procedures of the state as well as the state's legitimate domain—then society should be concerned that future generations coordinate as well and that agreements do not unravel. In this event, we can try to render a particular agreement and the corresponding equilibrium a more enduring focal point by expressing that agreement in explicit constitutional language. In this way, a constitutional bargain isolates a particular equilibrium and establishes expectations that people will choose strategies in accordance with it (Lewis 1969, Hardin 1989, Ordeshook 1992).

We can argue, then, that the beliefs a constitution seeks to establish influence choices only if we can show that the absence of any agreement or that a different agreement can yield different beliefs and, thus, a different outcome. Thus, with respect to the specific issue of secession, we must establish two things. First, we must show that in the event of a constitutional prohibition of secession that provides for the punishment of defecting subunits, the subunits of a federation would, in fact, punish one of their number were it to try to secede and that the threatened punishment is sufficient to keep subunits from seceding. Second, we must show that, barring such a prohibition—in effect, granting a constitutional right to secede—a different equilibrium can prevail; namely, one in which states secede without incurring any sanction. Put differently, to establish that constitutional prohibitions of secession or commitments to allow it can influence choices and outcomes, we must establish that there are at least two alternative equilibria, that without some means of coordination, society need not achieve either of these equilibria (or any equilibrium at all), and that alternative constitutional language can direct society to one or the other of these equilibria.

Of course, the existence of two or more equilibria is but a necessary condition for supposing that constitutional provisions can influence choices and outcomes. The mere existence of multiple equilibria, the necessity for coordination, and the possibility of drafting constitutional language consistent with one or the other of them does not establish that the constitution has in fact influenced anything. Coordination may arise from other sources (for example, religion), and a written document may merely be an affirmation or recording of outcomes that would prevail for these other reasons. Thus, we can argue here only that one can imagine circumstances in which a necessary condition for that influence—a necessary condition for constitutional provisions to be both decisive and self-enforcing—is satisfied.

Briefly, that argument consists of the construction of a simple three-person recursive game that allows federal units to secede and that confronts others with the choice of punishing or not punishing a unit that does so. We then establish that this game has at least two equilibria. In the first—which corresponds to a constitutional right to secede—a federal unit secedes only if it fails to receive a share of the benefits from federation that equals or exceeds what it can secure acting alone and the other units in the federation do not punish it for doing so in this circumstance. In the second equilibrium—which corresponds to a constitutional prohibition of secession—a subunit does not secede even though it may receive less than this share because it is punished if it defects. And since these equilibria coexist for a range of parameter values in our model, we infer that a constitution can coordinate the players to either equilibrium.

II. Preliminaries

Choosing a model that captures the processes surrounding secession is difficult since the analysis of federalism encompasses nearly all aspects of political-institutional design. Our purposes are served, however, by considering a simple possibility that focuses on what we believe are the core aspects of secession. Specifically, we want a model that admits of these considerations:

1. A federation that is "profitable" in the aggregate, so that subunits can earn more acting in concert than each can earn acting separately.
2. Benefits from federation that are not allocated among the subunits in a way that guarantees to each subunit what it might earn if it were to become a sovereign entity. Some subunits may earn less than what they can earn as a sovereign entity, and they may thereby regard themselves as disadvantaged by confederation.
3. The opportunity to punish subunits that try to secede by forcing them to remain in the federation, but with a reduced share of the benefits from confederation.
4. The absence of subunits that are sufficiently powerful to sustain the federation unilaterally.
5. Punishments that are costly to those who administer them.
6. A continual and ongoing threat of secession. There is never the "permanent" elimination of the possibility of secession owing to the creation of some new technology of confederation or binding commitment.

This last consideration—the continual threat of secession —warrants additional comment. The things with which constitutions deal are not single events that, once resolved, can be ignored thereafter. Constitutions treat problems and processes that persist over time and that cannot be resolved with a single choice—the maintenance of a separation of powers, of national defense, of a common domestic market, of civil liberties, and so on. Because a subunit can postpone secession and because an unsuccessful attempt at secession need not preclude a second attempt, any model of a constitution's role must be dynamic—it must view the situation as part of some ongoing process. A model that merely gives a subunit a one-time choice of seceding and not seceding and others a one-time choice of punishing and not punishing cannot be adequate for our purposes.

III. The Model

With the preceding six considerations in mind, suppose the federation consists of three subunits (our analysis can be generalized to larger federations in obvious ways), denoted by $I=\{1, 2, 3\}$. Next, suppose each subunit, $i \in I$, holds an initial resource endowment, π_i, which measures what it can secure in the event of the dissolution of the federation. However, because of economies of scale or other advantages of being in a larger unit, suppose the total payoff for all units if the federation is maintained is $\pi = K\sum_{i=1}^{3} \pi_i$, where, in accordance with consideration 1, $K > 1$.

Next, suppose subunit 1 can decide whether or not to secede at any stage of the federation's existence, so that its choice set is $S_1 = \{0, 1\}$, where 0 corresponds to "not secede" and 1 corresponds to "secede". If 1 chooses to secede, subunits 2 and 3 must then choose between punishing and not punishing 1, so their choice sets are $S_j = \{0, 1\}$, for $j = 2, 3$, where 0 corresponds to "not punish" and 1 corresponds to "punish".[1] Finally, in accordance with consideration 4, we assume that punishment maintains the federation only if both subunits punish an attempted secession. A unilateral decision to punish cannot thwart the seceding unit's intent, so if either subunit 2 or 3 fails to punish, the federation is dissolved. On the other hand, if 2 and 3 both choose to punish, the federation is preserved, at least temporarily.

Figure 1 shows the game tree that describes these choices.[2] But to this figure we have added dashed lines that indicate the way in which our model accommodates consideration 6. Specifically, if subunit 1 chooses not to secede, the game repeats itself so that 1 confronts the same choice of seceding versus not seceding in the next period. That is, choosing not to secede does not preclude the possibility that 1 will choose to secede at some later date. Similarly, if 1 chooses to secede and if subunits 2 and 3 choose to punish, the game again repeats. After incurring its punishment—a one-time reduction in payoff—subunit 1 is confronted again with the choice between seceding and not seceding. Only if 1 chooses to secede and 2 or 3 fail to punish is there no need to consider the issue of secession—the federation in this instance is dissolved.

1 We appreciate that a wholly general model allows any subunit to secede. But because our model is sufficient to illustrate the role of a constitutional secession clause, we prefer not to allow the attendant mathematical complexity to obscure this initial exploration of the potential influence of such a clause.

2 We use p_i in Figure 1 to denote the probability that subunit i chooses to secede or punish. But this notation is an analytic convenience since we only consider pure strategies. That is, in looking for equilibria, we only allow $p_i = 0$ or 1.

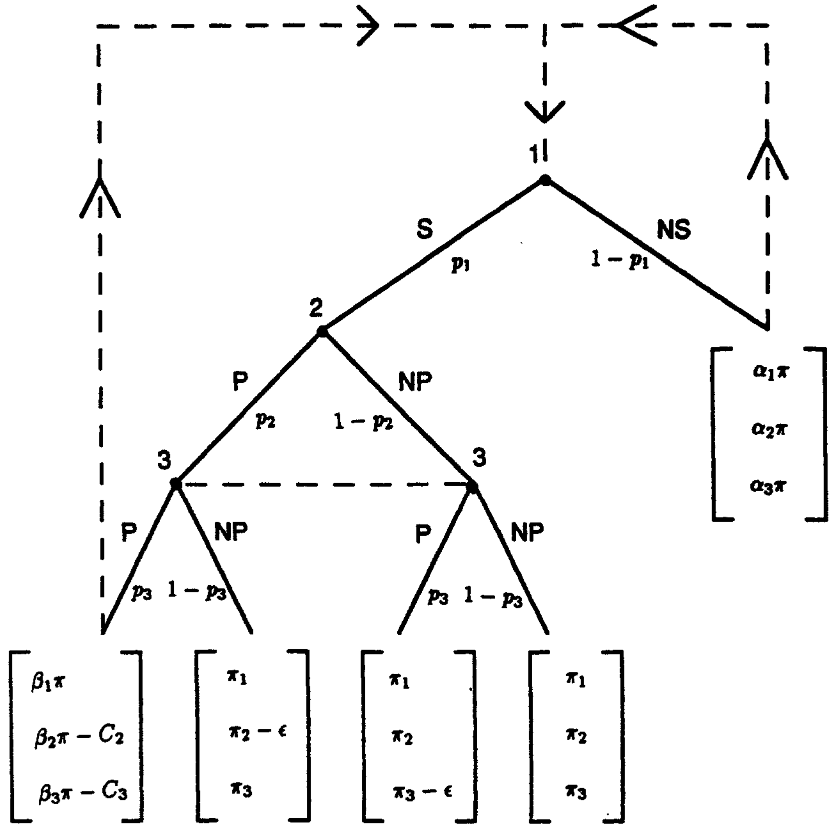

Figure 1. Three-Player Secession Game

Insofar as the payoffs entered in Figure 1 are concerned,

1. if subunit 1 does not secede, subunit i gets $\alpha_i\pi$ for that period and the game proceeds to the next period. Thus, α_i denotes subunit i's share of the total value of the federation;
2. if subunit 1 chooses secession and if 2 and 3 punish, the payoffs for that period are $\beta_1\pi$, $\beta_2\pi - C_2$ and $\beta_3\pi - C_3$ and the game repeats. Thus, in accordance with consideration 5, the punishing players incur a cost of punishment ($C_j > 0, j = 2, 3$) whereas the punishment itself is a one-period reallocation of the pie such that $\sum_{i=1}^{3} \beta_i = 1$, and $\beta_1 < \alpha_1$;

3. a unilateral decision to punish also yields some small cost, ϵ which we can suppose derives, for example, from the political costs of mobilizing public opinion to an ineffectual end;
4. finally, if subunits 2 or 3 choose not to punish, the federation dissolves, and each subunit gets its per-period endowment, π_i, forever.

Before proceeding, we should comment on alternative forms for this game, since we do not want to argue that the preceding game provides the best possible model of opportunities for secession and its consequences. First, to the extent that we allow $\alpha_i\pi > \pi_i$, it might appear that we are treating a federation that would not form in the first place and that we are not modeling federalism as much as we are empire. Second, notice that we fail to allow for the possibility of punishment when subunit 1 does not secede. Aside from whatever permanent disadvantage subunit 1 might incur from its inclusion in the federation as reflected by the payoff $\alpha_i\pi$, we do not permit subunits 2 and 3 to extract more in the short or long term. Thus, it might appear that we have removed one of the reasons why a subunit might choose to secede in the first place. In fact, both of these considerations can be addressed within the context of our model. The first can be treated by supposing that the federation pre-exists and that our analysis begins after some event has rearranged payoffs. Alternatively, we can suppose that, prior to forming a federation in which all subunits anticipate earning a net benefit, each must consider the possibility of a future in which they are disadvantaged. With respect to the matter of unprovoked punishments, permanent punishments can, of course, be incorporated into our configuration of payoffs. Nevertheless, we show later how such moves can be added explicitly to the analysis. Doing so only expands the set of equilibria from which states must choose and to which they can precommit, and thus, does not disturb the essential conclusions we reach with this simpler model.

IV. Analysis

Notice now that our model corresponds to a recursive game so that its solution requires specification of continuation values that are consistent with the choices of the different subunits. For example, if 1 chooses not to secede, then it gets $\alpha_1\pi$ in that period plus the value of playing the game further, say $\overline{v_1}$, discounted by one period. If it chooses to secede, but its actions are blocked by 2 and 3, then it gets $\beta_1\pi$ for that one period plus the discounted value of $\overline{v_1}$. And if it chooses to secede but 2 or 3 fail to punish, then it gets π_1 forever. Thus, we must solve for $\overline{v_1}$, as well as for $\overline{v_2}$ and $\overline{v_3}$, such that the choices implied by these values and by the other specified payoffs yield decisions that are consistent with these values—that is, these values must be self-fulfilling prophecies.

Because our game allows for infinite repetitions, it, like the repeated prisoners' dilemma, allows for an infinite variety of strategies. For example, subunit 1 could try to secede at every turn until it is punished, say, x times, at which point it abandons the idea of secession. Similarly, subunits 2 and 3 could select strategies that punish the first y attempts at secession, and then allow it thereafter. However, since we are interested in establishing the possibility of multiple equilibria, we consider only the simplest possibility, namely stationary strategies. Briefly, a stationary strategy is one that requires a player to make history-independent choices. Thus, with a stationary strategy, a player makes the same choice at any two equivalent decision nodes in the game's extensive form.[3] This restriction means, then, that the equilibria our analysis uncovers are, in all likelihood, only a small subset of the possible equilibria in our game. But this restriction also means that if a constitutional secession clause can influence outcomes in our analysis, then there is an even greater variety of possible influences than our analysis suggests directly.

With $\overline{v_i}$ representing the *value of the game* for subunit i, and using the usual definitions of an equilibrium, the strategy 3-tuple (p_1^*, p_2^*, p_3^*) is a stationary Nash equilibrium if and only if $v_i(p_i^*/p_{-i}^*) \geq v_i(1 - p_i^*/p_{-i}^*)$, and $\overline{v}_i = v_i(p_i^*|p_{-i}^*)$, where $p_i^* \in \{0, 1\}$ and $i = 1, 2, 3$. Next, let δ be the discount factor for all players (we avoid excessive subscripts by assuming that all subunits have the same discount factor). Then Proposition 1, which employs the following shorthand,

$$\Pi_j^b = \beta_j\pi - \frac{\pi_j}{1-\delta} + \frac{\delta}{1-\delta}\alpha_j\pi,$$

where $j = 2, 3$, establishes that our game has three stationary Nash equilibria.

3 See Myerson (1991) for precise definitions and Baron and Ferejohn (1989) and Niou and Ordeshook (1991) for an application of the ideas of continuation values and stationary strategies in a political context.

Proposition 1. For the infinitely repeated secession game, Table 1 describes the stationary Nash equilibria and their conditions.

Table 1: Stationary Nash Equilibria, Conditions and Aggregate Values

Equilibria	Subunit 1	Subunit 2	Subunit 3	Aggregate Values
(0, 0, 0)	$\alpha_1 \geq \frac{\pi_1}{\pi}$	-	-	$\sum_{i=1}^{3} \overline{v}_i = \frac{K\sum_i \pi_i}{1-\delta}$
(1, 0, 0)	$\alpha_1 < \frac{\pi_1}{\pi}$	-	-	$\sum_{i=1}^{3} \overline{v}_i = \frac{\sum_i \pi_i}{1-\delta}$
(0, 1, 1)	$\alpha_1 \geq \beta_1$	$C_2 < \Pi_2^b$	$C_3 < \Pi_3^b$	$\sum_{i=1}^{3} \overline{v}_i = \frac{K\sum_i \pi_i}{1-\delta}$

Notice now that the first two equilibria, (0, 0, 0) and (1, 0, 0), form a pair in which, regardless of 1's actions, subunits 2 and 3 do not punish, and subunit 1's decision depends solely on whether the benefits it derives from confederation are at least as great as what it can secure acting alone. Thus, these two equilibria together correspond to an agreement whereby secession is allowed whenever a subunit finds it in its self-interest to secede. Since the conditions under which either (0, 0, 0) or (1, 0, 0) is an equilibrium span the full range of parameter values (aside from the restriction on α_i, there are no other restrictions on parameters other than that costs are indeed costs), the existence of any additional equilibria point to the need for coordination in order to ensure the realization of any equilibrium. And, in fact, Proposition 1 establishes that there is such an equilibrium, (0, 1, 1), in which subunit 1's share, α_1, can be less than its proportionate share, $\frac{\pi_1}{\pi}$, but in which 1 is deterred from seceding owing to the threat of punishment.

These conclusions can be summarized formally by two corollaries that follow straightforwardly from the conditions set forth in Table 2 in the proof of Proposition 1 (see the Appendix). Briefly, this table establishes that each subunit has two thresholds in making a decision. Letting $M_1 = max\{\beta_1, \frac{\pi_1}{\pi}\}$ and $m_1 = min\{\beta_1, \frac{\pi_1}{\pi}$, whereas for $j = 2$ and 3 letting $M_j = max\{\Pi_j^a, \Pi_j^b\}$, $m_j = min\ \{\Pi_j^a, \Pi_j^b\}$, then,

Corollary 1. When $\alpha_1 \geq M_1$, $p_1 = 0$ is a dominant strategy for 1. When $\alpha_1 < m_1$, $p_1 = 1$ is a dominant strategy for 1. Similarly, for subunit 2 and 3, when $C_j \geq M_j$, $p_j = 0$ is a dominant strategy; when $C_j < m_j$, $p_j = 1$ is a dominant strategy, $j = 2, 3$.

Thus, if the conditions set forth in Corollary 1 are satisfied, a constitutional specification of secession rights cannot influence choices and outcomes. However, Corollary 2 identifies the conditions under which no dominant strategy exists so that (0, 1, 1) and (1, 0, 0) are stationary equilibria simultaneously.

Corollary 2. When $\alpha_1 \in (\beta_1, \frac{\pi_1}{\pi})$, $C_2 \in (0, \Pi_2^b)$, and $C_3 \in (0, \Pi_3^b)$, both (0, 1, 1) and (1, 0, 0) are equilibria to the secession game.

Before we conclude this section, though, we should see what happens if we allow subunits 2 and 3 to "punish" 1 even if 1 chooses not to secede. One approach is to append the "punish—do not punish" subgame to the right branch of the game in Figure 1 and to consider the equilibria that can prevail in this expanded game. Doing so would expand the set of equilibria to include things like "do not punish if 1 secedes, but punish if 1 does not secede." Complicating our model in this way, though, is unnecessary. Notice that such a subgame, taken in isolation from everything else, has two equilibria—(punish, punish) and (do not punish, do not punish). The (punish, punish) pair presumably yields the payoff vector $(\beta_1\pi, \beta_2\pi - C_2, \beta_3\pi - C_3)$ whereas the (do not punish, do not punish) pair yields $(\alpha_1'\pi, \alpha_2'\pi, \alpha_3'\pi)$. However, since we are considering only stationary strategies, we can suppose that one or the other of these vectors always prevails whenever player 1 does not secede. Thus, we can suppose that $\alpha_i\pi = \beta_i\pi$ or $\alpha_i'\pi$, depending on the equilibrium that prevails here. That is, rather than complicate the extensive form of our model, if we restrict the analysis to stationary strategies we can suppose that 2 and 3's decision to expropriate from 1 determines the relative values of the α's.

V. Conclusions

Corollary 2 establishes that there is at least one non-trivial circumstance under which a constitutional secession provision can influence eventual outcomes—when subunits, in Sunstein's (1991) terms, can credibly pre-commit to allow or prohibit secession and when a subunit's decision whether or not to secede depends on prior coordinating agreements.

Specifically, if $\alpha_1 < \frac{\pi_1}{\pi}$—if subunit 1 gets less than its security value from acting alone—but not if $\alpha_1 < \beta_1$—if 1's share does not become so low that it would actually gain from the punishment. Thus, there is a range of values of α_1 in which a subunit is disadvantaged and is thereby likely to demand a provision that allows for secession whereas, because they are advantaged in such a circumstance, the remaining subunits prefer a clause that prohibits secession.

Naturally, there are several extensions to our model that must be considered before we can use it to utter definitive conclusions about the influence of constitutional secession clauses. Although our analysis establishes the need for coordination, it cannot explain why a federation forms in the first place in the specific circumstance in which a constitution's coordination function is required—that circumstance being where one subunit is permanently disadvantaged. Of course, we can justify the present analysis by supposing that it does not model the circumstances that prevail when the federation is formed; rather, it models some future worst case scenario and that states are merely assessing their position in that scenario. Nevertheless, to fully accommodate federal formation requires that we allow federal subunits to change their strategies as the game proceeds—that is, we should consider non-stationary strategies that allow subunits to implement more sophisticated patterns of choices. In this way we can allow subunits, for example, to "occasionally" expropriate.

Second, we should allow some stochastic indeterminacy in the determination of payoffs in each period of play. We can then combine this extension with the first to consider constitutional provisions that allow for conditional secession. Taking James Buchanan's (1991) suggestion that constitutional secession clauses need not fit some unitary mode, we can explore the influence of clauses that allow secession, for example, if a subunit's rewards from confederation fall below some level for a pre-specified period of time. Finally, we should add an analysis of bargaining so that the allocation of federation resources, $(\alpha_1, \alpha_2, ..., \alpha_n)$, becomes an endogenous vector that can be reconfigured in each time period. This last extension would allow us to ascertain whether the form of a constitution's secession clause can influence eventual payoffs and in this way we can begin to understand the role of constitutions generally as determinants of political outcomes.

It is generally true, of course, that describing desirable extensions of a model is easier than actually implementing them. Of course, our analysis allows some reasonable guesses about things since the influence of parameters here conforms to intuition and since we can see no reason why that intuition would be contradicted by a more general analysis. For example, regardless of a model's ultimate form, no state should prefer a constitution that prohibits secession if it believes that it would be permanently disadvantaged in the federation. From 1's point of view the equilibrium (0, 1, 1) merely opens the door to exploitation whereas (-, 0, 0) ensures against this possibility. Unfortunately, our present model does not allow us to answer other questions about a secession clause's ultimate impact on outcomes—most notably those that concern the distribution of benefits. In a model with renegotiated terms of confederation [renegotiated values of $\alpha = (\alpha_1, \alpha_2, \ldots, \alpha_n)$ and stochastic shocks to α], does allowing secession force states to negotiate more equitable values of α or does the mere act of prohibiting secession force states, in equilibrium, to pre-commit to strategies whereby only wholly equitable distributions prevail?

In addition, predicting the types of strategy n-tuples that might exist in equilibrium in a more complicated model is difficult owing to the fact that in such a model, the assumption of stationarity is less palatable. In a simple model such as the one we offer here, this assumption probably does not exclude the most interesting possibilities. But in a model in which subunits are allowed to renegotiate distributions of resources or in which nature can intervene with random shocks, stationarity precludes demands for inter-temporal compensation or strategies that postpone secession until it is revealed that nature is biased against one subunit or another.

Nevertheless, such extensions, although desirable from the point of view of understanding the ultimate implications of a constitutional secession clause, are unlikely to undermine the central conclusion of this essay. Specifically, that conclusion is: the on-going processes of federalism occasion more than one equilibrium outcome, and at least two such outcomes correspond to a pre-commitment, embodied in the provisions of a constitution, allowing or prohibiting secession.

Appendix. Proof of Proposition 1

Proof: Denote the strategy set for subunit 1 as $\{S, \bar{S}\}$, which corresponds to "secede" and "not secede" respectively; and the strategy set for subunit 2 and 3 as $\{P, \bar{P}\}$, which corresponds to "punish" and "not punish'' respectively. Since we only consider pure stationary strategies, the values of the game for the three subunits are the maximum of the values of the respective strategies, which, defined recursively, are as follows,

$$\overline{v_1} = max\{v_1(S), v_1(\tilde{S})\}$$

$$= max\{p_2 p_3(\beta_1\pi + \delta\overline{v_1}) + (1 - p_2 p_3)\frac{\pi_1}{1 - \delta}, \alpha_1\pi + \delta\overline{v_1}\},$$

$$\overline{v_j} = max\{v_j(P), v_j(\tilde{P})\}$$

$$= max\{p_1 p_k(\beta_j\pi - C_j + \delta\overline{v_j}) + p_1(1 - p_k)(\frac{\pi_j}{1 - \delta} - \epsilon) + (1 - p_1)(\alpha_j\pi + \delta\overline{v_j}),$$

$$p_1\frac{\pi_j}{1 - \delta} + (1 - p_1)(\alpha_j\pi + \delta\overline{v_j})\}$$

where j, k = 2, 3, and $j \neq k$.

Applying the definition of a stationary Nash equilibrium, subunit 1 chooses to secede (p_1 = 1) if and only if the value of seceding ($v_1(S)$) is greater than the value of not seceding ($v_1(\tilde{S})$) whereby the value of the game for subunit 1 ($\overline{v_1}$) is the value of not seceding; subunit 1 chooses not to secede (p_1 = 0) if and only if the opposite conditions hold. Similarly, subunit j (j=2, 3) chooses to punish (p_j= 1) if and only if the value of punishing ($v_j(P)$) is greater than the value of not punishing ($v_j(\tilde{P})$) whereby the value of the game ($\overline{v_j}$) is the value of punishing; subunit j chooses not to punish (p_j=0) if and only if the opposite conditions hold. Formally,

$$p_1 = 1 \leftrightarrow \begin{cases} v_1(S) > v_1(\tilde{S}) \\ \overline{v_1} = v_1(S), \end{cases}$$

$$p_1 = 0 \leftrightarrow \begin{cases} v_1(S) \leq v_1(\tilde{S}) \\ \overline{v_1} = v_1(\tilde{S}), \end{cases}$$

$$p_j = 1 \leftrightarrow \begin{cases} v_j(P) > v_j(\tilde{P}) \\ \overline{v_j} = v_j(P), \end{cases}$$

$$p_j = 0 \leftrightarrow \begin{cases} v_j(P) \leq v_j(\tilde{P}) \\ \overline{v_j} = v_j(\tilde{P}), \end{cases}$$

where $j = 2, 3$. Simplifying these conditions,

$$p_1 = 1 \leftrightarrow p_2 p_3 \beta_1 \pi + (1 - p_2 p_3) \frac{\pi_1}{1 - \delta} > \frac{1 - p_2 p_3 \delta}{1 - \delta} \alpha_1 \pi, \quad (1)$$

$$p_1 = 1 \leftrightarrow p_2 p_3 \beta_1 \pi + (1 - p_2 p_3) \frac{\pi_1}{1 - \delta} \leq \frac{1 - p_2 p_3 \delta}{1 - \delta} \alpha_1 \pi, \quad (2)$$

$$p_j = 1 \leftrightarrow p_k \beta_j \pi + \frac{p_k \delta (1 - p_1) \alpha_j \pi}{1 - \delta + \delta p_1} - \frac{p_k \pi_j}{1 - \delta + \delta p_1} - (1 - p_k)\epsilon > p_k C_j, \quad (3)$$

$$p_j = 0 \leftrightarrow p_k \beta_j \pi + \frac{p_k \delta (1 - p_1) \alpha_j \pi}{1 - \delta + \delta p_1} - \frac{p_k \pi_j}{1 - \delta + \delta p_1} - (1 - p_k)\epsilon \leq p_k C_j, \quad (4)$$

where $j, k = 2, 3$ and $j \neq k$. Note that since we do not consider mixed strategies, we assume that $i \in I$ chooses $p_i = 0$ when it is indifferent between $p_i = 0$ and $p_i = 1$. Substituting $p_i = 0$ or 1 in (1), (2), (3) or (4), there are eight possible cases, described in Table 2 along with the conditions required for them to be stationary Nash equilibria. We employ the following shorthand in Table 2:

Table 2. Eight Possible Cases and Conditions Required to Be Equilibria

Possible Cases	Subunit 1	Subunit 2	Subunit 3
(0, 0, 0)	$\alpha_1 \geq \frac{\pi_1}{\pi}$	$\epsilon \geq 0$	$\epsilon \geq 0$
(0, 1, 0)	$\alpha_1 \geq \frac{\pi_1}{\pi}$	$\epsilon < 0$	$C_3 \geq \Pi_3^b$
(0, 0, 1)	$\alpha_1 \geq \frac{\pi_1}{\pi}$	$C_2 \geq \Pi_2^b$	$\epsilon < 0$
(0, 1, 1)	$\alpha_1 \geq \beta_1$	$C_2 < \Pi_2^b$	$C_3 < \Pi_3^b$
(1, 0, 0)	$\alpha_1 < \frac{\pi_1}{\pi}$	$\epsilon \geq 0$	$\epsilon \geq 0$
(1, 1, 0)	$\alpha_1 < \frac{\pi_1}{\pi}$	$\epsilon < 0$	$C_3 \geq \Pi_3^a$
(1, 0, 1)	$\alpha_1 < \frac{\pi_1}{\pi}$	$C_2 \geq \Pi_2^a$	$\epsilon < 0$
(1, 1, 1)	$\alpha_1 < \beta_1$	$C_2 < \Pi_2^a$	$C_3 < \Pi_3^a$

$\Pi_j^a = \beta_j\pi - \pi_j$, and $\Pi_j^b = \beta_j\pi - \frac{\pi_j}{1-\delta} + \frac{\delta}{1-\delta}\alpha_j\pi$, where $j = 2, 3$.

From this table we can see that (0, 1, 0), (0, 0, 1), (1, 1, 0), (1, 0, 1) and (1, 1, 1) cannot be stationary equilibria since otherwise we must contradict the assumption that $\epsilon > 0$, and $\alpha_1 \geq \beta_1$. Therefore, the only equilibria are (0, 0, 0), (0, 1, 1) and (1, 0, 0). **Q.E.D.**

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