Online Appendix

A Supporting Information for Baseline Model

Table A.1: Summary of Parameters and Choice Variables

Stage	Variables/description
Primitives	• G: government • C: regional challenger • δ: discount factor • t: time
1. Distribution of power stage	• σ: Probability C is strong in any period t in the s.q. territorial regime
2. Taxation stage	• τ_t: G's proposed tax rate
3. Fighting decision stage	• p: C's probability of winning if it initiates a war in a strong period
4. Labor supply stage	• L_t: C's formal-sector labor supply • $\theta(\cdot)$: formal-sector production function • η: formal-sector output elasticity • $\kappa(\cdot)$: opportunity cost, from foregoing informal-sector production, of supplying formal-sector labor • ω: parameterizes opportunity cost of formal-sector labor (higher $\omega \implies$ higher labor elasticity)
Continuation values	• $V^G_{\text{s.q.}}$: G's future continuation value in the s.q. territorial regime • $V^C_{\text{s.q.}}$: C's future continuation value in the s.q. territorial regime • V^C_{sec}: C's future continuation value in the secession subgame
Parameters in greed extensions	• ϕ: Percentage of C's formal-sector production destroyed in the period of a separatist civil war • x: Percentage of C's formal-sector production (not destroyed by the war) that accrues to G • R: Value to C of simple revolt option • Y^C: value of formal-sector output • $\frac{Y^C}{b}$: value of formal-sector output in bust periods • γ: frequency of boom periods

A.1 Equilibrium Existence

A Markov Perfect Equilibrium (MPE) requires players to choose best responses to each other, with strategies predicated upon the state of the world and on actions within the current period. Three types of periods compose the three values of the state variable μ_t in a generic period t. If C is strong in period t, then $\mu_t = \mu^s$. If C is weak in period t, then $\mu_t = \mu^w$. If C won a civil war in a previous period, then $\mu_t = \mu^0$. The superscripts respectively stand for "strong," "weak," and "0 taxation after secession."

If $\mu_t \in \{\mu^s, \mu^w\}$, then G's strategy is a function $\tau(\cdot)$ that assigns a tax rate to each state. Formally, $\tau : \{\mu^s, \mu^w\} \rightarrow [0,1]$, and τ^*_s and τ^*_w represent equilibrium choices. If $\mu_t = \mu^0$, then τ_t is fixed at 0 by assumption. C's strategy consists of two functions, $\alpha(\cdot)$ and $L(\cdot)$, that respectively assign an acceptance/fighting decision and a formal-sector labor supply to each state of the world and to G's current-period choice of τ_t. Formally, $\alpha : \{\mu^s\} \times [0,1] \rightarrow [0,1]$, and α^* represents the equilibrium probability of acceptance term. Additionally, $L : \Big(\{\mu^s, \mu^w\} \times [0,1]\Big) \cup \{\mu^0\} \rightarrow \mathbb{R}_+$, and L^*_s, L^*_w, and L^*_0 represent equilibrium choices. An MPE is a strategy profile $\left\{\tau_s^*, \tau_w^*, L_s^*, L_w^*, L_0^*, \alpha^*\right\}$ such that G's and C's strategies compose best responses to each other. An MPE strategy profile is peaceful if $\alpha^* = 1$.

Proof of Lemma 1. C solves:

$$L^*(\tau_t) \in \arg\max_{L_t \geq 0} \; (1-\tau_t)\cdot\theta(L_t) - \kappa(L_t)$$

For expositional clarity, I will solve this as an unconstrained optimization problem and then verify that the constraint $L_t \geq 0$ is satisfied. Because $\theta(L_t)$ is strictly concave in L_t and $\kappa(L_t)$ is strictly convex in L_t (which can easily be verified by computing the second derivatives), the objective function is strictly concave in L_t. This implies that the solution to the first-order condition is the unique maximizer. The first order condition implicitly defines L^*:

$$(1-\tau_t)\cdot\frac{\partial\theta(L^*)}{\partial L_t} - \frac{\partial\kappa(L^*)}{\partial L_t} = 0$$

Substituting in $\frac{\partial\theta(L_t)}{\partial L_t} = \eta\cdot L_t^{\eta-1}$ and $\frac{\partial\kappa(L^*)}{\partial L_t} = L_t^{\frac{1}{\omega}}$ yields:

$$\underbrace{(1-\tau_t)\cdot\eta\cdot L_t^{\eta-1}}_{\text{MB}} = \underbrace{L_t^{\frac{1}{\omega}}}_{\text{MC}}$$

This solves to:

$$L^*(\tau_t) = \Big[(1-\tau_t)\cdot\eta\Big]^{\frac{\omega}{1+\omega\cdot(1-\eta)}} \tag{A.1}$$

Finally, $L^*(\tau_t) \geq 0$ for all τ_t because $\tau_t \leq 1$ and $\eta > 0$ by assumption. The consumption terms stated in Lemma 1 follow directly. ■

Lemma A.1 formalizes the claim from the text that the results would be unchanged if residents of the region independently make labor allocation decisions after the rebel leader makes a decision to fight or not.

Lemma A.1. *If $N \in \mathbb{Z}_{++}$ residents independently choose how much labor to supply, then total labor allocation in the unique symmetric equilibrium is identical to the case considered in the text of a single leader among C choosing the labor allocation.*

Proof. Assume $\theta(\cdot)$ and $\kappa(\cdot)$ are each a function of average labor input. Therefore, a generic resident i solves:

$$\max_{L_i \geq 0} \; (1-\tau_t)\cdot\left(\frac{L_i + \sum_{N\setminus\{i\}} L_j}{N}\right)^{\eta} - \frac{\omega}{1+\omega}\cdot\left(\frac{L_i + \sum_{N\setminus\{i\}} L_j}{N}\right)^{\frac{1+\omega}{\omega}}$$

Denote the per-person equilibrium labor supply as L^* and the average equilibrium labor supply as $\overline{L}^* \equiv \frac{\sum_N L^*}{N}$. Solving the first-order condition yields:

$$(1-\tau_t)\cdot\eta\cdot\frac{1}{N}\cdot\left(\overline{L}^*\right)^{-(1-\eta)} = \frac{1}{N}\cdot\left(\overline{L}^*\right)^{\frac{1}{\omega}}$$

This yields the same average labor supply function in the text:

$$\overline{L}^*(\tau_t) = \Big[(1-\tau_t)\cdot\eta\Big]^{\frac{\omega}{1+\omega\cdot(1-\eta)}}$$ ■

The following lemma will be used to prove Lemma 2.

Lemma A.2. *If $a \in (0,1)$, then $f(\tau) = \tau \cdot (1-\tau)^a$ is strictly concave in τ over $\tau \in (0,1)$.*

Proof. It suffices to show that the second derivative is strictly negative. $f' = (1-\tau)^a - \tau \cdot a \cdot (1-\tau)^{a-1}$ and $f'' = -a \cdot (1-\tau)^{a-2} \cdot \big[2\cdot(1-\tau) + \tau\cdot(1-a)\big]$. This term is strictly negative if $a \in (0,1)$ and $\tau \in (0,1)$. ■

Proof of Lemma 2. Solving backwards on the stage game, Equation 2 characterizes C's optimal labor supply function. G solves:

$$\overline{\tau} \in \arg\max_{\tau_t\in[0,1]} \tau_t \cdot \theta\big(L^*(\tau_t)\big)$$

For expositional clarity, I will solve this as an unconstrained optimization problem and then verify that the constraint $\tau_t \in [0,1]$ is satisfied. After substituting in functional forms, this objective function is equivalent to:

$$\overline{\tau} \in \arg\max_{\tau_t\in[0,1]} \tau_t \cdot \Big[(1-\tau_t)\cdot\eta\Big]^{\frac{\omega\cdot\eta}{1+\omega\cdot(1-\eta)}}$$

Because $\omega \in (0,1)$ and $\eta \in (0,1)$, $\frac{\omega\cdot\eta}{1+\omega\cdot(1-\eta)} \in (0,1)$. Furthermore, $\eta^{\frac{\omega\cdot\eta}{1+\omega\cdot(1-\eta)}} > 0$. Therefore, invoking Lemma A.2 implies that the objective function is strictly concave in τ_t, which implies that the solution to the first-order condition is the unique maximizer.

The first-order condition solves to:

$$\Big[(1-\overline{\tau})\cdot\eta\Big]^{\frac{\omega\cdot\eta}{1+\omega(1-\eta)}} \cdot \Bigg[1 - \overline{\tau}\cdot\Big(1 - \frac{\omega\cdot\eta}{1+\omega(1-\eta)}\Big)\Bigg] = 0 \tag{A.2}$$

Rearranging yields:

$$\overline{\tau} = \frac{1+\omega\cdot(1-\eta)}{1+\omega}$$

Because $\omega > 0$ and $\eta < 1$ by assumption, $\overline{\tau} > 0$. Because additionally $\eta > 0$ by assumption, $\overline{\tau} < 1$. ■

Definition A.1 characterizes a minimum discount rate for C to credibly separate in a strong period in reaction to an offer $\tau_t = \overline{\tau}$ in every period in the status quo territorial regime. Sufficient patience is necessary because C does not reap the expected gains of fighting until the future. It is possible to explicitly solve for δ because none of the optimal choice variables included in Definition A.1 are a function of δ.

Definition A.1 (Lower bound discount rate for credible fighting threat)**.**

$$\underline{\delta}_C \equiv \frac{(1-\overline{\tau})\cdot\theta(\overline{L}) - \kappa(\overline{L})}{p\cdot\Big\{\big[\theta(L_0^*) - \kappa(L_0^*)\big] - \big[(1-\overline{\tau})\cdot\theta(\overline{L}) - \kappa(\overline{L})\big]\Big\}}$$

Definition A.2 revises Equation 3 to characterize the current-period tax offer in a strong period that makes C indifferent between accepting and fighting, holding fixed future equilibrium values. This offer is unique because $\Psi(\tau_t)$ strictly decreases in τ_t, which can be shown by applying the envelope theorem to C's consumption function. It is only possible to have $\Psi(\tau_t) = 0$ if $\delta > \underline{\delta}_C$.

Definition A.2 (Indifference condition for current-period tax rate)**.**

$$\Psi(\tau_t) \equiv (1 - \tau_t) \cdot \theta\big(L^*(\tau_t)\big) - \kappa\big(L^*(\tau_t)\big)$$

$$+\frac{\delta \cdot p}{1-\delta} \cdot \Big\{\sigma \cdot \Big[(1-\tau_s^*) \cdot \theta(L_s^*) - \kappa(L_s^*)\Big] + (1-\sigma) \cdot \Big[(1-\overline{\tau}) \cdot \theta(\overline{L}) - \kappa(\overline{L})\Big]\Big\}$$

$$-\frac{\delta \cdot p}{1-\delta} \cdot \Big[\theta(L_0^*) - \kappa(L_0^*)\Big] = 0$$

The proof of Lemma 3 begins by defining C's optimal acceptance function and G's optimization problem for τ_t, and proving that three cases partition the parameter space. In the first two cases, a peaceful path of play is possible in equilibrium. Case 1 characterizes optimal actions if G can induce acceptance from C in a strong period by offering $\tau_t = \overline{\tau}$. Case 2 characterizes optimal actions if G cannot induce acceptance from C in a strong period by offering $\tau_t = \overline{\tau}$ but there do exist $\tau_t > 0$ such that G can induce acceptance. Case 3 characterizes optimal actions if a peaceful path of play is not possible in equilibrium.

Proof of Lemma 3.

Preliminaries. Solving backwards on the stage game if $\mu_t = \mu^s$, Equation 2 characterizes C's unique optimal labor supply function. For the fighting decision stage, recall that $\alpha(\tau_t)$ denotes C's probability of acceptance given the period t proposed tax rate if the continuation values specify acceptance in all future periods. Any equilibrium must satisfy:

$$\alpha(\tau_t) = \begin{cases} 0 & \Psi(\tau_t) < 0 \\ [0,1] & \Psi(\tau_t) = 0 \\ 1 & \Psi(\tau_t) > 0, \end{cases} \tag{A.3}$$

for $\Psi(\tau_t)$ defined in Definition A.2. C cannot profitably deviate to $\alpha(\tau_t) > 0$ if $\Psi(\tau_t) < 0$, or to $\alpha(\tau_t) < 1$ if $\Psi(\tau_t) > 0$.

If G chooses τ_t to buy off C, it solves:

$$\max_{\tau_t \in [0,1]} \tau_t \cdot \Big[(1-\tau_t) \cdot \eta\Big]^{\frac{\omega \cdot \eta}{1+\omega \cdot (1-\eta)}} + \delta \cdot V^G_{\text{s.q.}} \text{ s.t. } \Psi(\tau_t) \geq 0 \tag{A.4}$$

This optimization problem posits a single deviation for G from the posited equilibrium strong-period tax offer τ_s^* because τ_s^* is assumed fixed in future periods, a term subsumed into the continuation value $V^G_{\text{s.q.}}$ and into $\Psi(\tau_t)$. Equation A.4 can be written as a Lagrangian with an inequality constraint. Because the optimal strong-period tax rate is interior for the same reasons as shown in Lemma 2, I ignore the boundary constraints on the tax rate to avoid notational clutter. Defining the Lagrange multiplier on the inequality as λ, the first-order condition enables implicitly solving for τ_s^*:

$$\Big[(1-\tau_s^*) \cdot \eta\Big]^{\frac{\omega \cdot \eta}{1+\omega(1-\eta)}} \cdot \Big[1 - \tau_s^* \cdot \Big(1 - \frac{\omega \cdot \eta}{1+\omega(1-\eta)}\Big) - \lambda\Big] = 0,$$

This term is nearly is identical to Equation A.2. The difference arises from the multiplier λ, and that part of the expression results from applying the envelope theorem to C's consumption function. This simplifies to the first KKT condition:

$$(1)\quad \lambda^* = 1 - \tau_s^* \cdot \left(1 - \frac{\omega \cdot \eta}{1 + \omega(1-\eta)}\right)$$

The other KKT conditions are:

$$(2)\ \lambda^* \cdot \Psi^*(\tau_s^*) = 0, \quad (3)\ \lambda^* \geq 0, \quad (4)\ \Psi^*(\tau_s^*) \geq 0,$$

which follows from substituting in the equilibrium term $\tau_t = \tau_s^*$ and modifying the definition of $\Psi(\cdot)$ in Definition A.2 to define:

$$\Psi^*(\tau_s^*) \equiv (1-\tau_s^*) \cdot \theta(L_s^*) - \kappa(L_s^*) + \frac{\delta \cdot p}{1-\delta} \cdot \left\{\sigma \cdot \left[(1-\tau_s^*) \cdot \theta(L_s^*) - \kappa(L_s^*)\right] + (1-\sigma) \cdot \left[(1-\overline{\tau}) \cdot \theta(\overline{L}) - \kappa(\overline{L})\right]\right\}$$
$$- \frac{\delta \cdot p}{1-\delta} \cdot \left[\theta(L_0^*) - \kappa(L_0^*)\right] = 0$$

Three cases generically partition the parameter space:

1. $\Psi^*(\overline{\tau}) > 0$
2. $\Psi^*(\overline{\tau}) < 0 < \Psi^*(0)$
3. $\Psi^*(0) < 0$

Cases 1 and 2 feature peaceful bargaining in equilibrium. Applying the envelope theorem to C's consumption function establishes that $\Psi^*(\tau_s^*)$ strictly decreases in τ_s^*, which implies that these cases partition the parameter space.

Case 1. $\boldsymbol{\Psi^*(\overline{\tau}) > 0}$. Need to show that if $\Psi^*(\overline{\tau}) > 0$, then $\tau_s^* = \overline{\tau}$. First, prove $\tau_s^* = \overline{\tau}$ is a solution. If $\Psi^*(\overline{\tau}) \geq 0$ and $\tau_s^* = \overline{\tau}$, then the fourth KKT condition is trivially satisfied. Substituting the term for $\overline{\tau}$ from Equation 5 into the first KKT condition yields $\lambda^* = 0$, which also trivially satisfies the second and third KKT conditions.

Second, prove $\tau_s^* = \overline{\tau}$ is the unique solution by generating contradictions for alternative candidate solutions.

- Any $\tau_s^* > \overline{\tau}$ cannot be a solution. λ^*, as defined in KKT condition 1, is a strictly decreasing function of τ_s^*. Because $\lambda^* = 0$ for $\tau_s^* = \overline{\tau}$, the first KKT condition implies $\lambda^* < 0$ for any $\tau_s^* > \overline{\tau}$, which violates the third KKT condition. (For high enough τ_s^*, C may reject the offer. This does not alter the proof, however, because it is not incentive-compatible for G to offer $\tau_s^* > \overline{\tau}$ and experience fighting rather than to consume maximum revenues in every period.)
- If $\Psi^*(\overline{\tau}) = 0$, then $\tau_s^* = \overline{\tau}$ is a solution (see above), and it is unique because the strict monotonicity of $\Psi^*(\tau_s^*)$ implies that any solution is unique.
- If $\Psi^*(\overline{\tau}) > 0$, then any $\tau_s^* < \overline{\tau}$ cannot be a solution. KKT condition 1 shows that $\lambda^* > 0$ for any $\tau_t < \overline{\tau}$. Furthermore, because Ψ^* strictly decreases in τ_s^*, if $\Psi^*(\overline{\tau}) > 0$ and $\tau_s^* < \overline{\tau}$, then $\Psi^*(\tau_s^*) > 0$. Having both $\lambda^* > 0$ and $\Psi^*(\tau_s^*) > 0$ violates the second KKT condition.

Case 2. $\boldsymbol{\Psi^*(\overline{\tau}) < 0 < \Psi^*(0)}$. I will further disaggregate this case into four parts. Part 1 solves for the offer $\tau_t = \tau_s^*$ such that $\Psi^*(\tau_s^*) = 0$. Part 2 shows that C does not have a profitable deviation from playing $\alpha(\tau_s^*) = 1$, i.e., accepting with probability 1 the strong-period offer that makes it indifferent between accepting and fighting. Part 3 shows that no equilibrium exists in which $\alpha(\tau_s^*) < 1$, i.e., there is no equilibrium in which C rejects with positive probability an offer that makes it indifferent between accepting and fighting. Part 4 shows that G cannot profitably deviate from offering $\tau_t = \tau_s^*$.

Part 1. Need to show that if $\Psi^*(\overline{\tau}) < 0 < \Psi^*(0)$, then there exists a unique $\tau_s^* \in (0, \overline{\tau})$ such that $\Psi^*(\tau_s^*) = 0$. If $\Psi^*(\overline{\tau}) < 0$, then only τ_s^* such that $\tau_s^* < \overline{\tau}$ can possibly satisfy the fourth KKT condition from the optimization problem in Equation A.4. The first KKT condition implies for any $\tau_s^* < \overline{\tau}$ that $\lambda^* > 0$ (which trivially satisfies the third KKT condition). This in turn implies that only τ_s^* such that $\Psi^*(\tau_s^*) = 0$ satisfy the second KKT condition (which also trivially satisfies the fourth KKT condition). Applying the intermediate value theorem demonstrates the existence of at least one $\tau_s^* \in (0, \overline{\tau})$ such that $\Psi^*(\tau_s^*) = 0$.

- We are currently assuming $\Psi^*(\overline{\tau}) < 0$.
- We are currently assuming $\Psi^*(0) > 0$.
- $L^*(\tau_t)$ is a continuous function and $\theta(\cdot)$ is assumed continuous in L_t. Therefore, $\Psi^*(\cdot)$ is continuous in τ_s^*.

Furthermore, the strict monotonicity of $\Psi^*(\cdot)$ in τ_s^* implies the τ_s^* that satisfies all four KKT conditions is unique.

Part 2. Follows immediately from Equation A.3 and from defining τ_s^* as the solution to $\Psi^*(\tau_s^*) = 0$.

Part 3. I will demonstrate that there does not exist an equilibrium strategy profile in which $\alpha(\tau_s^*) < 1$ by generating a contradiction. If $\alpha(\tau_s^*) < 1$, then a peaceful equilibrium strategy profile requires offering some $\tau_t > \tau_s^*$ (see the definition of a peaceful equilibrium strategy profile above when defining the equilibrium concept, and Equation A.3). Modifying Equation A.4, G therefore chooses:

$$\max_{\tau_t \in [0,1]} \tau_t \cdot \Big[(1 - \tau_t) \cdot \eta\Big]^{\frac{\omega \cdot \eta}{1 + \omega \cdot (1 - \eta)}} + \delta \cdot V^G_{\text{s.q.}} \text{ s.t. } \Psi(\tau_t) > 0$$

The strict inequality on the constraint generates an open set problem that yields a profitable deviation for G from any τ_t such that $\tau_t > \tau_s^*$.

Part 4. Combining Equation A.3 and Part 3 establishes that the only possible equilibrium acceptance functions for C involve acceptance with probability 1, if $\tau_t \geq \tau_s^*$, or acceptance with probability 0, if $\tau_t < \tau_s^*$. If it is possible to induce acceptance, i.e., if $\Psi^*(\overline{\tau}) < 0 < \Psi^*(0)$, then G cannot profitably deviate to making an unacceptable offer $\tau_t > \tau_s^*$ if:

$$\tau_s^* \cdot \Big[(1 - \tau_s^*) \cdot \eta\Big]^{\frac{\omega \cdot \eta}{1 + \omega \cdot (1 - \eta)}} + \delta \cdot V^G_{\text{s.q.}} \geq \delta \cdot \Big[p \cdot V^G_{\text{sec}} + (1 - p) \cdot V^G_{\text{s.q.}}\Big],$$

which is true because $V^G_{\text{s.q.}} > V^G_{\text{sec}}$. The proof of Case 2 shows G will not deviate to choosing $\tau_t < \tau_s^*$.

Case 3. $\Psi^*(0) < 0$. I will further disaggregate this case into two parts. First, I characterize the conditions under which $\overline{\sigma} \in (0, 1)$, defined in Equation 6. Second, I characterize equilibrium actions in a conflictual equilibrium.

Part 1. Because $\Psi^*(\cdot)$ strictly decreases in τ_s^*, it follows that $\Psi^*(\cdot) < 0$ for all $\tau_s^* \in [0, 1]$ if $\Psi^*(0) < 0$. For $\delta < \underline{\delta}_C$ (Definition A.2), algebraic manipulation easily demonstrates that $\Psi^*(0) > 0$ for all σ. In this case, $\overline{\sigma}$ is set to 0. If $\delta > \underline{\delta}_C$, then applying the intermediate value theorem demonstrates the existence of at least one $\overline{\sigma}$ that satisfies $\Psi^*(\tau_s^*) = 0$. Note that $\Phi(\overline{\sigma})$ defined in Equation 6 is equivalent to $\Psi^*(0)$.

- $\Phi(0) < 0$ if $\delta > \underline{\delta}_C$
- $\Phi(1) = \theta(L_0^*) - \kappa(L_0^*) > 0$
- $\Phi(\cdot)$ is continuous in σ

Furthermore, because $\Phi(\cdot)$ strictly increases in σ, $\overline{\sigma}$ constitutes a unique threshold such that $\Phi(\cdot) < 0$ if $\sigma < \overline{\sigma}$ and $\Phi(\cdot) > 0$ if $\sigma > \overline{\sigma}$.

Part 2. If and only if C strictly prefers to fight in a strong period than to accept a tax offer of 0, any equilibrium will feature fighting in every strong period. This is formalized as:

$$V_s^C > U_C(\tau_t = 0) + \delta \cdot \Big[\sigma \cdot V_s^C + (1 - \sigma) \cdot V_w^C\Big], \tag{A.5}$$

where V_s^C is C's continuation value in the posited strategy profile in a strong period, V_w^C is C's continuation value in a weak period, and $U_C(\tau_t = 0) = \theta(L_0^*) - \kappa(L_0^*)$. The following two equations enable solving for V_s^C and V_w^C:

$$V_s^C = \delta \cdot \left\{p \cdot \frac{U_C(\tau_t = 0)}{1 - \delta} + (1 - p) \cdot \Big[\sigma \cdot V_s^C + (1 - \sigma) \cdot V_w^C\Big]\right\} \tag{A.6}$$

$$V_w^C = U_C(\tau_t = \overline{\tau}) + \delta \cdot \Big[\sigma \cdot V_s^C + (1 - \sigma) \cdot V_w^C\Big], \tag{A.7}$$

for $U_C(\tau_t = \overline{\tau}) = \big(1 - \overline{\tau}\big) \cdot \theta\big(\overline{L}\big) - \kappa\big(\overline{L}\big)$. Solving the system of equations defined by Equations A.6 and A.7 and substituting the continuation values into Equation A.5 yields $\sigma \leq \overline{\sigma}$, for the same $\overline{\sigma}$ defined in Equation 6. This is consistent with the imposed parameter assumption $\sigma < \overline{\sigma}$ for the conflictual equilibrium. Finally, G cannot profitably deviate from mixing over all possible τ_t in a strong period. Because C fights in response to any offer, G's utility is not a function of τ_t.

For all these cases, the equilibrium strategic actions immediately imply the consumption amounts stated in Lemma 3. ■

A.2 Comparative Statics

Proof of Lemma 4. $-\frac{d\overline{\tau}}{d\eta} = \frac{\omega}{1+\omega} > 0$ because $\omega > 0$ by assumption. $-\frac{d\overline{\tau}}{d\omega} = \frac{\eta}{(1+\omega)^2} > 0$ because $\eta > 0$ by assumption. ■

The relationship between elasticity and the tax rate, discussed in the text, can be illustrated even more clearly in a more general parameterization of a government's tax problem. Suppose C's optimal formal-sector labor supply is $\left[(1-\tau_t)\cdot\mu\right]^{\alpha}$, for some $\mu \in (0,1)$ and $\alpha \in (0,1)$, and formal-sector output equals L_t^{β}, for some $\beta \in (0,1)$. Here, α is labor-supply elasticity and β is output elasticity. Then, G's tax objective function is $\tau_t \cdot \left[(1-\tau_t)\cdot\mu\right]^{\alpha\beta}$ and the optimal tax rate solves to $\tau^* = \frac{1}{1+\alpha\beta}$. This is clearly a strictly decreasing function of both the labor supply elasticity parameter and the output elasticity parameter.

The following lemma will be used to prove several of the propositions.

Lemma A.3. *For a generic parameter* ϵ*, if* $\frac{\partial\Phi(\overline{\sigma})}{\partial\epsilon} > 0$*, for* $\Phi(\overline{\sigma})$ *defined in Equation 6, then* $\frac{\partial\overline{\sigma}}{\partial\epsilon} < 0$*. If* $\frac{\partial\Phi(\overline{\sigma})}{\partial\epsilon} < 0$*, then* $\frac{\partial\overline{\sigma}}{\partial\epsilon} > 0$*.*

Proof. Using the implicit function theorem to calculate the partial derivative of $\overline{\sigma}$ (defined in Equation 6) with respect a generic parameter ϵ yields:

$$\frac{\partial\overline{\sigma}}{\partial\epsilon} = \frac{\frac{\partial\Phi(\overline{\sigma})}{\partial\epsilon}}{-\frac{\partial\Phi(\overline{\sigma})}{\partial\sigma}}$$

It suffices to demonstrate that the denominator is strictly negative:

$$-\frac{\partial\Phi(\overline{\sigma})}{\partial\sigma} = -\delta\cdot p\cdot\left\{\left[\theta(L_0^*) - \kappa(L_0^*)\right] - \left[(1-\overline{\tau})\cdot\theta(\overline{L}) - \kappa(\overline{L})\right]\right\} < 0.$$

The strict positivity of the term in brackets follows because C's consumption function strictly decreases in τ_t, which can be shown by applying the envelope theorem to C's consumption function. ■

Proof of Proposition 2. Because of Lemmas 4 and A.3, it suffices to demonstrate:

$$\frac{\partial\Phi(\overline{\sigma})}{\partial\overline{\tau}} = -\delta\cdot p\cdot(1-\overline{\sigma})\cdot\theta(\overline{L}) < 0.$$

■

A.3 Government Transfers?

For simplicity, the setup does not provide a budget from which G can offer C transfers in any period. However, introducing this possibility would not qualitatively alter Lemmas 2 and 3 except in the substantively uninteresting case in which G's budget is large enough to prevent fighting for all parameter values. G would not offer transfers in a weak period because C does not pose a coercive threat. Transfers from G would facilitate a wider range of parameters in which G can buy off C in a strong period by raising the opportunity cost of seceding, but the absence of equilibrium transfers in a weak period would still imply that, for low enough σ, G would not be able to buy off C in a strong period.

B Supporting Information for Non-Markovian SPNE

B.1 Equilibrium Existence

The following formally states the strategy profile.

Proposition B.1. ***Part a.*** *If $\sigma > \hat{\sigma} > 0$ and $\delta > \max\left\{\underline{\delta}_C, \underline{\underline{\delta}}_C\right\}$, for $\hat{\sigma}$ defined below in Equation B.6, $\underline{\delta}_C$ defined in Definition A.1, and $\underline{\underline{\delta}}_C$ defined below in Equation B.10, the following composes a SPNE strategy profile. Define $\mathbb{W}$ as the set of periods since the greater of the first period of the game and the period in which the most recent civil war occurred. Equation B.1 below defines $\hat{\underline{\tau}}$.*

1. *G's tax offer:*
   (a) *If $\tau_j \leq \hat{\underline{\tau}}$ for all $j \in \mathbb{W}$, then $\tau_t = \hat{\underline{\tau}}$.*
   (b) *If $\tau_j > \hat{\underline{\tau}}$ for any $j \in \mathbb{W}$, then $\tau_t = \overline{\tau}$.*
2. *C's separatist civil war decision if $\mu_t = \mu^s$:*
   (a) *If $\tau_j \leq \hat{\underline{\tau}}$ for all $j \in \mathbb{W}$, then C accepts $\tau_t \leq \hat{\underline{\tau}}$ and fights otherwise.*
   (b) *If $\tau_j > \hat{\underline{\tau}}$ for any $j \in \mathbb{W}$, then C fights in response to any $\tau_t \in [0, 1]$.*
3. *C sets labor optimally according to Equation 2.*
4. *Secession subgame is identical to the MPE in Proposition 1.*

Part b. *If $\delta < \underline{\delta}_C$, then G proposes $\tau_t = \overline{\tau}$ in every period, C accepts any offer $\tau_t \leq \overline{\tau}$, and C sets labor optimally according to Equation 2. Secession subgame is identical to MPE.*

Part a is the main case of interest, whereas part b is the trivial case in which C's discount rate is so low that it prefers to accept any offer in a strong period no greater than the G's revenue-maximizing tax rate because it assigns sufficiently low weight to the potential gains from fighting (note that the full strategy specification for part b entails a threshold value of τ_t higher than $\overline{\tau}$ that C will accept).

This is not the only non-Markovian SPNE of the game, of which there are infinite, but it is substantively relevant for several reasons. First, the constant tax rate across periods naturally expresses the idea of a regional autonomy deal. Notably, within the class of punishment strategies stated in Proposition B.1, cooperation could be sustained for a lower value of σ if G taxed at 0 in strong periods and at a rate in weak periods that satisfies Equation 7 with equality (which will exceed $\hat{\underline{\tau}}$). This minimizes G's incentives to deviate from the cooperative strategy in a weak period. However, the intuition is qualitatively similar for this strategy profile, and it is less substantively interesting because we would not expect governments and regional challengers to construct regional autonomy deals in this manner. Second, the chosen punishment strategy—C punishes any deviation by G with a civil war in the next period it can, before returning to cooperation—also appears substantively relevant. Although cooperation could be achieved for a wider range of σ values with a grim trigger-type punishment strategy with war in every strong period after a single defection, empirically, it seems infeasible for a challenger to follow-through with permanent war (plus, initiating even a single civil war is quite a costly punishment in reaction to a deviation).

The following proves the non-trivial case with an interior tax offer, part a.

Proof of Proposition B.1, part a. First, need to prove the existence of a unique $\underline{\hat{\tau}} \in (0, \overline{\tau})$. Equation 7 follows from identical considerations as Equation 3 and states the conditions under which C will accept a constant per-period tax offer $\hat{\tau}$. Substituting

$$\hat{V}^C_{sec} = \frac{\theta(L^*_0) - \kappa(L^*_0)}{1-\delta} \text{ and } \hat{V}^C_{s.q.} = \frac{(1-\underline{\hat{\tau}}) \cdot \theta\big(L^*(\underline{\hat{\tau}})\big) - \kappa\big(L^*(\underline{\hat{\tau}})\big)}{1-\delta}$$

into Equation 7 and re-arranging yields C's indifference condition:

$$\chi(\underline{\hat{\tau}}) \equiv (1-\delta)\cdot\Big[(1-\underline{\hat{\tau}})\cdot\theta\big(L^*(\underline{\hat{\tau}})\big)\Big] - \delta\cdot p\cdot\Big\{\Big[\theta(L^*_0)-\kappa(L^*_0)\Big] - \Big[(1-\underline{\hat{\tau}})\cdot\theta\big(L^*(\underline{\hat{\tau}})\big) - \kappa\big(L^*(\underline{\hat{\tau}})\big)\Big]\Big\} = 0 \tag{B.1}$$

Applying the intermediate value theorem demonstrates the existence of at least one $\underline{\hat{\tau}} \in (0, \overline{\tau})$ that satisfies Equation B.1:

- $\chi(0) = (1-\delta) \cdot \Big[\theta(L^*_0) - \kappa(L^*_0)\Big] > 0$
- $\delta > \underline{\delta}_C$ implies $\chi(\overline{\tau}) < 0$.
- $\theta(\cdot)$ and $\kappa(\cdot)$ are continuous functions of τ_t, which implies $\chi(\cdot)$ is continuous in $\underline{\hat{\tau}}$.

Additionally, applying the envelope theorem to C's consumption function shows that $\chi(\underline{\hat{\tau}})$ strictly decreases in $\underline{\hat{\tau}}$, which establishes the uniqueness of $\underline{\hat{\tau}}$.

Now we can check the incentive-compatibility of each action specified in the Proposition B.1 strategy profile.

1a. G's lifetime expected utility to following the strategy profile in any period is:

$$\frac{\underline{\hat{\tau}} \cdot \theta\big(L^*(\underline{\hat{\tau}})\big)}{1-\delta} \tag{B.2}$$

G's most profitable deviation entails offering $\tau_t = \overline{\tau}$ in a period that C has weak capacity for rebellion. The lifetime value of this deviation, evaluated from the perspective of the period of the defection, is denoted as V^G_w and equals:

$$V^G_w = \overline{\tau} \cdot \theta(\overline{L}) + \delta \cdot \Big[\sigma \cdot V^G_s + (1-\sigma) \cdot V^G_w\Big],$$

where V^G_s expresses G's lifetime expected utility from the perspective of the next period that C has strong capacity for rebellion. The recursive equation solves to:

$$V^G_w = \frac{\overline{\tau} \cdot \theta(\overline{L}) + \delta \cdot \sigma \cdot V^G_s}{1-\delta(1-\sigma)}. \tag{B.3}$$

C will initiate a civil war in the first strong period, and therefore:

$$V^G_s = \frac{\delta}{1-\delta} \cdot (1-p) \cdot \underline{\hat{\tau}} \cdot \theta\big(L^*(\underline{\hat{\tau}})\big). \tag{B.4}$$

After the war, with probability p, G never consumes C's production again because C successfully secedes. With probability $1-p$ the secession attempt fails and the players revert to the original regional autonomy deal.

Then, substituting Equation B.4 into Equation B.3 and comparing to Equation B.2 yields the inequality that governs G's incentive compatibility constraint in a weak period.

$$\underbrace{\underline{\hat{\tau}} \cdot \theta\big(L^*(\underline{\hat{\tau}})\big)}_{\text{Follow strategy profile}} \geq \underbrace{\frac{(1-\delta) \cdot \overline{\tau} \cdot \theta(\overline{L}) + \delta^2 \cdot \hat{\sigma} \cdot (1-p) \cdot \underline{\hat{\tau}} \cdot \theta\big(L^*(\underline{\hat{\tau}})\big)}{1-\delta(1-\hat{\sigma})}}_{\text{Optimal deviation}} \tag{B.5}$$

This implicitly defines a threshold value of $\hat{\sigma}$ such that G does not renege if $\sigma > \hat{\sigma}$ but does if $\sigma < \hat{\sigma}$. The threshold $\hat{\sigma}$ is the analog of $\overline{\sigma}$ for this SPNE:

$$\Omega(\hat{\sigma}) \equiv \Bigg\{1 - \delta \cdot \Big[1 - \hat{\sigma} \cdot \big[1 - \delta \cdot (1-p)\big]\Big]\Bigg\} \cdot \underline{\hat{\tau}} \cdot \theta\big(L^*(\underline{\hat{\tau}})\big) - (1-\delta) \cdot \overline{\tau} \cdot \theta(\overline{L}) = 0 \tag{B.6}$$

It is easy to see that $\hat{\sigma} > 0$: (1) the expression in Equation B.6 is strictly negative if $\sigma = 0$ and (2) it strictly increases in σ.

1b. Because C will initiate a civil war in the next strong period regardless of G's current-period action, G cannot profitably deviate from setting the revenue-maximizing tax rate.

2a. This is incentive-compatible because, by construction, $\tau_t \leq \underline{\hat{\tau}}$ satisfies Equation 8 whereas $\tau_t > \underline{\hat{\tau}}$ violates it.

2b. Need to verify that it is incentive-compatible for C to reject any offer in a strong period if G has previously deviated. Denote C's payoff to the punishment phase as $\hat{V}^C_{punish}$. Because the most favorable offer that G can make to C entails $\tau_t = 0$, need:

$$\delta \cdot \Big[p \cdot \hat{V}^C_{sec} + (1-p) \cdot \hat{V}^C_{s.q.}\Big] \geq \underbrace{\theta\big(L^*_0\big) - \kappa\big(L^*_0\big)}_{E[U_C(\tau_t=0)]} + \delta \cdot \hat{V}^C_{punish},$$

which easily rearranges to:

$$\underbrace{\delta \cdot \Big[p \cdot \hat{V}^C_{sec} + (1-p) \cdot \hat{V}^C_{s.q.} - \hat{V}^C_{punish}\Big]}_{\text{LT benefit of fighting}} \geq \underbrace{E\big[U_C(\tau_t = 0)\big]}_{\text{ST cost of fighting}} \tag{B.7}$$

Because C's calculus involves weighing a long-term benefit against a short-term cost, C needs to be sufficiently patient to uphold the punishment. The following characterizes $\underline{\underline{\delta}}_C$. We have:

$$\hat{V}^C_{punish} = \sigma \cdot \delta \cdot \Big[p \cdot \hat{V}^C_{sec} + (1-p) \cdot \hat{V}^C_{s.q.}\Big] + (1-\sigma) \cdot \Big\{E\big[U_C(\tau_t = \overline{\tau})\big] + \delta \cdot \hat{V}^C_{punish}\Big\},$$

which solves to:

$$\hat{V}^C_{punish} = \frac{\sigma \cdot \delta \cdot \big[p \cdot \hat{V}^C_{sec} + (1-p) \cdot \hat{V}^C_{s.q.}\big] + (1-\sigma) \cdot E\big[U_C(\tau_t = \overline{\tau})\big]}{1 - \delta \cdot (1-\sigma)}$$

Substitution enables rearranging the left-hand side of Equation B.7 to:

$$\frac{\delta}{1 - \delta \cdot (1-\sigma)} \cdot \Big[(1-\delta) \cdot \big[p \cdot \hat{V}^C_{sec} + (1-p) \cdot V^C_{s.q.}\big] - (1-\sigma) \cdot E\big[U_C(\tau_t = \overline{\tau})\big]\Big]$$

Substituting in for the continuation values yields the following statement for the long-term expected benefit of fighting:

$$\frac{\delta}{1-\delta\cdot(1-\sigma)}\cdot\left[p\cdot E\big[U_C(\tau_t=0)\big]+(1-p)\cdot E\big[U_C(\tau_t=\hat{\underline{\tau}})\big]-(1-\sigma)\cdot E\big[U_C(\tau_t=\overline{\tau})\big]\right] \tag{B.8}$$

This term is strictly positive because $E\big[U_C(\tau_t=0)\big]>E\big[U_C(\tau_t=\hat{\underline{\tau}})\big]>E\big[U_C(\tau_t=\overline{\tau})\big]$. Deriving Equation B.8 with respect to δ shows the LT benefit of fighting strictly increases in δ:

$$\frac{1}{\big[1-\delta\cdot(1-\sigma)\big]^2}\cdot\left\{p\cdot E\big[U_C(\tau_t=0)\big]+(1-p)\cdot E\big[U_C(\tau_t=\hat{\underline{\tau}})\big]-(1-\sigma)\cdot E\big[U_C(\tau_t=\overline{\tau})\big]\right\}$$
$$+\frac{\delta\cdot(1-p)}{1-\delta\cdot(1-\sigma)}\cdot\frac{d}{d\delta}E\big[U_C(\tau_t=\hat{\underline{\tau}})\big] \tag{B.9}$$

Given the result just proven, the term on the first line of Equation B.9 is strictly positive. Therefore, it suffices to demonstrate $\frac{d}{d\delta}E\big[U_C(\tau_t=\hat{\underline{\tau}})\big]>0$. By construction of $\hat{\underline{\tau}}$, we know:

$$E\big[U_C(\tau_t=\hat{\underline{\tau}})\big]=\delta\cdot\Big\{p\cdot E\big[U_C(\tau_t=0)\big]+(1-p)\cdot E\big[U_C(\tau_t=\hat{\underline{\tau}})\big]\Big\},$$

which solves to:

$$E\big[U_C(\tau_t=\hat{\underline{\tau}})\big]=\frac{\delta\cdot p}{1-\delta\cdot(1-p)}\cdot E\big[U_C(\tau_t=0)\big],$$

Therefore:

$$\frac{d}{d\delta}E\big[U_C(\tau_t=\hat{\underline{\tau}})\big]=\frac{p}{\big[1-\delta\cdot(1-p)\big]^2}\cdot E\big[U_C(\tau_t=0)\big]>0$$

Because Equation B.8 is continuous and strictly increases in δ, we can define a unique $\underline{\underline{\delta}}_C$ such that Equation B.7 holds if $\delta\geq\underline{\underline{\delta}}_C$ and not otherwise:

$$\frac{\underline{\underline{\delta}}_C}{1-\underline{\underline{\delta}}_C\cdot(1-\sigma)}\cdot\left[p\cdot E\big[U_C(\tau_t=0)\big]+(1-p)\cdot E\Big[U_C\big(\tau_t=\hat{\underline{\tau}}\big(\underline{\underline{\delta}}_C\big)\big)\Big]-(1-\sigma)\cdot E\big[U_C(\tau_t=\overline{\tau})\big]\right]$$
$$=E\big[U_C(\tau_t=0)\big] \tag{B.10}$$

3. This consideration is unchanged from the MPE case. ■

B.2 Comparative Statics

The proof of Proposition 3 uses the following lemma.

Lemma B.1. *For a generic parameter ϵ, if $\frac{\partial\Omega(\hat{\sigma})}{\partial\epsilon}>0$, for $\Omega(\hat{\sigma})$ defined in Equation B.6, then $\frac{\partial\hat{\sigma}}{\partial\epsilon}<0$. If $\frac{\partial\Omega(\hat{\sigma})}{\partial\epsilon}<0$, then $\frac{\partial\hat{\sigma}}{\partial\epsilon}>0$.*

Proof. Using the implicit function theorem to calculate the partial derivative of $\hat{\sigma}$ (defined in Equation B.6) with respect a generic parameter ϵ yields:

$$\frac{\partial\hat{\sigma}}{\partial\epsilon} = \frac{\frac{\partial\Omega(\hat{\sigma})}{\partial\epsilon}}{-\frac{\partial\Omega(\hat{\sigma})}{\partial\sigma}}$$

It suffices to demonstrate that the denominator is strictly negative:

$$-\frac{\partial\Omega(\hat{\sigma})}{\partial\sigma} = -\delta\cdot\big[1-\delta\cdot(1-p)\big]\cdot\underline{\hat{\tau}}\cdot\theta\big(L^*(\underline{\hat{\tau}})\big) < 0$$

■

Proof of Proposition 3. Because of Lemmas 4 and B.1, it suffices to demonstrate $\frac{\partial\Omega(\hat{\sigma})}{\partial\overline{\tau}} = -(1-\delta)\cdot\theta(\overline{L}) < 0$. ■

B.3 Discount Factor and War

The Markov Perfect equilibrium provides a surprising result relative to many models of conflict: war becomes *more* likely in equilibrium as players become increasingly patient. By contrast, the opposite may be true in the subgame perfect Nash equilibrium just presented, as Table B.1 summarizes. The first, anti-folk theorem result arises because C suffers a short-term cost (war) to potentially achieve a long-term benefit by gaining independence. A more patient challenger places greater weight on the long-term gain and therefore war occurs under a wider range of parameter values.

Table B.1: Costs and Benefits to Fighting in Different Equilibria

	MPE	**Constant-tax MPE**
Cost of fighting	ST for C	Direct: LT for G Indirect: ST for C
Benefit of fighting	LT for C	Direct: ST for G Indirect: LT for C
Effect of δ	Higher δ causes fighting	Direct: higher δ prevents fighting Indirect: higher δ causes fighting

The constant-tax SPNE features countervailing direct and indirect effects. The direct effect of higher δ creates opposing incentives for G compared to C's incentives in the MPE. In the SPNE, G can always choose a tax rate low enough that C will optimally accept in strong periods. Deviating yields a short-term *benefit* for G because it maximally taxes C until the first strong period, but G subsequently suffers an expected long-term *cost* because of the fighting period and the possibility of C permanently seceding. However, two indirect effects of δ in the constant-tax SPNE resemble those from the MPE because higher δ increases C's expected utility from fighting. First, C's greater bargaining leverage decreases $\underline{\hat{\tau}}$, which increases G's incentives to deviate. Second, C's war punishment is not incentive compatible in the SPNE unless C is sufficiently patient. This implies that the anti-folk theorem result from the MPE is necessary to generate the negative direct effect of δ on $\hat{\sigma}$ in the SPNE by enforcing G's cooperation.[22] Proposition B.2

[22]If instead the players had different discount factors, δ_G and δ_C, then higher δ_G would unambiguously

formalizes these claims.[23]

Proposition B.2 (Discount factor and war)**.**

Part a.
$$\frac{d\overline{\sigma}}{d\delta} > 0$$

Part b.
$$\frac{d\hat{\sigma}}{d\delta} = \underbrace{\frac{\partial\hat{\sigma}}{\partial\delta}}_{<0} + \underbrace{\frac{\partial\hat{\sigma}}{\partial\underline{\hat{\tau}}}}_{<0} \cdot \underbrace{\frac{d\underline{\hat{\tau}}}{d\delta}}_{<0}$$

Proof of Proposition B.2, part a. Given Lemma A.3, it suffices to demonstrate:

$$\frac{\partial\Theta(\overline{\sigma})}{\partial\delta} = -\big[\theta(L_0^*) - \kappa(L_0^*)\big] - p\cdot(1-\overline{\sigma})\cdot\Big\{\big[\theta(L_0^*) - \kappa(L_0^*)\big] - \big[(1-\overline{\tau})\cdot\theta(\overline{L}) - \kappa\big(\overline{L}\big)\big]\Big\} < 0$$

Part b.

$$\frac{\partial\hat{\sigma}}{\partial\delta} = -\frac{\Big[1-\hat{\sigma}\cdot\big[1-\delta\cdot(1-p)\big]\Big]\cdot\delta\cdot\hat{\sigma}\cdot(1-p)\cdot\underline{\hat{\tau}}\cdot\theta\big(L^*(\underline{\hat{\tau}})\big) + \overline{\tau}\cdot\theta(\overline{L})}{\delta\cdot\big[1-\delta\cdot(1-p)\big]\cdot\underline{\hat{\tau}}\cdot\theta\big(L^*(\underline{\hat{\tau}})\big)} < 0$$

Applying the implicit function theorem to Equation B.6 yields:

$$\frac{\partial\hat{\sigma}}{\partial\underline{\hat{\tau}}} = -\frac{1-\delta\cdot\Big[1-\hat{\sigma}\cdot\big[1-\delta\cdot(1-p)\big]\Big]}{\delta\cdot\big[1-\delta\cdot(1-p)\big]\cdot\underline{\hat{\tau}}} < 0$$

Applying the implicit function theorem to Equation B.1 yields:

$$\frac{d\underline{\hat{\tau}}}{d\delta} = -\frac{(1-\underline{\hat{\tau}})\cdot\theta\big(L^*(\underline{\hat{\tau}})\big) + p\cdot\Big\{\big[\theta(L_0^*) - \kappa(L_0^*)\big] - \Big[(1-\underline{\hat{\tau}})\cdot\theta\big(L^*(\underline{\hat{\tau}})\big) - \kappa\big(L^*(\underline{\hat{\tau}})\big)\Big]\Big\}}{\big[1-\delta\cdot(1-p)\big]\cdot\theta\big(L^*(\underline{\hat{\tau}})\big)} < 0$$

■

Intuitively, for $\frac{\partial\hat{\sigma}}{\partial\delta} < 0$, higher δ decreases the weight that G places on greater consumption prior to the war, and more weight on the strictly higher payoff following the first strong period from not deviating. For $\frac{\partial\hat{\sigma}}{\partial\underline{\hat{\tau}}} < 0$, a higher regional autonomy tax rate increases G's opportunity cost to deviating to a high tax rate, generating a smaller range of σ values in which G deviates. For $\frac{d\underline{\hat{\tau}}}{d\delta} < 0$, higher δ increases the value of C's war option, which lowers the tax rate that makes C indifferent between accepting and fighting.

make peace more likely in the constant-tax SPNE because the direct effect works solely through δ_G and the indirect effects solely through δ_C.

[23]Powell's (1993) model of the guns and butter tradeoff provides another example of an anti-folk theorem result in the conflict literature.

C Supporting Information for Greed Results

C.1 Looting and Rebel Arming Advantage

For Proposition 4, need to restate an analog for $\overline{\sigma}$ that accounts for the additional wartime consumption parameters (also note that C now chooses a labor amount even in a war period). This is denoted $\overline{\sigma}_g$, where "g" stands for greed. Introducing wartime consumption adds one additional technical consideration: G must be sufficiently patient to prefer to buy off C in a strong period (because G consumes more in period t if a war occurs than if it offers 0 taxes to C), so Proposition 4 only holds for δ sufficiently high (it is straightforward to analytically characterize the lower-bound discount factor).

$$\Phi(\overline{\sigma}_g) \equiv \overbrace{(1-\delta)\cdot\Big\{\big[\theta(L_0^*)-\kappa(L_0^*)\big]-\big[(1-\phi)\cdot(1-x)\cdot\theta\big(L^*(x)\big)-\kappa\big(L^*(x)\big)\big]\Big\}}^{C\text{'s contemporaneous gains from accepting } \tau_t=0 \text{ rather than fighting}}$$
$$\underbrace{-\,\delta\cdot p\cdot(1-\overline{\sigma}_g)\cdot\Big\{\big[\theta(L_0^*)-\kappa(L_0^*)\big]-\big[(1-\overline{\tau})\cdot\theta(\overline{L})-\kappa\big(\overline{L}\big)\big]\Big\}}_{C\text{'s long-term opportunity cost from forgoing fighting}}=0 \qquad \text{(C.1)}$$

Proof of Proposition 4. Given the assumption $\frac{dx}{d\eta}<0$ and because an analog of Lemma A.3 holds for Equation C.1, it suffices to demonstrate:

$$\frac{\partial\Phi(\overline{\sigma}_g)}{\partial x}=(1-\delta)\cdot(1-\phi)\cdot\theta\big(L^*(x)\big)>0.$$

■

Proof of Proposition 5. Given the assumptions $\frac{dp}{d\eta}>0$ and $\frac{dp}{d\omega}>0$, and because of Lemma A.3, it suffices to demonstrate:

$$-\frac{\partial\Phi(\overline{\sigma})}{\partial p}=-\delta(1-\overline{\sigma})\cdot\Big\{\big[\theta(L_0^*)-\kappa(L_0^*)\big]-\big[(1-\overline{\tau})\cdot\theta(\overline{L})-\kappa\big(\overline{L}\big)\big]\Big\}>0.$$

■

C.2 Fighting for a Large Prize

A distinct greed hypothesis is that oil production raises fighting prospects by creating a lucrative secession prize. For example, Collier and Hoeffler (2005, 44) proclaim a second major reason that natural resources might be a powerful risk factor for civil wars is "the lure of capturing resource ownership permanently if the rebellion is victorious." Laitin (2007, 22) proclaims: "If there is an economic motive for civil war in the past half-century, it is in the expectation of collecting the revenues that ownership of the state avails, and thus the statistical association between oil (which provides unimaginably high rents to owners of states) and civil war." However, the theoretical effect of a large prize is ambiguous. Although it raises the expected utility of fighting, it also increases the opportunity cost of fighting. Furthermore, the argument that p should be low in oil-rich regions also diminishes the magnitude of the conflict-inducing prize of winning mechanism, and therefore a larger prize could in fact deter separatism—similar to accepted mechanisms linking rich countries to few civil wars.

Formally, assume that C's formal sector output sells a price $Y^C > 0$ (as opposed to 1 in the baseline model), which captures the size of the prize. It is uncontroversial to assert that oil is a high-yield economic activity that should raise the value of C's formal-sector production, Y^C, although the necessity of negotiating with international oil companies dampens this effect somewhat (Menaldo, 2016). Correspondingly, greed theories correctly argue that the "prize of winning" oil effect raises separatist propensity, i.e., higher Y^C increases C's consumption conditional on winning a civil war (Collier and Hoeffler 2004, 2005; Garfinkel and Skaperdas 2006; Besley and Persson 2011, ch. 4). However, these theories have not carefully examined a crucial countervailing effect that renders ambiguous the overall impact of a larger prize. A larger prize also diminishes fighting incentives by raising the opportunity cost of initiating a civil war. Higher Y^C increases the amount of output destroyed from C's region during a fight. This "prize opportunity cost" effect increases the relative lucre of the wealth-sharing deal that C gets from G—compared to fighting and decreasing consumption in that period.

As a preliminary result, the prize term slightly changes C's optimal labor supply function, although G's most-preferred tax rate is unchaged:

$$L^*(\tau_t) = \Big[(1-\tau_t)\cdot\eta\cdot Y^C\Big]^{\frac{\omega}{1+\omega\cdot(1-\eta)}} \tag{C.2}$$

Accepting an offer $\tau_t = 0$ from G as opposed to fighting yields a gain in consumption of $\theta(L_0^*)\cdot Y^C - \kappa(L_0^*)$. Therefore, a larger prize increases the marginal opportunity cost of fighting by $\theta(L_0^*)$, the prize opportunity cost effect. By contrast, conditional on winning, initiating a separatist civil war yields a net expected benefit of $\frac{\delta}{1-\delta}\cdot(1-\sigma)\cdot\Big\{\big[\theta(L_0^*)\cdot Y^C - \kappa(L_0^*)\big] - \big[(1-\overline{\tau})\cdot\theta(\overline{L})\cdot Y^C - \kappa(\overline{L})\big]\Big\}$ in future periods. Therefore, a larger prize increases the marginal benefit to fighting, conditional on winning, by $\frac{\delta}{1-\delta}\cdot(1-\sigma)\cdot\Big[\theta(L_0^*) - (1-\overline{\tau})\cdot\theta(\overline{L})\Big]$. This is the future-period prize of winning effect. Finally, the magnitude of the prize of winning effect is modified by C's probability of winning, p, since C only reaps secessionist gains if it wins the war.

For Proposition C.1, need to restate an analog for $\overline{\sigma}$ that account for the prize parameter. This is denoted $\overline{\sigma}_p$, where "p" stands for prize.

$$\Phi(\overline{\sigma}_p) \equiv \overbrace{(1-\delta)\cdot\big[\theta(L_0^*)\cdot Y^C - \kappa(L_0^*)\big]}^{C\text{'s contemporaneous gains from accepting } \tau_t = 0 \text{ rather than fighting}}$$
$$-\underbrace{\delta\cdot p\cdot(1-\overline{\sigma}_p)\cdot\Big\{\big[\theta(L_0^*)\cdot Y^C - \kappa(L_0^*)\big] - \big[(1-\overline{\tau})\cdot\theta(\overline{L})\cdot Y^C - \kappa\big(\overline{L}\big)\big]\Big\}}_{C\text{'s long-term opportunity cost from forgoing fighting}} = 0 \tag{C.3}$$

Proposition C.1 states a threshold value of p that determines which of these two effects dominates the other.

Proposition C.1 (Coercive capacity and the countervailing effects of a larger prize)**.** *An increase in C's oil production through its effect on increasing the prize, Y^C, ambiguously affects the range of σ values small enough that fighting occurs.*

- *If p is sufficiently large, then the probability of winning multiplied by prize of winning effect, $p \cdot \frac{\delta}{1-\delta} \cdot (1-\sigma) \cdot \left[\theta(L_0^*) - (1-\overline{\tau}) \cdot \theta(\overline{L})\right]$, dominates the prize opportunity cost effect, $\theta(L_0^*)$, and an increase in Y^C increases the equilibrium likelihood of separatist civil wars, that is, increases the range of σ values small enough that C will reject any offer in a strong period. Formally, if $p > \overline{p}$, then $\frac{d\overline{\sigma}_p}{dY^C} > 0$, for $\overline{p}$ defined in the proof and $\overline{\sigma}_p$ defined in Equation C.3.*

- *If $p < \overline{p}$, then the prize opportunity cost effect dominates the probability of winning times prize of winning effect, and an increase in Y^C diminishes $\overline{\sigma}_p$. Formally, if $p < \overline{p}$, then $\frac{d\overline{\sigma}_p}{dY^C} < 0$.*

Proof. It is trivial to demonstrate that $\frac{d\overline{\sigma}_p}{dY^C} = \frac{\partial\overline{\sigma}_p}{\partial Y^C}$. Because of Lemma A.3, the sign of $\frac{d\overline{\sigma}_p}{dY^C}$ has the opposite sign as $\frac{\partial\Phi(\overline{\sigma}_p)}{\partial Y^C}$. This can be calculated as:

$$\frac{\partial\Phi(\overline{\sigma}_p)}{\partial Y^C} = (1-\delta) \cdot \theta(L_0^*) - \delta \cdot p \cdot (1-\overline{\sigma}_p) \cdot \left[\theta(L_0^*) - (1-\overline{\tau}) \cdot \theta(\overline{L})\right]$$

$\frac{\partial\Phi(\overline{\sigma}_p)}{\partial Y^C}$ strictly decreases in p, and is positive if $p < \overline{p}$ and negative if $p > \overline{p}$, for:

$$\overline{p} \equiv \frac{\overbrace{(1-\delta) \cdot \theta(L_0^*)}^{\text{Prize opportunity cost effect}}}{\underbrace{\delta \cdot (1-\overline{\sigma}) \cdot \left[\theta(L_0^*) - (1-\overline{\tau}) \cdot \theta(\overline{L})\right]}_{\text{Prize of winning effect}}}$$

■

Overall, the prize effect is indeterminate. Furthermore, the substantive considerations that oil production should tend to lower p (by providing revenues to the government) suggest that oil-rich regions often do not exhibit the parameter values in which the overall prize effect is conflict-inducing. This finding resembles Chassang and Padro-i Miquel's (2009) result that the size of the economy is insufficient to explain civil war onset. However, the present setup with endogenous labor allocation enables studying the tradeoff between the prize of winning and the opportunity cost of fighting with regard to how an aspect of state capacity impacts the overall effect, as opposed to their model where these two mechanisms perfectly cancel out. Here, if the government has strong military capacity, then the prize of winning effect is small in magnitude and a larger prize diminishes fighting prospects.

In fact, emphasizing the importance of the opportunity cost mechanism largely follows the logic of arguments for why rich countries tend not to fight civil wars. Although richer countries create a larger prize, richer citizens also face a higher opportunity cost to rebelling. Because governments in rich countries tend to have strong coercive capacity, the opportunity cost effect tends to outweigh the prize of winning effect to deter civil war. Furthermore, the fact that citizens in oil-rich regions tend not to be rich follows from the redistributive grievances argument rather than from the large prize.

C.3 Oil Discoveries and Volatile Oil Prices

To facilitate focusing on core issues in the greed and grievances debate, the model so far has abstracted away from another important attribute of oil income: volatility. Ross (2012, 50-54) and Karl (1997) each detail this aspect of oil production, albeit without linking it to civil wars. Two important components of this variance are (a) discovering a new oil field, especially a giant oil field, can cause a dramatic spike in income (Lei and Michaels, 2014), and (b) historically, international oil prices have been quite volatile (Ross 2012, 51). This section incorporates these considerations by assuming periods differ between boom and bust. The main finding is that greater inter-period volatility in formal-sector income increases the likelihood of separatist civil wars if bust periods occur infrequently. The overall logic resembles that for the prize mechanism despite yielding a somewhat different substantive implication. The first section sketches the argument and the following, more technical, section provides most of the formal details.

Main theoretical insights. Formally, the value of C's formal-sector output is Y^C in boom periods (as in the previous extension) and $\frac{Y^C}{b}$ in bust periods, for $b > 1$. Higher b decreases the value of output in bust periods and therefore corresponds with higher inter-period income volatility. Under the substantively relevant assumption that oil-rich regions have higher income volatility, we are interested in comparative statics for b. The analysis considers two cases. First, an oil discovery case in which period 1 is a bust period and all future periods are boom periods. In other words, an oil field is discovered in period 1 but does not come online until period 2. Second, a volatile prices case in which each period is boom with probability $\gamma \in (0, 1)$ and bust with complementary probability, and these draws are independent across periods. This extension features six states of the world determined by all permutations of (a) C is weak in the status quo territorial regime, C is strong in the status quo territorial regime, and C has seceded, and (b) boom and bust production periods. It is solved with MPE. This setup bears some resemblance to Dunning (2005), although his two-period model examines how price volatility affects incentives to fund public goods rather than how the present tradeoffs affect prospects for civil wars.

The key considerations are closely related to those discussed for the prize effect. With volatile income, the opportunity cost of fighting in a bust period is $\theta\big(L_b^*(0)\big) \cdot \frac{Y^C}{b} - \kappa\big(L_b^*(0)\big)$. The term $L_b^*(\cdot)$ is the analog of the optimal labor supply function defined in Equation C.2 for bust periods, and is formally defined below. The bust period opportunity cost decreases as volatility increases because, simply, there is less to destroy. This result follows an identical logic as the prize opportunity cost effect presented in Proposition C.1. However, although higher b also decreases the future prize of winning effect, b only affects future *bust* periods—unlike Y^C, which affects consumption in all future periods.

In the oil discovery case, all future periods are boom. The only effect of higher volatility is to lower the period 1 opportunity cost of fighting and, therefore, higher b unambiguously increases prospects for separatist civil war (assuming the non-trivial case in which C has strong capacity for rebellion in period 1). These considerations are somewhat more involved in the volatile prices case because b also affects C's consumption in some future periods. Therefore, higher b not only lowers the opportunity cost of fighting in a present bust period, but also lowers the expected utility of seceding. However, the less frequent are future bust periods, i.e., the higher is γ, the less that the volatility parameter b affects future-period considerations. If γ is sufficiently large, then the overall effect of higher b increases equilibrium prospects for separatist civil war by decreasing the opportunity cost of fighting by a greater magnitude than it decreases the expected utility of secession. Therefore, volatile oil prices may provide an additional trigger to separatism, but only when the future is expected to be valuable.

These findings about income volatility relate to some existing theoretical arguments and empirical evidence. Showing that oil discoveries can cause civil war resembles an implication from Bell and Wolford (2015), although the present result focuses on the opportunity cost mechanism rather than on oil causing future shifts in the balance of power. Instead, combining the result from this section with Proposition C.1 yields a point of congruence with Chassang and Padro-i Miquel (2009): larger *fluctuations* in income rather than higher income *levels* provide a more coherent explanation for war onset because income variability creates periods with relatively low opportunity costs of fighting relative to the expected future prize of fighting. Empirically, this theoretical result corresponds with Blair's (2014) finding that oil discoveries positively correlate with separatist civil war onset, and the Sudan case presented in the text provides an example.

Additional formal details. C's optimal labor choice in a bust period differs slightly from that in every period in the original model because the lower value of formal-sector output affects the marginal benefit of supplying labor. Defining C's labor supply function in a bust period as $L_b(\cdot)$ and solving a similar optimization problem as in Lemma 1, we have:

$$L_b^*(\tau_t) = \left[(1-\tau_t)\cdot\eta\cdot\frac{Y^C}{b}\right]^{\frac{\omega}{1+\omega\cdot(1-\eta)}}.$$

The revenue-maximizing tax rate $\overline{\tau}$ is unchanged in bust periods because $\overline{\tau}$ is not a function of the value of formal sector output (see Equation 5). Following similar logic as used to define $\overline{\sigma}$ in Equation 6, offering $\tau_s^* = 0$ in every strong period enables G to buy off C in a bust period in which C is coercively strong if and only if:

$$\theta\big(L_b^*(0)\big)\cdot\frac{Y^C}{b} - \kappa\big(L_b^*(0)\big) - \delta\cdot p\cdot\left(\tilde{V}^C_{\text{sec}} - \tilde{V}^C_{\text{s.q.}}\right) \geq 0, \tag{C.4}$$

The continuation values are defined as follows:

$$\tilde{V}^C_{\text{sec}} = \gamma\cdot\Big[\theta(L_0^*)\cdot Y^C - \kappa(L_0^*)\Big] + (1-\gamma)\cdot\Big[\theta\big(L_b^*(0)\big)\cdot\frac{Y^C}{b} - \kappa\big(L_b^*(0)\big)\Big] \tag{C.5}$$

$$\begin{aligned}\tilde{V}^C_{\text{s.q.}} &= \gamma\cdot\Big\{\sigma\cdot\Big[\theta(L_0^*)\cdot Y^C - \kappa(L_0^*)\Big] + (1-\sigma)\cdot\Big[(1-\overline{\tau})\cdot\theta(\overline{L})\cdot Y^C - \kappa(\overline{L})\Big]\Big\}\\ &+ (1-\gamma)\cdot\Big\{\sigma\cdot\Big[\theta\big(L_b^*(0)\big)\cdot\frac{Y^C}{b} - \kappa\big(L_b^*(0)\big)\Big] + (1-\sigma)\cdot\Big[(1-\overline{\tau})\cdot\theta\big(L_b^*(\overline{\tau})\big)\cdot\frac{Y^C}{b} - \kappa\big(L_b^*(\overline{\tau})\big)\Big]\Big\}\end{aligned} \tag{C.6}$$

Substituting Equations C.5 and C.6 into Equation C.4 and finding a σ threshold that solves Equation C.4 with equality, denoted $\tilde{\sigma}$, yields:

$$\begin{aligned}\Gamma(\tilde{\sigma}) \equiv (1-\delta)\cdot&\Big[\theta\big(L_b^*(0)\big)\cdot\frac{Y^C}{b} - \kappa\big(L_b^*(0)\big)\Big]\\ -\delta\cdot p\cdot(1-\tilde{\sigma})\cdot&\Big\{\gamma\cdot\Big(\big[\theta(L_0^*)\cdot Y^C - \kappa(L_0^*)\big] - \big[(1-\overline{\tau})\cdot\theta(\overline{L})\cdot Y^C - \kappa(\overline{L})\big]\Big)\\ + (1-\gamma)\cdot\bigg(&\Big[\theta\big(L_b^*(0)\big)\cdot\frac{Y^C}{b} - \kappa\big(L_b^*(0)\big)\Big] - \Big[(1-\overline{\tau})\cdot\theta\big(L_b^*(\overline{\tau})\big)\cdot\frac{Y^C}{b} - \kappa\big(L_b^*(\overline{\tau})\big)\Big]\bigg)\Big\} = 0\end{aligned} \tag{C.7}$$

Proposition C.2 (Volatile oil income and secession)**.** *An increase in C's oil production through its effect on increasing b raises the equilibrium likelihood of separatist civil war, that is, increases the range of σ values small enough that C will reject any offer in a strong period, if $\gamma > \tilde{\gamma}$, for $\tilde{\gamma} < 1$ defined the proof, and strictly decreases this range of σ values otherwise. Formally, for $\tilde{\sigma}$ defined in Equation C.7, $\frac{d\tilde{\sigma}}{db} > 0$ if $\gamma > \tilde{\gamma}$, and $\frac{d\tilde{\sigma}}{db} < 0$ if $\gamma < \tilde{\gamma}$.*

Proof. Applying the implicit function theorem to Equation C.7 yields:

$$\frac{d\tilde{\sigma}}{db} = -\frac{\frac{\partial\Gamma}{\partial b}}{\frac{\partial\Gamma}{\partial\tilde{\sigma}}}$$

for

$$\frac{\partial\Gamma}{\partial b} = -\Big\{(1-\delta)\cdot\theta\big(L_b^*(0)\big) - \delta\cdot p\cdot(1-\tilde{\sigma})\cdot(1-\gamma)\cdot\Big[\theta\big(L_b^*(0)\big) - (1-\overline{\tau})\cdot\theta\big(L_b^*(\overline{\tau})\big)\Big]\Big\}\cdot\frac{Y^C}{b^2}$$

and

$$\frac{\partial\Gamma}{\partial\tilde{\sigma}} = \delta\cdot p\cdot\Big\{\gamma\cdot\Big[\Big(\theta(L_0^*)\cdot Y^C - \kappa(L_0^*)\Big) - \Big((1-\overline{\tau})\cdot\theta(\overline{L})\cdot Y^C - \kappa(\overline{L})\Big)\Big]$$

$$+(1-\gamma)\cdot\Big[\Big(\theta\big(L_b^*(0)\big)\cdot\frac{Y^C}{b} - \kappa\big(L_b^*(0)\big)\Big) - \Big((1-\overline{\tau})\cdot\theta\big(L_b^*(\overline{\tau})\big)\cdot\frac{Y^C}{b} - \kappa\big(L_b^*(\overline{\tau})\big)\Big)\Big]\Big\} > 0$$

$\frac{d\tilde{\sigma}}{db}$ is strictly positive if and only if $\frac{\partial\Gamma}{\partial b}$ is strictly negative, which is true if and only if:

$$\gamma > \tilde{\gamma} \equiv 1 - \frac{(1-\delta)\cdot\theta\big(L_b^*(0)\big)}{\delta\cdot p\cdot(1-\tilde{\sigma})\cdot\Big[\theta\big(L_b^*(0)\big) - (1-\overline{\tau})\cdot\theta\big(L_b^*(\overline{\tau})\big)\Big]}$$

The claim $\tilde{\gamma} < 1$ follows because the second term on the right-hand side of the inequality is strictly positive. ■

In the oil discovery case, $\gamma = 1$ (note that this implies the continuation values are identical to those in the baseline game). Therefore, an increase in b raises equilibrium separatism prospects for all parameter values in the oil discovery case. For the price volatility case, bust periods must be sufficiently rare to generate the same result.

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