Appendix A1: Proofs of Propositions

Proof of Proposition 1

First, observe that after a disaster hits and the balance of power permanently shifts to p_d, A_2 will accept any offer $x < p_2 + c_2$ in any subgame perfect equilibrium, and A_1 will accept any $x > p_d - c_1$. Thus, in each period after a disaster, there exist peaceful settlements $x \in [p_d - c_1, p_d + c_2]$. Since A_1 is making offers in bargaining, in equilibrium A_1 will offer $x' = p_d + c_2$, and A_2 will accept any $x \leq x'$. With similar arguments, it can be established that when no disaster occurs in period 2, the peaceful bargaining outcome is $x' = p + c_2$, and war is avoided.

Proof of Proposition 2

First, we will show that war results when the inequality in the proposition is satisfied. To prove by contradiction, suppose that the condition holds, but there exists a peaceful settlement that satisfies both A_1 and A_2. The most A_2 can receive in bargaining is when A_1 concedes the whole pie to A_2 in the first round, which, by supposition of a peaceful settlement, should be greater than A_2's war payoff. Thus, it must be that

$$\begin{aligned} 1 + \delta\left(\alpha\frac{1 - p_d - c_2}{1-\delta} + (1-\alpha)\frac{1-p-c_2}{1-\delta}\right) &\geq \frac{1-p-c_2}{1-\delta} \\ \delta\alpha(p_d - p) &\leq (1-\delta)(p+c_2) \end{aligned}$$

which contradicts the initial supposition.

Second, we will show that peace results when the condition is not satisfied. Suppose that the condition given in the proposition is not satisfied. Then, given the first part of the proof,

A_2 will be satisfied with $x = 0$ in period 1, i.e. A_2 receiving the whole pie in that period. Next, we show that A_2 prefers war to $x = 1$ in period 1, i.e. A_1 receiving the whole pie in that period:

$$
\begin{aligned}
\delta\left(\alpha\frac{1-p_d-c_2}{1-\delta} + (1-\alpha)\frac{1-p-c_2}{1-\delta}\right) &< \frac{1-p-c_2}{1-\delta} \\
\delta\left(\alpha\frac{1-p_d-c_2}{1-\delta} + (1-\alpha)\frac{1-p-c_2}{1-\delta}\right) &< 1-p-c_2+\delta\left(\alpha\frac{1-p-c_2}{1-\delta} + (1-\alpha)\frac{1-p-c_2}{1-\delta}\right) \\
0 &< 1-p-c_2+\delta\alpha(p_d-p)
\end{aligned}
$$

which always holds because $c_2 < 1-p$ and $p_d > p$. Since A_2's continuation value from a peaceful settlement is continuous and strictly increasing in its share of the pie, then there must exist a settlement $x^* \in [0,1)$ that leaves A_2 indifferent between war and peace. We will now show that A_1 prefers that settlement to war as well, and offers it in equilibrium since A_1 is making offers in bargaining. To see this, first denote A_2's continuation value from a peaceful settlement at x^*, where A_2 is indifferent between war and peace as $C_2(x^*) = \frac{1-p-c_2}{1-\delta}$. Since a peaceful settlement does not destroy any value in the game, it must be that A_1's continuation value $C_1(x^*) = \frac{1}{1-\delta} - C_2(x^*) = \frac{p+c_2}{1-\delta} > \frac{p-c_1}{1-\delta}$, which means A_1 must also prefer x^* to war. Thus, A_1 offers x^* in equilibrium and A_2 accepts any $x \leq x^*$, and goes to war otherwise.

Appendix A2: Repeated Disasters Model Extension

In this section, we show that our substantive results hold if we allow for repeated disasters in the model. We consider two versions: one with disasters with permanent effects that can happen in multiple periods; and another in which disasters may repeat but each disaster's effect is temporary.

Repeated Disasters with Permanent Effects

In this version, we extend the model we present in the paper by assuming that the disaster may also happen in periods other than the second period. More specifically, suppose that for every period without a history of a disaster, no disaster takes place with $1-\alpha$ probability, and with α probability, a disaster occurs and the balance parameter shifts from p to p_d. Thus, until a disaster occurs, there is a possibility of disasters in every period. Before a disaster occurs, the balance parameter is p, and after the disaster takes place, it shifts permanently to p_d for the rest of the game.

To analyze the equilibrium behavior in this game, first note that for periods with a disaster, Proposition 1 applies, and states reach a peaceful settlement with the division described as in the proposition. Before a disaster, the best A_2 can possibly do short of war is to accept the whole stake every period until the disaster arrives. Thus, the following recursive equation determines this best case scenario for A_2:

$$\begin{aligned} R_{A2}(1) &= 1+\delta\left[\alpha W_{A2}^{d}+(1-\alpha)R_{A2}(1)\right] \\ R_{A2}(1) &= \frac{1+\delta\alpha W_{A2}^{d}}{1-\delta(1-\alpha)} \end{aligned}$$

where $W_{A2}^{d}=\frac{1-p_d-c_2}{1-\delta}$ is what A_2 expects to receive once the disaster arrives, based on

Proposition 1. Thus, if this best case scenario's payoff is worse than the war payoff ($W_{A2} = \frac{1-p-c_2}{1-\delta}$) for A_2, war results. More specifically, war occurs before a disaster takes place when

$$\begin{aligned} W_{A2} &> R_{A2}(1) \\ \delta\alpha(W_{A2} - W^d_{A2}) &> 1 - (1-\delta)W_{A2} \\ \delta\alpha(p_d - p) &> (1-\delta)(p + c_2) \qquad (1) \end{aligned}$$

Similar arguments to the ones presented in the Proof of Proposition 2 establish the equilibrium. Thus, as in the simpler version presented in the text, in this version of the game as well, war is more likely before the disaster arrives as the magnitude of the shift ($p_d - p$) gets larger due to the disaster, and as disasters get more likely (α increases).[1]

Repeated Disasters with Temporary Effects

Now, we instead assume that repeated disasters have temporary effects. In each period of the game, a disaster may hit with α probability, and no disaster occurs with a probability of $1 - \alpha$. For every period with a disaster, the balance parameter is p_d, and for every period without a disaster, the balance is p. Thus, after a period with a disaster, unless another disaster strikes, A_1 and A_2 recover and the balance parameter shifts back to p.

As above, we are interested in the equilibrium conditions for war in periods without a disaster. Denote A_2's payoff for the subgames that experienced a disaster with S^d_{A2}. If such subgames involve war, then $S^d_{A2} = W^d_{A2}$. Otherwise, $W^d_{A2} \leq S^d_{A2} = \frac{1-x*+\delta(1-\alpha)S_{A2}}{1-\delta\alpha} \leq V_d - W^d_{A1}$, where V_d is the expected total value of the disaster subgame, W^d_{A1} is A_1's payoff from war in a disaster subgame, $x* \in [0,1]$ is A_1's share of the stake in bargaining in a disaster subgame,

[1] One example parameter configuration guaranteeing war before a disaster is $\delta = .95$, $\alpha = .1$, $p_d = .5$, $p = .3$, and $c_2 = .01$.

and S_{A2} is A_2's payoff from subgames that do not experience a disaster. Same as above, for periods without a disaster, the best A_2 can do is to accept the whole stake every period until a disaster arrives. Thus, the following recursive equation determines this best case scenario for A_2:

$$
\begin{aligned}
R_{A2}(1) &= 1 + \delta\left[\alpha S^d_{A2} + (1-\alpha) R_{A2}(1)\right] \\
R_{A2}(1) &= \frac{1 + \delta\alpha S^d_{A2}}{1 - \delta(1-\alpha)}
\end{aligned}
$$

Likewise, war occurs before a disaster takes place if and only if

$$
\begin{aligned}
W_{A2} &> R_{A2}(1) \\
\delta\alpha(W_{A2} - S^d_{A2}) &> 1 - (1-\delta) W_{A2} \qquad (2)
\end{aligned}
$$

Note that this condition is very similar to the one given in Proposition 2. Given that S^d_{A2} is bounded above by $\frac{1}{1-\delta} - W^d_{A1}$ (this is the most A_2 can possibly do in any given period, as A_1 will never accept any payoff below its war payoff), a sufficient condition for war is[2]

$$
\begin{aligned}
\delta\alpha(W_{A2} - \frac{1}{1-\delta} + W^d_{A1}) &> 1 - (1-\delta) W_{A2} \\
\delta\alpha(p_d - p - (c_1 + c_2)) &> (1-\delta)(p + c_2) \qquad (3)
\end{aligned}
$$

Thus, in this version of the game as well, war condition is more likely to be satisfied before a disaster as the magnitude of the shift in favor of A_1 due to a disaster $(p_d - p)$ gets larger, and as disasters with temporary effects get more likely (α increases).[3]

---

[2]This equilibrium condition is established based on arguments that are very similar to those presented in the proof of Proposition 2.

[3]As in the previous extension, one example parameter configuration that guarantees war before a disaster is $\delta = .95$, $\alpha = .1$, $p_d = .5$, $p = .3$, $c_1 = .01$, and $c_2 = .01$.

Appendix A3: Additional Tests

Table A1: Interstate Conflict and Disaster Risks, Including Disaster Dyads, Post-1945

	Pol. Rel. Dyads			All Dyads		
	MA1	MA2	MA3	MA4	MA5	MA6
Ave. Disaster Risk	-	0.190**	0.199**	-	0.129**	0.149**
		(0.039)	(0.039)		(0.037)	(0.038)
Total Dis. Events	-	-	0.012**	-	-	0.024**
			(0.006)			(0.008)
Cyclones Risk	0.035*	-	-	0.064*	-	-
	(0.019)			(0.033)		
Droughts Risk	0.063**	-	-	0.031	-	-
	(0.020)			(0.019)		
Earthquake Risk	0.102*	-	-	0.166**	-	-
	(0.058)			(0.054)		
Floods Risk	0.066**	-	-	0.056**	-	-
	(0.019)			(0.020)		
Landslides Risk	-0.042	-	-	-0.169**	-	-
	(0.056)			(0.054)		
Volcanoes Risk	-0.305**	-	-	-0.100	-	-
	(0.109)			(0.124)		
Cyclone Events	0.042*	0.042*	-	0.083**	0.092**	-
	(0.024)	(0.024)		(0.025)	(0.023)	
Drought Events	-0.248**	-0.240**	-	-0.472**	-0.468**	-
	(0.098)	(0.097)		(0.102)	(0.101)	
Earthq. Events	0.041	0.057*	-	0.118**	0.131**	-
	(0.033)	(0.032)		(0.036)	(0.034)	
Flood Events	0.072	0.060	-	0.233**	0.205**	-
	(0.064)	(0.067)		(0.056)	(0.059)	
Landsl. Events	-0.124	-0.130	-	-0.321**	-0.321**	-
	(0.107)	(0.110)		(0.124)	(0.126)	
Volcano Events	0.495**	0.300**	-	0.325**	0.233*	-
	(0.144)	(0.151)		(0.125)	(0.120)	
Relative Cap.	0.571	0.441	0.415	-0.409	-0.338	-0.534
	(0.574)	(0.546)	(0.559)	(0.488)	(0.477)	(0.506)
Contiguity	-0.273**	-0.299**	-0.280**	-0.712**	-0.714**	-0.709**
	(0.046)	(0.044)	(0.043)	(0.037)	(0.037)	(0.039)
Joint Democ.	-0.574**	-0.601**	-0.575**	-0.363**	-0.418**	-0.368*
	(0.223)	(0.228)	(0.232)	(0.183)	(0.178)	(0.194)
Rivalry	1.281**	1.262**	1.252**	1.496**	1.552**	1.531**
	(0.182)	(0.180)	(0.183)	(0.203)	(0.203)	(0.211)
Alliance	0.011	0.076	0.073	-0.002	0.048	0.042
	(0.057)	(0.060)	(0.061)	(0.060)	(0.062)	(0.064)
Observations	36,486	36,486	36,486	392,860	392,860	392,860

Note: All years, including disaster years. Peace year polynomials not reported to save space.
** p < 0.10, ** p < 0.05*