Technical Appendix

[Verdier, Daniel. "Bargaining Strategies for Governance Complex Games"]

1 Forum Shifting for the Weak Game

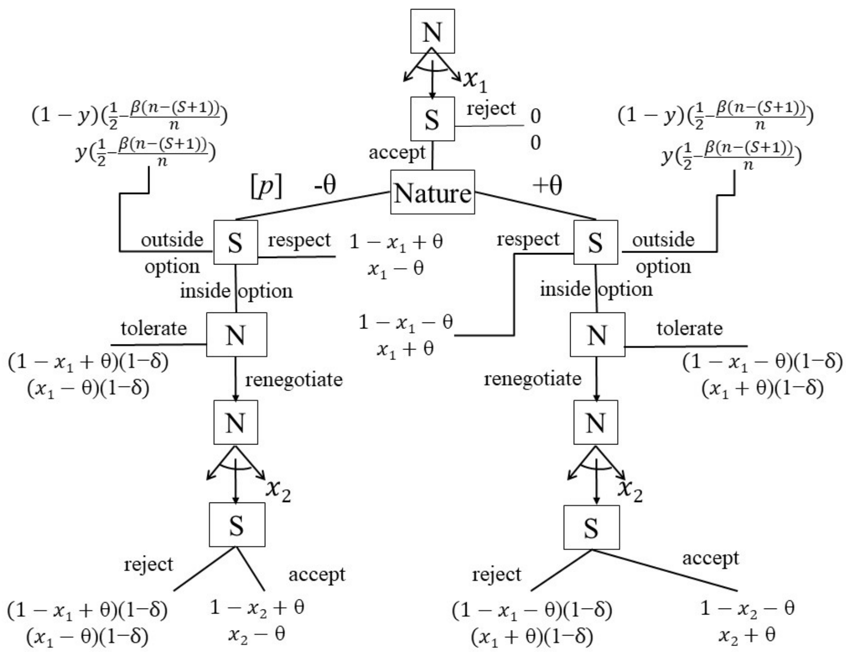


Figure 1: The Forum Shifting For The Weak game tree

1.1 Terminology

x_1 : share of IP pie offered by North to South during initial negotiation, $0 \leq x_1 \leq 1$;

p : probability that Nature chooses bad circumstances for South (good for North), $0 \leq p \leq 1$;

θ : incremental payoff added or subtracted by Nature to the players' payoffs,

$0 < \theta < 1$;

δ : index of degradation, $0 < \delta < 1$;

x_2 : share of IP pie offered by North to South during renegotiation, $0 \leq x_2 \leq 1$.

y : share of IP pie kept by South in rival organization.

β : parameter capturing the relative inefficiency of the rival organization.

n : number of countries.

S : South's core subset.

1.2 Assumption

An implicit assumption behind the construction of the game tree is that South will wait for Nature's shock before contemplating the option of building a rival organization. However, they would not wait if their payoff for building a rival organization were greater than South's initial reservation value of 0. Therefore, to insure they wait, I assume that $y\left(\frac{1}{2} - \frac{\beta(n-(S+1))}{n}\right) < 0 \Rightarrow S < -\frac{1}{2\beta}\left(n + 2\beta - 2n\beta\right) \equiv \bar{S}$. This assumption does not prevent South from pursuing a rival organization as long as $py\left(\frac{1}{2} - \frac{\beta(n-(S+1))}{n}\right) + (1-p)\left(x_1 + \theta\right) \geq 0$.

1.3 Solution concept

The game calls for subgame perfection. In light of the large number of possible equilibria, backward induction is impractical. Instead, I follow the spirit of the mechanism design approach, which consists in first identifying the equilibria that North—the agenda setter—could possibly favor, then identifying the incentive constraints that each of these equilibria must meet, and finally have North choose among them the equilibria that deliver the highest payoffs, one for every plausible parametric configuration. But firstly, two lemma help reduce the number of possible equilibria.

Lemma 1 *North always renegotiates.*

Proof. On the left side of the tree, South accept the x_2 offer if $x_2 - \theta \geq (x_1 - \theta)(1 - \delta) \Rightarrow x_2 \geq (x_1 - \theta)(1 - \delta) + \theta$. Since North minimize x_2, we have

$$x_2^* = x_1 - \delta x_1 + \theta\delta \tag{1}$$

For this result to exist, one must have $x_1 - \delta x_1 + \theta\delta \leq 1 \Rightarrow x_1 \leq \frac{1}{\delta - 1}(\theta\delta - 1)$, which is always true. Furthermore, for this result to be binding, one must have $x_1 - \delta x_1 + \theta\delta \geq 0$, which is also always true.

Still on the left side, North's renegotiation payoff is $U_P(renego) = 1 - x_{2L}^* + \theta$, while their "tolerate" payoff is $U_P(tolerate) = (1 - x_1 + \theta)(1 - \delta)$. After substitution, renegotiation is better than tolerate if $1 - (x_1(1 - \delta) + \delta\theta) + \theta - (1 - x_1 + \theta)(1 - \delta) \Rightarrow \delta > 0$, which is always so.

On the right side of the tree, using a similar reasoning, it can be shown that $x_2^* = \max(0, x_1(1 - \delta) - \delta\theta)$. It is easy to show after substitution that $1 - x_2^* - \theta \geq (1 - x_1 - \theta)(1 - \delta)$. ■

Lemma 2 *South always respects in the case of good circumstances.*

Proof. $U_A(inside) = x_2 + \theta$ with $x_2^* = \max(0, x_1(1 - \delta) - \delta\theta)$, is always inferior to $U_A(respect) = x_1 + \theta$. ■

This leaves four possible equilibria: (1) the *regime-shifting equilibrium*, having for path "inside option-renegotiate-accept" on the left side of the tree, "respect" on the right side and "accept" at the top; (2) the *respect equilibrium*, having for path "respect" on both sides and "accept" at the top; (3) the outside-option equilibrium, having for path "outside option" on the right side, "respect" on the left side and "accept" at the top; and (4) the *no-deal equilibrium* with for path "reject" at the top. North chooses the equilibrium that delivers the highest payoff. I analyze each one sequentially.

1.4 Simplification

To simplify the analysis, I assume that $y = 1$; South appropriates the entire pie generated by the outside option.

1.5 The regime-shifting (inside option) equilibrium

For South to prefer the regime shifting equilibrium on the left side of the tree, it has to deliver a higher payoff than the other three equilibria.

Concerning the respect equilibrium, it was already calculated in lemma 1 that North offer x_2^* and that South accept. Moving up the path, South exercise their outside option if $x_2^* - \theta \geq x_1 - \theta$, which, after substitution, yields incentive constraint $x_1 \leq \theta$.

With respect to the outside option equilibrium, regime shifting prevails if

$x_2^* - \theta \geq \frac{1}{2} - \frac{\beta(n-S-1)}{n} \Rightarrow$

$$x_1 \geq -\frac{1}{2}\frac{n + 2\beta + 2S\beta + 2n\theta - 2n\beta - 2n\theta\delta}{n(\delta - 1)}. \qquad (2)$$

This incentive constraint exists if the fraction is inferior or equal to unity, or $\theta \leq \frac{1}{2}\frac{-n+2\beta+2S\beta-2n\beta+2n\delta}{n(\delta-1)} \equiv \ddot{\theta}$. It is binding if it is superior to zero, or $\theta > \frac{1}{2}\frac{n+2\beta+2S\beta-2n\beta}{n(\delta-1)} \equiv \acute{\theta}$; otherwise $x_1 = 0$.

Finally, regime shifting beats the no-deal equilibrium if $p(x_2^* - \theta) + (1-p)(x_1 + \theta) \geq 0 \Rightarrow$

$$x_1 \geq \frac{\theta - 2p\theta + p\theta\delta}{p\delta - 1}, \qquad (3)$$

an incentive constraint that always exist but is binding only when $p > \frac{1}{2-\delta}$; $x_1 = 0$ otherwise.

To steer South toward the regime-shifting equilibrium, North offers the smallest x_1 that satisfies the binding incentive constraint. Between the two candidates to bindingness, (2) and (3), it is easy to determine that the former is binding if $\theta > \frac{1}{4}(p\delta - 1)\frac{n+2\beta+2S\beta-2n\beta}{n(\delta-1)(p-1)} = \ddot{\Theta}$, otherwise the latter is. If neither is binding, then $x_1^* = 0$.

One last constraint that must be met is North's participation constraint: $p(1 - x_2^* + \theta) + (1-p)(1 - x_1 - \theta) \geq 0$. It is easily verified that this last condition is always met by (3) and $x_1^* = 0$, while (2) meets it when $\theta < \frac{1}{4}\frac{n-2\beta-2S\beta+2n\beta-2n\delta+np\delta+2p\beta\delta+2Sp\beta\delta-2np\beta\delta}{n(\delta-1)(p-1)} \equiv \vec{\Theta}$.

In sum, we have established the following conditions and values for the regime-shifting equilibrium:

IF	&	THEN $x_1 =$
$\vec{\Theta}, \ddot{\theta} < \theta$		$\nexists$
$\acute{\theta}, \ddot{\Theta} < \theta < \vec{\Theta}, \ddot{\theta}$		$-\frac{1}{2}\frac{n+2\beta+2S\beta+2n\theta-2n\beta-2n\theta\delta}{n(\delta-1)} \equiv s_1$
$\theta < \ddot{\Theta}$	$p > \frac{1}{2-\delta}$	$\theta\frac{-2p+p\delta+1}{p\delta-1} \equiv s_4$
$\theta < \acute{\theta}$	$p < \frac{1}{2-\delta}$	$0 \equiv s_0$

1.6 The Respect equilibrium

For South to prefer the respect equilibrium on the left side of the tree, it has to deliver a higher payoff than the other three equilibria. We saw in the prior section that respect beats regime shifting if

$$x_1 \geq \theta. \tag{4}$$

We now establish that respect beats outside option if $x_1 - \theta \geq \frac{1}{2} - \frac{\beta(n-S-1)}{n} \Rightarrow$

$$x_1 > \frac{1}{2}\frac{n+2\beta+2S\beta+2n\theta-2n\beta}{n}. \tag{5}$$

This incentive constraint exists if $\frac{1}{2}\frac{n+2\beta+2S\beta+2n\theta-2n\beta}{n} \leq 1 \Rightarrow \theta < -\frac{1}{2}\frac{-n+2\beta+2S\beta-2n\beta}{n} \equiv \bar{\theta}$. It is binding if $\frac{1}{2}\frac{n+2\beta+2S\beta+2n\theta-2n\beta}{n} > 0 \Rightarrow \theta > -\frac{1}{2}\frac{n+2\beta+2S\beta-2n\beta}{n} \equiv \vec{\theta}$, otherwise $x_1 = 0$.

Last, respect beats the no-deal equilibrium if $p(x_1 - \theta) + (1-p)(x_1 + \theta) \geq 0$ $\Rightarrow$

$$x_1 \geq \theta(2p-1). \tag{6}$$

While this lower limit always exists, it is binding only when $p \geq \frac{1}{2}$, otherwise $x_1 = 0$.

For any of these constraints to be binding, they must first meet North's participation constraint: $p\,(1 - x_1 + \theta) + (1 - p)\,(1 - x_1 - \theta) \geq 0$. In the case of (4), this condition is realized for values of $\theta < -\frac{1}{2(p-1)} \equiv \bar{\Theta}$, while in the other two cases, it is always realized.

Among the three incentive constraints, (4) always binds in relation to (6) while (4) binds in relation to (5) if $\theta \geq \frac{1}{2}\frac{n+2\beta+2S\beta+2n\theta-2n\beta}{n} \Rightarrow S \leq \frac{1}{2}\frac{-n-2\beta+2n\beta}{\beta} \equiv \bar{S}$.

In sum, the values and conditions for existence of the respect equilibrium are:

IF	&	$THEN\ x_1 =$
$\bar{\Theta}, \vec{\theta} < \theta < \bar{\theta}$		$\frac{1}{2}\frac{n+2\beta+2S\beta+2n\theta-2n\beta}{n} \equiv r_3$
$\vec{\theta} < \theta < \bar{\theta}, \bar{\Theta}$	$S > \bar{S}$	$\frac{1}{2}\frac{n+2\beta+2S\beta+2n\theta-2n\beta}{n}$
$\vec{\theta} < \theta < \bar{\theta}, \bar{\Theta}$	$S < \bar{S}$	$\theta \equiv r_5$
$\theta < \vec{\theta}$		θ

1.7 The no-deal equilibrium: conjecture

North's utility for this equilibrium being naught, I conjecture that it is weakly dominated by at least one of the others. Proof is postponed until the end.

1.8 The outside option equilibrium

A necessary condition for the South to exercise their outside option in equilibrium is for them to prefer it to the other three available strategies.

South prefers outside option to respect if, as calculated above, $x_1 \leq \frac{1}{2}\frac{n+2\beta+2S\beta+2n\theta-2n\beta}{n}$, and thus with existence condition $\theta \geq \vec{\theta}$ and binding condition $\theta \leq \bar{\theta}$.

South prefers outside option to regime shifting if, also as calculated above, $x_1 \leq -\frac{1}{2}\frac{n+2\beta+2S\beta+2n\theta-2n\beta-2n\theta\delta}{(\delta-1)n}$, and thus with existence condition $\theta \geq \acute{\theta}$ and binding condition $\theta \leq \ddot{\theta}$.

Finally, South prefers outside option to the no-deal equilibrium if

$$x_1 \geq \frac{p\left(\frac{1}{n}\beta\left(S-n+1\right)+\frac{1}{2}\right)-\theta\left(p-1\right)}{p-1}, \tag{7}$$

with existence condition $\theta > \frac{1}{2}\frac{2n+2p\beta-np+2Sp\beta-2np\beta}{n(p-1)} \equiv \dot{\theta}$ and binding condition $\theta < \frac{1}{2}p\frac{n+2\beta+2S\beta-2n\beta}{n(p-1)} \equiv \vec{\theta}$. This potentially binding value for x_1 must meet the North's participation equilibrium: $p\left(\left(1-y\right)\left(\frac{1}{2}-\frac{\beta(n-S-1)}{n}\right)\right)+\left(1-p\right)\left(1-x_1-\theta\right) \geq 0$, with $y=1$, yielding $S > \frac{1}{2}\frac{-2n-2p\beta+np+2np\beta}{p\beta} \equiv \Sigma$.

The values and conditions for the outside option equilibrium are:

IF	$THEN\ x_1 =$
$\dot{\theta}, \vec{\theta}, \acute{\theta} < \theta < \vec{\theta}$	$\frac{p\left(\frac{1}{n}\beta(S-n+1)+\frac{1}{2}\right)-\theta(p-1)}{p-1} \equiv o_2$
$\vec{\theta} < \theta < \vec{\theta}, \acute{\theta}$	$0 \equiv o_0$

*

Table 1 recapitulates the results so far. It provides a partition of the binding incentive constraints faced by North for each available strategy (regime shifting, respect, and outside option). For each case—there are ten in total, each defined by a special configuration of parameters θ and p—North faces a selection of strategies among which they choose the most favorable.

Table 1: Partition of binding incentive constraints

θ	p	RShift	respect	OutOpt	case
$\vec{\theta} < \theta < \dot{\theta}, \bar{\theta}$		s_4	r_5		1
$\dot{\theta}, \acute{\theta} < \theta < \ddot{\Theta}$		s_4	r_5	o_2	2
$\ddot{\Theta} < \theta < \underline{\Theta}, \bar{\theta}$		s_1	r_5	o_2	3
$\acute{\theta}, \underline{\Theta} < \theta < \bar{\Theta}, \bar{\theta}$		s_1	r_5	o_0	4
$\bar{\Theta} < \theta < \vec{\Theta}, \bar{\theta}$		s_1	r_3	o_0	5
$\vec{\Theta} < \theta < \bar{\theta}$			r_3	o_0	6
$\vec{\theta} < \theta < \acute{\theta}$	$> \frac{1}{2-\delta}$	s_0	r_5		7
$\theta < \vec{\theta}$	$> \frac{1}{2-\delta}$	s_0	r_5		8
$\vec{\theta}, \dot{\theta} < \theta < \acute{\theta}$	$< \frac{1}{2-\delta}$	s_4	r_5		9
$\theta < \vec{\theta}$	$< \frac{1}{2-\delta}$	s_4	r_5		10

The rest of the analysis follows two steps. First, I consider each case separately to determine the winning equilibrium. Then, I collect all the results and draw a map of the winning equilibria.

1.9 Case-by-case solution

Case 1: $\vec{\theta} < \theta < \dot{\theta}, \bar{\theta}; s_4, r_5$

$U_N^{RS}(x_1 = s_4) > U_N^{resp}(x_1 = r_5) \Rightarrow p(1 - x_2^* + \theta) + (1-p)(1 - s_4 - \theta) > p(1 - r_5 + \theta) + (1-p)(1 - r_5 - \theta) \Rightarrow 1 > -2\theta + 2p\theta + 1$, always. Therefore, case 1 features regime shifting (with $x_1 = s_4$) as dominant strategy.

Case 2: $\dot{\theta}, \acute{\theta} < \theta < \ddot{\Theta}; s_4, r_5, o_2$

From case 1, $U_N^{RS}(x_1 = s_4) > U_N^{resp}(x_1 = r_5)$.

$U_N^{oo}(x_1 = o_2) > U_N^{resp}(x_1 = r_5) \Rightarrow p\left((0)\left(\frac{1}{2} - \frac{\beta(n-S-1)}{n}\right)\right) + (1-p)(1-o_2-\theta) > p(1-r_5+\theta) + (1-p)(1-r_5-\theta) \Rightarrow \frac{1}{2}\frac{2n+2p\beta-np+2Sp\beta-2np\beta}{n} > -2\theta+2p\theta+1 \Rightarrow \theta > \frac{1}{4}p\frac{-n+2\beta+2S\beta-2n\beta}{n(p-1)} \equiv \dot{\Gamma}$, otherwise $U_N^{oo}(x_1 = o_2) < U_N^{resp}(x_1 = r_5)$

$U_N^{oo}(x_1 = o_2) > U_N^{RS}(x_1 = s_4) \Rightarrow p\left((0)\left(\frac{1}{2} - \frac{\beta(n-S-1)}{n}\right)\right) + (1-p)(1-o_2-\theta) > p(1-x_2^* + \theta) + (1-p)(1-s_4-\theta) \Rightarrow \frac{1}{2}\frac{2n+2p\beta-np+2Sp\beta-2np\beta}{n} > 1 \Rightarrow S > \frac{1}{2}\frac{n-2\beta+2n\beta}{\beta}$, which cannot be given that case 2 assumes $S < \bar{S}$. Therefore, case 2 also features regime shifting (with $x_1 = s_4$) as dominant strategy.

Case 3: $\ddot{\Theta} < \theta < \underline{\Theta}, \bar{\theta}; s_1, r_5, o_2$

From Case 2, $U_N^{oo}(x_1 = o_2) > U_N^{resp}(x_1 = r_5)$ for $\theta > \dot{\Gamma}$, the reverse otherwise.

$U_N^{RS}(x_1 = s_1) > U_N^{resp}(x_1 = r_5) \Rightarrow p(1-x_2^*+\theta) + (1-p)(1-s_1-\theta) > p(1-r_5+\theta) + (1-p)(1-r_5-\theta) \Rightarrow -\frac{1}{2}\frac{n-2\beta-2S\beta-4n\theta+2n\beta-2n\delta+4np\theta+np\delta+4n\theta\delta+2p\beta\delta+2Sp\beta\delta-4np\theta\delta-2np\beta\delta}{n(\delta-1)} > -2\theta+2p\theta+1 \Rightarrow S < \bar{S}$, which matches the case definition.

$U_N^{oo}(x_1 = o_2) > U_N^{RS}(x_1 = s_1) \Rightarrow p\left((0)\left(\frac{1}{2} - \frac{\beta(n-S-1)}{n}\right)\right) + (1-p)(1-o_2-\theta) > p(1-x_2^*+\theta) + (1-p)(1-s_1-\theta) \Rightarrow \frac{1}{2}\frac{2n+2p\beta-np+2Sp\beta-2np\beta}{n} > -\frac{1}{2}\frac{n-2\beta-2S\beta-4n\theta+2n\beta-2n\delta+4np\theta+np\delta+4n\theta\delta+2p\beta\delta+2Sp\beta\delta-4np\theta\delta-2np\beta\delta}{n(\delta-1)} \Rightarrow \theta > \frac{1}{4}\frac{-n-2\beta-2S\beta+2n\beta-2p\beta+np-2Sp\beta+2np\beta\cdots}{n(\delta-1)(p-1)} = \overleftarrow{\Theta}$, otherwise $U_N^{oo}(x_1 = o_2) < U_N^{RS}(x_1 = s_1)$.

Case 4: $\acute{\theta}, \underline{\Theta} < \theta < \bar{\Theta}, \bar{\theta}; s_1, r_5, o_0$

From Case 3, $U_N^{RS}(x_1 = s_1) > U_N^{resp}(x_1 = r_5)$.

$U_N^{oo}(x_1 = o_0) > U_N^{resp}(x_1 = r_5) \Rightarrow p\left((0)\left(\frac{1}{2} - \frac{\beta(n-S-1)}{n}\right)\right) + (1-p)(1 - x_1 - \theta)$
$> p(1 - r_5 + \theta) + (1-p)(1 - r_5 - \theta) \Rightarrow (\theta - 1)(p-1) > -2\theta + 2p\theta + 1 \Rightarrow \theta >$
$-\frac{p}{p-1} = \underline{\Gamma}$.

$U_N^{RS}(x_1 = s_1) > U_N^{oo}(x_1 = o_0) \Rightarrow p(1 - x_2^* + \theta) + (1-p)(1 - s_1 - \theta) >$
$p\left((0)\left(\frac{1}{2} - \frac{\beta(n-S-1)}{n}\right)\right) + (1-p)(1 - x_1 - \theta) \Rightarrow$
$-\frac{1}{2}\frac{n-2\beta-2S\beta-4n\theta+2n\beta-2n\delta+4np\theta+np\delta+4n\theta\delta+2p\beta\delta+2Sp\beta\delta-4np\theta\delta-2np\beta\delta}{n(\delta-1)} > -\frac{1}{2}\frac{-n+2\beta+2S\beta+4n\theta-2n\beta-4np\theta}{n} \Rightarrow$
$\theta > \frac{1}{2}\frac{-n-2\beta-2S\beta+2n\beta+2np-np\delta+2p\beta\delta+2Sp\beta\delta-2np\beta\delta}{(p-1)n(\delta-1)} = \overleftrightarrow{\Theta}$.

Case 5: $\bar{\Theta} < \theta < \vec{\Theta}, \bar{\theta}; s_1, r_3, o_0$

From case 4, $U_N^{RS}(x_1 = s_1) > U_N^{oo}(x_1 = o_0) \Rightarrow \theta > \overleftrightarrow{\Theta}$.

$U_N^{RS}(x_1 = s_1) > U_N^{resp}(x_1 = r_3) \Rightarrow p(1 - x_2^* + \theta) + (1-p)(1 - s_1 - \theta) >$
$p(1 - r_3 + \theta) + (1-p)(1 - r_3 - \theta) \Rightarrow$
$-\frac{1}{2}\frac{n-2\beta-2S\beta-4n\theta+2n\beta-2n\delta+4np\theta+np\delta+4n\theta\delta+2p\beta\delta+2Sp\beta\delta-4np\theta\delta-2np\beta\delta}{n(\delta-1)} > -\frac{1}{2}\frac{-n+2\beta+2S\beta+4n\theta-2n\beta-4np\theta}{n} \Rightarrow$
$S < \bar{S}$.

$U_N^{resp}(x_1 = r_3) > U_N^{oo}(x_1 = o_0) \Rightarrow p(1 - r_3 + \theta) + (1-p)(1 - r_3 - \theta) >$
$p\left((0)\left(\frac{1}{2} - \frac{\beta(n-S-1)}{n}\right)\right) + (1-p)(1 - x_1 - \theta) \Rightarrow -\frac{1}{2}\frac{-n+2\beta+2S\beta+4n\theta-2n\beta-4np\theta}{n} >$
$(\theta - 1)(p-1) \Rightarrow \theta < \frac{1}{2}\frac{n+2\beta+2S\beta-2n\beta-2np}{(p-1)n} \equiv \widehat{\Theta}$.

Case 6: $\vec{\Theta} < \theta < \bar{\theta}; r_3, o_0$

From case 5, $U_N^{resp}(x_1 = r_3) > U_N^{oo}(x_1 = o_0) \Rightarrow \theta < \widehat{\Theta}$.

Case 7: $\vec{\theta} < \theta < \acute{\theta}; S < \bar{S}; p > \frac{1}{2-\delta}; s_0, r_5$

$U_N^{RS}(x_1 = s_0) > U_N^{resp}(x_1 = r_5) \Rightarrow p(1 - x_2^* + \theta) + (1-p)(1 - s_0 - \theta) > p(1 - r_5 + \theta) +$

$(1-p)(1 - r_5 - \theta) \Rightarrow -(\theta - 2p\theta + p\theta\delta - 1) > -2\theta + 2p\theta + 1$, always.

Case 8: $\theta < \vec{\theta}; p > \frac{1}{2-\delta}; s_0, r_5$

See case 7.

Case 9: $\vec{\theta}, \dot{\theta} < \theta < \acute{\theta}; p < \frac{1}{2-\delta}; s_4, r_5$

$U_N^{RS}(x_1 = s_4) > U_N^{resp}(x_1 = r_5) \Rightarrow$

$p(1 - x_2^* + \theta) + (1-p)(1 - s_4 - \theta) > p(1 - r_5 + \theta) + (1-p)(1 - r_5 - \theta) \Rightarrow$

$1 > -2\theta + 2p\theta + 1$, always.

Case 10: $\theta < \vec{\theta}; p < \frac{1}{2-\delta}; s_4, r_5$

See case 9.

1.10 Comprehensive solution for $\theta = \frac{1}{2}$

I recapitulate the prior ten cases in a graph with p on the horizontal axis and θ on the vertical axis. Other parameters are set to:

$\beta = 1.1$

$n = 100$

$\delta = \frac{1}{2}$

$S = 40$

Moreover, to facilitate the interpretation of the graph, I color-code the various θ cutpoint values:

$\bar{\theta}$: black

$\dot{\theta}$: green

$\vec{\theta}$: red

$\ddot{\Theta}$: sienna

$\acute{\theta}$: blue

$\vec{\theta}$: yellow

$\bar{\Theta}$: pink dot dot dash

$\vec{\Theta}$: pink dash

$\dot{\Gamma}$: grey

$\overleftarrow{\Theta}$: orange dash

$\underline{\Gamma}$: orange

$\overleftrightarrow{\Theta}$: violet

$\widehat{\Theta}$: purple

Figure 2 represents the various cases:

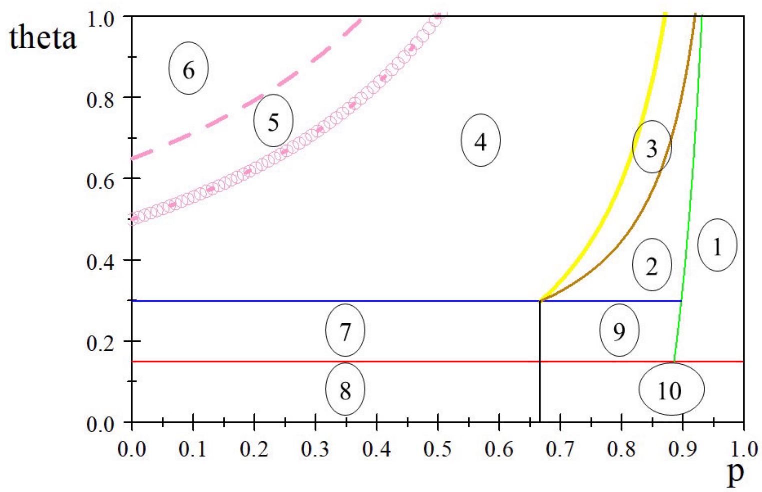


Figure 2: Mapping of cases $(n = 100, \beta = 1.1, S = 40, \delta = .5)$
Figure 3 includes the new cutpoints

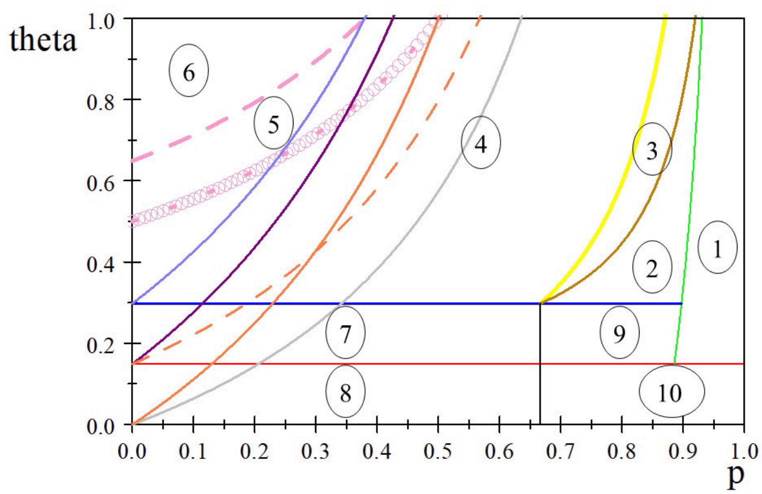


Figure 3: Mapping of cases along with cutpoints

Figure 4 takes into account the calculations performed in the case-by-case section:

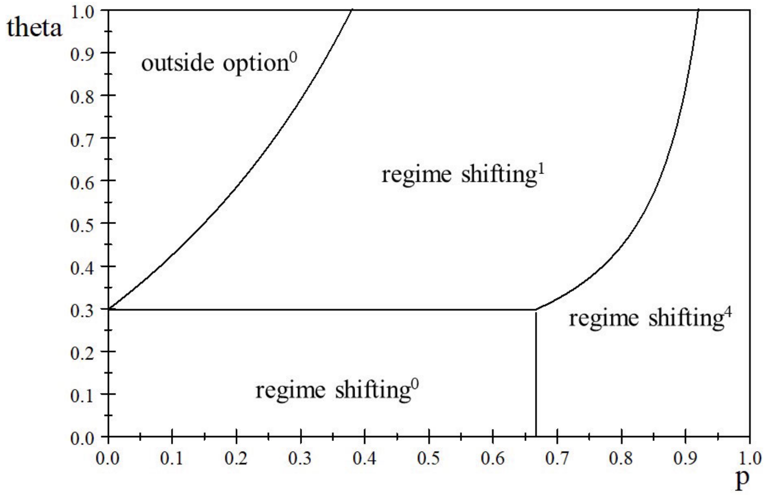


Figure 4: Mapping of equilibria

1.11 Varying δ

Varying δ does not modify the structure of the solution but merely displaces it. A higher δ shifts the schedule toward the north-east whereas a lower δ shift it south-west.

1.12 The no-deal equilibrium revisited

The graph featuring payoffs (Figure 3 in the main text) shows that the no-deal equilibrium is weakly dominated by the other equilibria.

2 Forum Shifting for the Strong Game

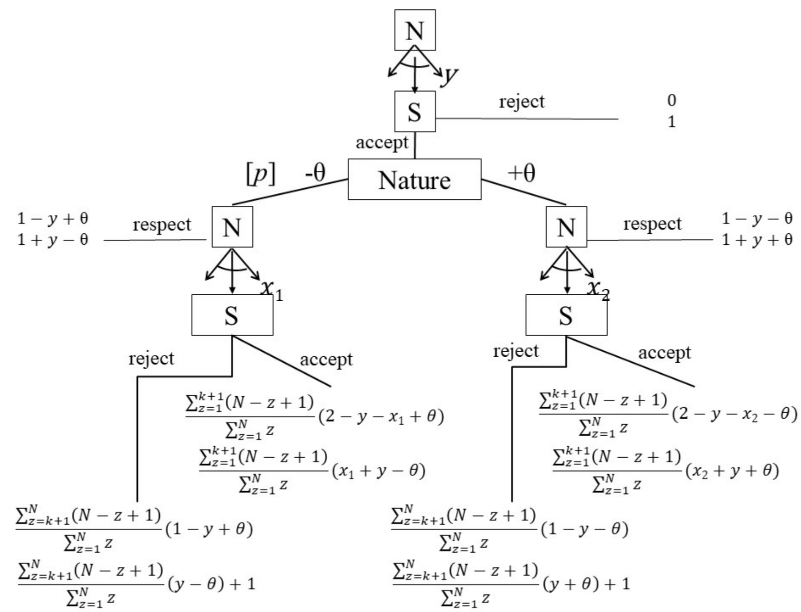


Figure 5: The Forum Shifting For The Strong game tree

2.1 Terminology

y : share of trade pie offered by North to South during initial negotiation, $0 \leq y \leq 1$;

p : probability that Nature chooses bad circumstances for South (good for North), $0 \leq p \leq 1$;

θ : incremental payoff added or subtracted by Nature to the players' payoffs, $0 < \theta < 1$;

x_1 : share of IP pie offered by North to South during renegotiation if Nature chose bad circumstances, $0 \leq x_1 \leq 1$;

x_2 : share of IP pie offered by North to South during renegotiation if Nature chose good circumstances, $0 \leq x_2 \leq 1$;

n : number of countries; $n = 100$.

k : number of Northern governments.

2.2 Solution concept

I am solving for a subgame perfect Nash equilibrium. Given the complexity of the game, I follow the mechanism approach. Many equilibria are conceivable a priori. On the left-hand side of the tree, there are two possible outcomes: North could respect Nature's move or North could offer a linkage cum succession alternative that is accepted. The same is true on the right-hand side, making four possible combinations between the two sides. I focus on the two most competitive strategy profiles: (1) the respect/respect equilibrium, featuring respect on both sides, and (2) the respect/linkage equilibrium featuring respect on the left side and regime cum secession on the right side. So doing, I calculate two versions of the respect/linkage equilibrium: the myopic version and the regular version.

2.3 The respect/respect equilibrium

On either side, North respects Nature's call. Before Nature's call, South accepts the initial deal if $p\left(1+y-\theta\right)+\left(1-p\right)\left(1+y+\theta\right)\geq 1 \Rightarrow y=\theta\left(2p-1\right)$ if $p>\frac{1}{2}$ and $y=0$ if $p<\frac{1}{2}$. Expected utilities for North are $U_N^{resp}\left(y=\theta\left(2p-1\right)\right)=1$ and $U_N^{resp}\left(y=0\right)=1-\theta+2p\theta$, while for South they are $U_S^{resp}\left(y=\theta\left(2p-1\right)\right)=1$ and $U_S^{resp}\left(y=0\right)=1+\theta-2p\theta$.

2.4 The respect/linkage equilibrium

I start on the right-hand side and then expands the analysis to the right side in order to calculate the myopic and regular versions of the equilibrium.

2.4.1 The bad circumstances subgame (right-hand side)

The k northern countries are assumed to be self-organized and moving as one player. South, however, outside the WTO operate as a disorganized group. To impose the WTO over the GATT, North need to convince the $k+1^{th}$ country to join, irrespective of what the other southern countries do, yet with the assurance that if the $k+1^{\tau h}$ joins, all the others will because the same deal is extended to all of them. Hence, for a Southern government to prefer the WTO over the GATT, the following incentive constraint has to be met: $\frac{\sum_{z=1}^{k+1}(n-z+1)}{\sum_{z=1}^{n} z}(y+x_2+\theta) \geq \frac{\sum_{z=k+1}^{n}(n-z+1)}{\sum_{z=1}^{n} z}(y+\theta)+1 \Rightarrow x_2 \geq 2\frac{4950y+4950\theta-200k\theta+k^2y+k^2\theta-200ky+5050}{(k+1)(k-200)} \equiv \bar{x}_2$. North offers $\bar{x}_2$. Analysis of existence and binding conditions reveal the following values and domains:

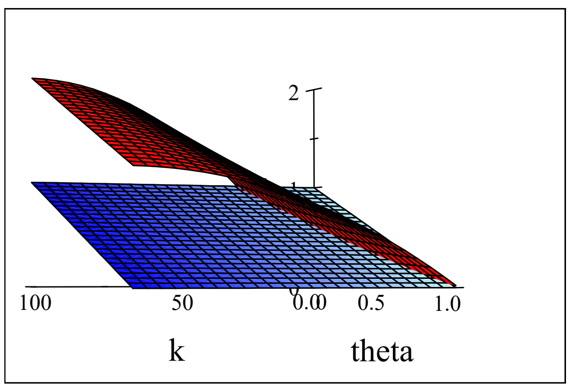
IF	&	THEN $x_2 =$
$k > \bar{k}$	$y > -\frac{4950\theta-200k\theta+k^2\theta+5050}{-200k+k^2+4950}$	$\bar{x}_2$
$k > \bar{k}$	$y < -\frac{4950\theta-200k\theta+k^2\theta+5050}{-200k+k^2+4950}$	0
$k < \bar{k}$		0

(8)

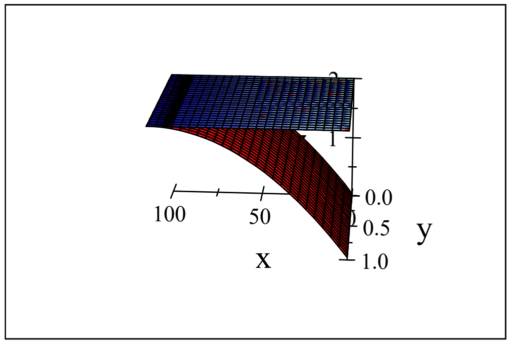
with $\bar{k} = 100 - 5\sqrt{202} = 28.937$. The value $\bar{x}_2$ must also meet North's incentive constraint: $(1-y+1-\bar{x}_2-\theta)\frac{\sum_{z=1}^{k+1}(n-z+1)}{\sum_{z=1}^{n} z} \geq 1-y-\theta$. It can be shown that this is always true.

2.4.2 The myopic equilibrium

Assume that Nature chose good circumstances (right side). Also assume that the game was initiated knowing that Nature would change the payoffs but without knowing that linkage cum succession was a possible move for North. Also fix the likelihood of good circumstances $p = \frac{1}{2}$. In such circumstances, North would have offered $y = 0$ and thus, given result (8), $x_2 = 0$, respectively yielding expected utilities $U_N^{resp} = 1 - \theta$ and $U_N^{LCS} = (2 - \theta) \frac{\sum_{z=1}^{k+1}(n-z+1)}{\sum_{z=1}^{n} z}$. A 3-D plot of North's utility show the superiority of the linkage cum succession payoff (red) over the respect payoff (blue) for most of the $(k \times \theta)$ space and especially for high values of k.



North prefers the linkage strategy over the respect strategy despite the former's greater inefficiency. The next graph computes the aggregate payoffs for each strategy. The respect strategy respects the size of the pie (= 2) throughout the space, whereas the linkage strategy falls below.



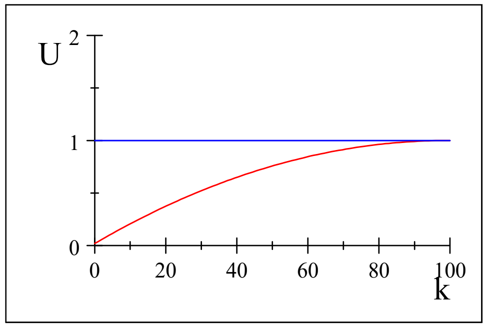
2.4.3 The regular equilibrium

I pair the linkage cum succession equilibrium on the right side with a respect equilibrium on the left side to create the most competitive strategy other than respect/respect. (In the final section I show that North systematically prefer respect/linkage to linkage/linkage.)

Before Nature calls the circumstances, South accept the initial deal if their expected utility for the respect/linkage strategy is greater than one. Formally, the incentive constraint is:

$p\left(1+y-\theta\right)+\left(1-p\right)\left(\bar{x}_2+y+\theta\right)\frac{\sum_{z=1}^{k+1}(n-z+1)}{\sum_{z=1}^{n}z}\geq 1$. Assuming $p=\frac{1}{2}$, North offers $y^*=-\frac{19\,800\theta-599k\theta+3k^2\theta+20\,200}{-599k+3k^2-400}$, whose existence is conditioned on $k>41.81$.

Therefore, North's utility for the respect/linkage strategy is equal to: $U_N^{resp/link}=p\left(1-y^*+\theta\right)+\left(1-p\right)\left(2-\bar{x}_2-y^*-\theta\right)\frac{\sum_{z=1}^{k+1}(n-z+1)}{\sum_{z=1}^{n}z}=-\frac{1}{10\,100}\left(k+1\right)\left(k-200\right).$ I draw North's expected utility for respect/linkage in the next graph, along with North's expected utility for respect/respect. Systematically clocking at one, the latter dominates, strictly so since $k = 100$ is not allowed by the assumptions.



Note that the equivalent expected utilities for South are both equal to one—South's reservation value.

2.5 The linkage/respect equilibrium

The purpose of this section is to show that the linkage/respect equilibrium is dominated by the respect/respect equilibrium.

On the left-hand side, a Southern government prefers the WTO over the GATT if the following incentive constraint is met: $\frac{\sum_{z=1}^{k+1}(n-z+1)}{\sum_{z=1}^{n} z}(y + x_1 - \theta) \geq \frac{\sum_{z=k+1}^{n}(n-z+1)}{\sum_{z=1}^{n} z}(y-\theta)+1$ yielding North to offer $x_1 \geq -2\frac{4950y-4950\theta+200k\theta+k^2y-k^2\theta-200ky+5050}{(k+1)(k-200)} \equiv \bar{x}_1$. However, a study of existence and bindingness reveals that the solution exists only for values of $k > \bar{k}$ and with $x_1 = 0$.

I now calculate the value of y that makes North pursue the linkage/respect strategy. It is such that $(1 - y + 1 - x_1 + \theta)\frac{\sum_{z=1}^{k+1}(n-z+1)}{\sum_{z=1}^{n} z} \geq 1 - y + \theta \Rightarrow y \geq \frac{-398k+9900\theta-199k\theta+k^2\theta+2k^2+9700}{(k-99)(k-100)}$. Given that North chooses the smallest value allowed and following a study of existence and bindingness conditions, the value of y is equal to:

IF	THEN $y =$
$\underline{\theta} < \theta < \overline{\theta}$	$\frac{-398k+9900\theta-199k\theta+k^2\theta+2k^2+9700}{(k-99)(k-100)}$
$\theta < \underline{\theta}$	0

, with $\underline{\theta} = -2\frac{-199k+k^2+4850}{(k-99)(k-100)}$ and $\overline{\theta} = -(k+1)\frac{k-200}{(k-99)(k-100)}$.

I now compare North's payoffs for the linkage/respect strategy with those for the respect/respect strategy. The latter are higher if $p\left(\frac{\sum_{z=1}^{k+1}(n-z+1)}{\sum_{z=1}^{n} z}(y+x_1-\theta)\right)+(1-p)(1-y-\theta) \leq p(1-y_3+\theta)+(1-p)(1-y_3-\theta)$, with $x_1 = 0$, $k > 28.937$ and

IF	&	THEN $y^{resp/resp} =$	& $y^{link/resp} =$
$p > \frac{1}{2}$	$\underline{\theta} < \theta < \overline{\theta}$	$\theta(2p-1)$	$\frac{-398k+9900\theta-199k\theta+k^2\theta+2k^2+9700}{(k-99)(k-100)}$
$p > \frac{1}{2}$	$\theta < \underline{\theta}$	$\theta(2p-1)$	0
$p < \frac{1}{2}$	$\underline{\theta} < \theta < \overline{\theta}$	0	$\frac{-398k+9900\theta-199k\theta+k^2\theta+2k^2+9700}{(k-99)(k-100)}$
$p < \frac{1}{2}$	$\theta < \underline{\theta}$	0	0

.

In all four cases, it can be shown that the above inequality holds.

2.6 The linkage/linkage equilibrium

Since North prefer the respect/respect equilibrium over both the respect/linkage and the linkage/respect equilibria, it follows that they also prefer it to the linkage/linkage equilibrium.