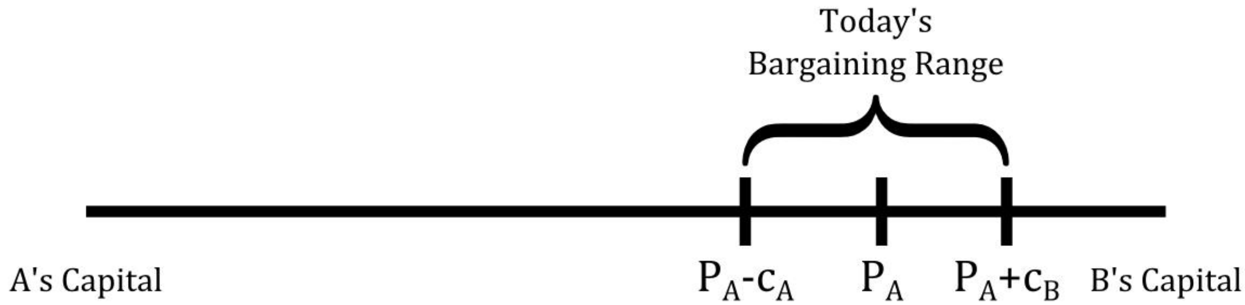
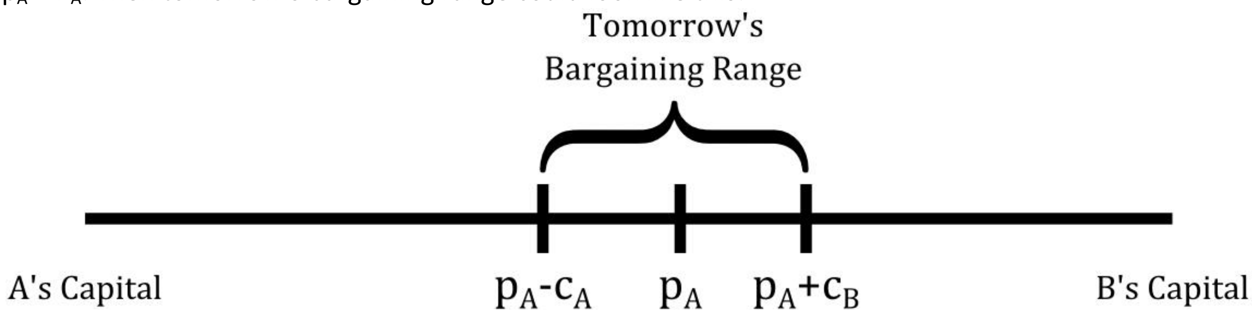
Chapter 3: Preventive War

Recall back to the geometric bargaining model. Suppose today's balance of power between A and B looked like this:

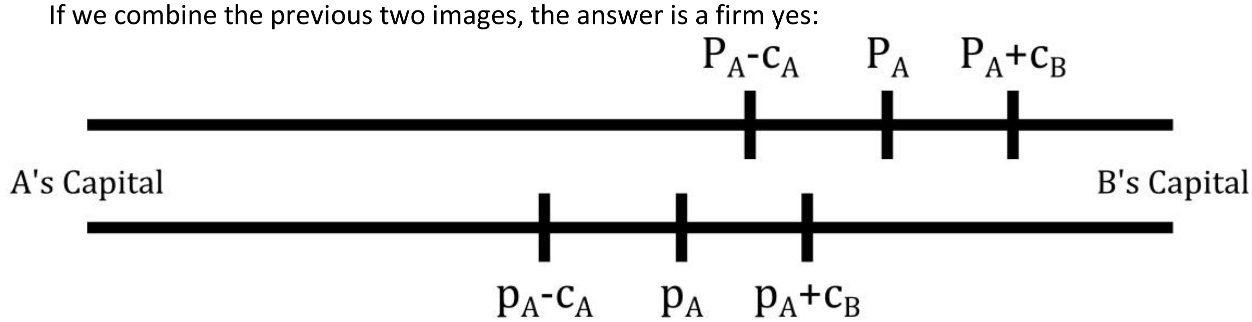


At present, A is strong—so strong, in fact, that we have replaced p_A with a capital P_A. But the political leaders in A are not so cheery. They know B recently developed a new style of tank. Once the assembly lines open, the balance of power will shift in B's favor. Let A's power tomorrow be p_A, where $p_A < P_A$. Then tomorrow's bargaining range could look like this:



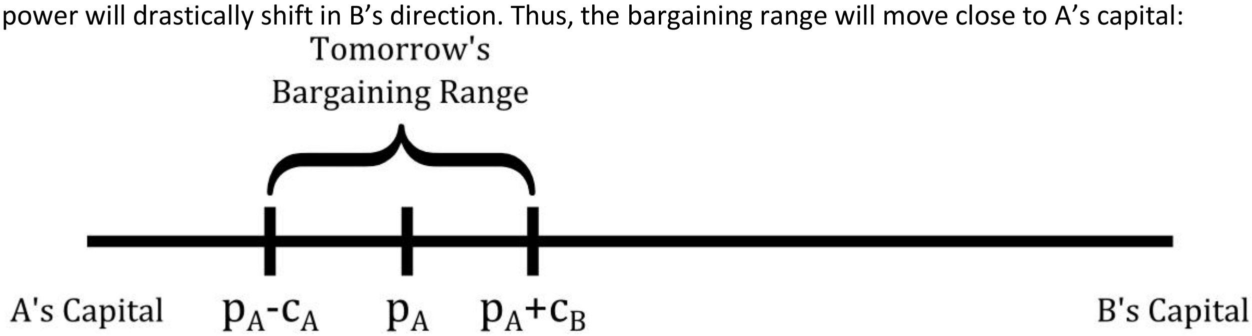
Can the states reach a settlement today, before the new tanks roll out?

If we combine the previous two images, the answer is a firm yes:

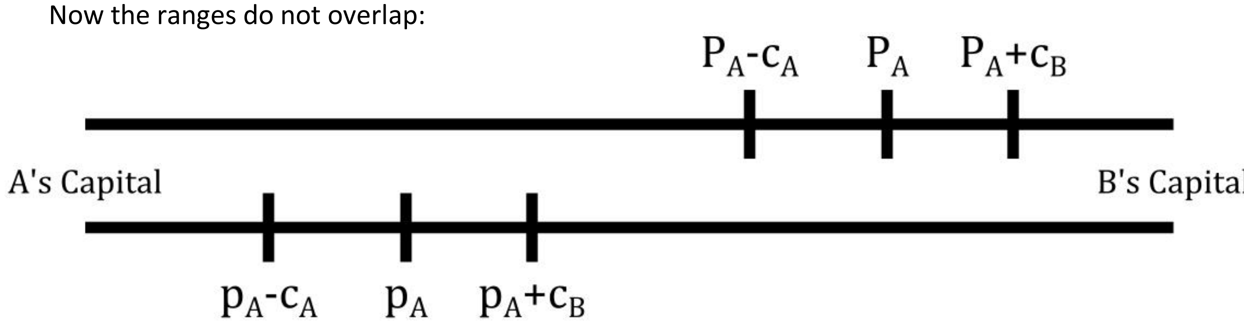


Notice the slight overlap between the bargaining ranges. Any settlement between $P_A - c_A$ and $p_A + c_B$ is mutually preferable to war both today and tomorrow.

But what if the technology was more powerful than a new tank? Perhaps B instead was developing nuclear weapons, as Iran might be doing currently. Tomorrow, B will proliferate, and the balance of power will drastically shift in B's direction. Thus, the bargaining range will move close to A's capital:

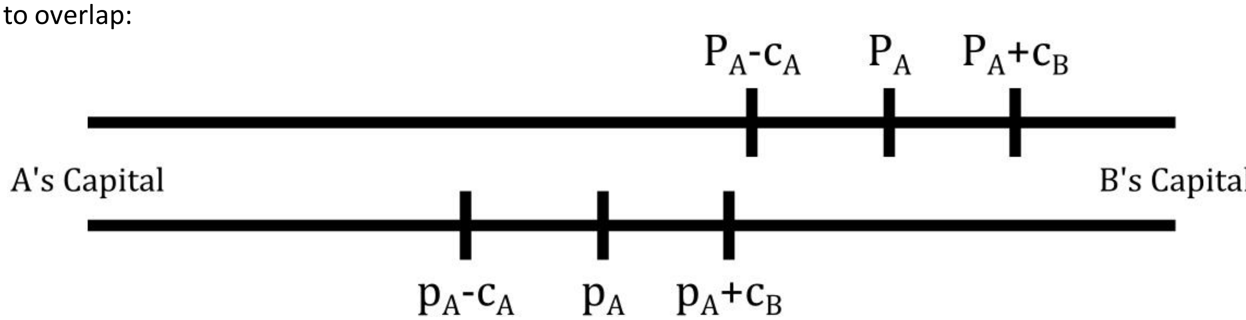


Now the ranges do not overlap:



This time, it appears the states are destined to fight. If A allows the power shift to transpire, it will have to concede a large amount of the good to B. Alternatively, A could start a war before the shift occurs, prevent B from developing the nuclear weapons, and lock in its war payoff of $P_A – c_A$. If A cares at all about the future, that is a much better outcome than receiving $p_A + c_B$ at best for the rest of time.

Broadly, we define a *preventive war* as a conflict in which a declining state intervenes against a rising state to stunt the rising state's growth. This chapter explores preventive war and its precise causal mechanisms, which are not as obvious as they might seem. For example, although the non-overlapping bargaining ranges argument appears reasonable at first, states can sometimes overcome the problem. Consider a middle case, where today's bargaining range and tomorrow's bargaining range just barely fail to overlap:



While the bargaining ranges still do not share any common space here, the states might not be destined to fight. Perhaps they could construct a settlement over time that would satisfy both sides. B, for example, could initially accept a border drawn extremely far to the right, perhaps even at B's capital. After the shift, the states could renegotiate the border within the new bargaining range. A would benefit during the present, B would benefit in the long run, and both would benefit from not paying the costs of fighting.

Although the shifting bargaining range suggests an interesting theory of war, the middle case demonstrates how difficult it is to pin down the exact reasons why states fight. Can states actually construct credible bargains over time to avoid war? Our search for rational preventive war has three steps in this chapter.

In the first section, we consider a bargaining model in which one state grows more powerful as a function of time. For example, although Iran is comparatively weak today, it might develop nuclear weapons at a later date. Depending on the particulars, war or peace can result. If the cost of intervening is too great for the declining state, or if the shift in power is minimal, or if the states care only about the present, the declining state allows the rising state to grow and concedes part of the good in the future. Interestingly, this post-shift transfer of the good is peaceful; there is no reason to expect the states to fight after the rising state has gained its strength. However, if the power shift is too great and the cost of intervention is too cheap, the declining state will rationally initiate preventive war.

Such a model assumes the rising state naturally grows more powerful, as though its guns grew on trees. In practice, becoming more powerful requires devoting more sectors of a state's economy to military production. Governments must actively make such decisions. If we give the rising state the option to build or not build in a model, we might wonder whether war still occurs rationally. As the second section will show, the war result disappears here. If the declining state can credibly threaten preventive war, the rising state simply maintains the status quo distribution of power. On the other hand, if preventive war is too unattractive for the declining state, the rising state recognizes its rival's weakness and shifts power. The declining state gives concessions afterward. Either way, war never occurs.

The third section then explores why states might nevertheless find themselves in a preventive war. One big issue is the matter of observability. Declining states may be unable to see exactly what is going on in the other country. The rising state might be building, or it might not be. Although the declining state would only wish to intervene in the former case, the inability to directly observe the rising state's behavior can trigger preventive war. Arms agreements are insufficient to deter violence here, as the rising states have incentive to cheat on these agreements since they will get away with the violation whenever the declining state does not invade.

Throughout this chapter, we will explore the interaction between Israel and Iran as Iran possibly seeks a nuclear weapon. Nuclear weapons will make Iran much stronger than it is now, which improves Iran's position at the bargaining table. As a result, Israel is thinking about fighting a costly war today to avoid finding itself in a disadvantageous position tomorrow. This motivating case study will elucidate the models' results just as the Columbian/Venezuelan oil crisis did in the previous chapter.

Remember that our overall goal is to explain why states fight. The previous chapter showed that the assumptions of the basic model were too strong, which resulted in the no-war prediction. However, as we relax assumptions, we must be careful to make wise modifications to the game. Exchanging ridiculous assumptions for ridiculous assumptions leads us no closer to understanding why diplomacy ends and gunshots begin.

3.1: Growing More Powerful over Time

To better illustrate this model, let's rename the states R and D, where R represents the rising state and D represents the declining state. The game begins with D choosing whether to launch preventive war or initiate bargaining. If D fights, it prevails in the war with probability P_D but pays a cost $c_D > 0$; R receives a similar payoff, winning with probability $1 - P_D$ but paying a cost $c_R > 0$. If D tries to bargain, it demands x of the good, where $0 \leq x \leq 1$. R can accept or reject that demand. If R rejects, the states fight a war in the same manner had D launched preventive war.

If R accepts, the game takes a new turn. The settlement x is only temporary. After R accepts, the states receive the short-term benefit from that division, and the game moves into a second stage. At this point, power has shifted, and R is more likely to triumph if the states fight. D then demands a new amount y, where $0 \leq y \leq 1$. Again, R accepts or rejects that demand. If R rejects, D wins the war with probability p_D, where $p_D < P_D$; thus, D wins the war less frequently than before. R prevails with probability $1 - p_D$.

If the states fight in the second stage, they still must pay the costs c_D and c_R. In the game we analyze below, these costs remain static over the course of the power transition; relaxing these assumptions to make states' costs smaller or larger will not have a substantive impact on our results.

We will also make an additional assumption about the costs of war to simplify the analysis below. Specifically, assume that $1 - P_D - c_R > 0$ and $p_D - c_D > 0$; that is, the states always receive a positive payoff by going to war. These assumptions are also trivial. If either side's expected utility for war were less than zero, settling the conflict becomes easy; one side would be willing to give away the entire good just to avoid war. By requiring their expected utilities for war to be positive, we merely ensure that the states consider war to be a viable option.

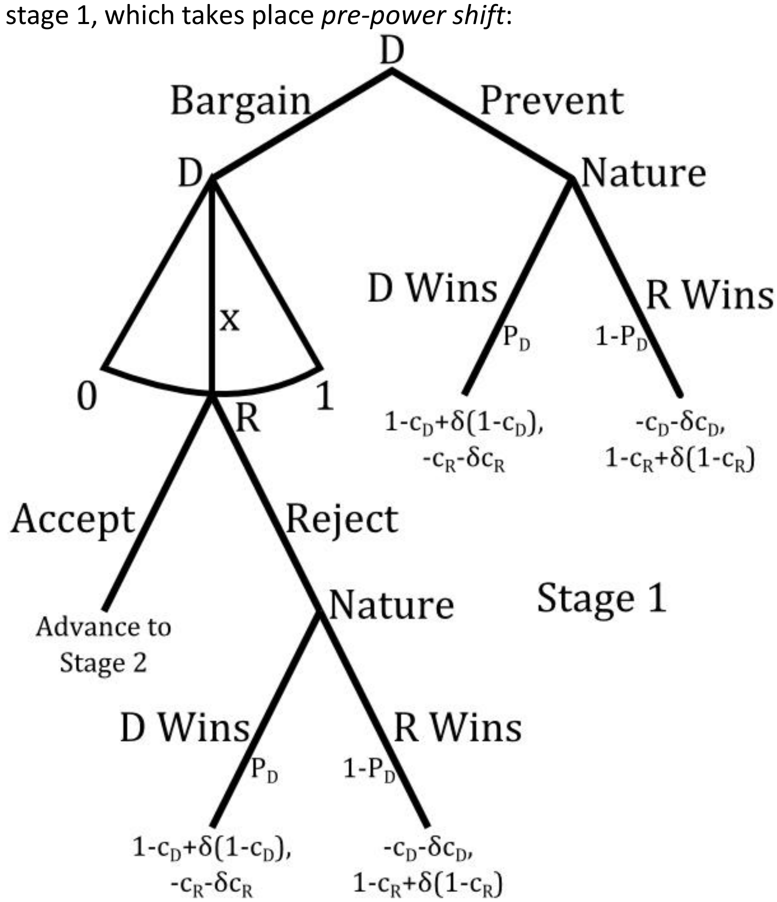
Before we can explicitly define payoffs, we need a method to define how the states value the good through time. For example, extremely impatient states may place more value on their share of the bargain today than they do in the future. In contrast, if the states are forward-looking or the power shift will take place very soon, the states would place greater emphasis on the payoffs in the second stage.

To cover these preferences, we multiply the states' second stage payoffs by δ, which is called a *discount factor*. The values for δ can be any number greater than 0. For example, if R accepts both of D's offers, D earns x + δ(y) and R earns 1 – x + δ(1 – y). Lower values of δ indicate impatience. In the extreme, if δ = 0, the states would not care at all about the second stage, and we would be left with the original bargaining game from the previous chapter. On the opposite end of the spectrum, as δ approaches infinity, the states only care about the future. In the middle, a δ of 3 means the states care about the future three times as much as they care about the present.

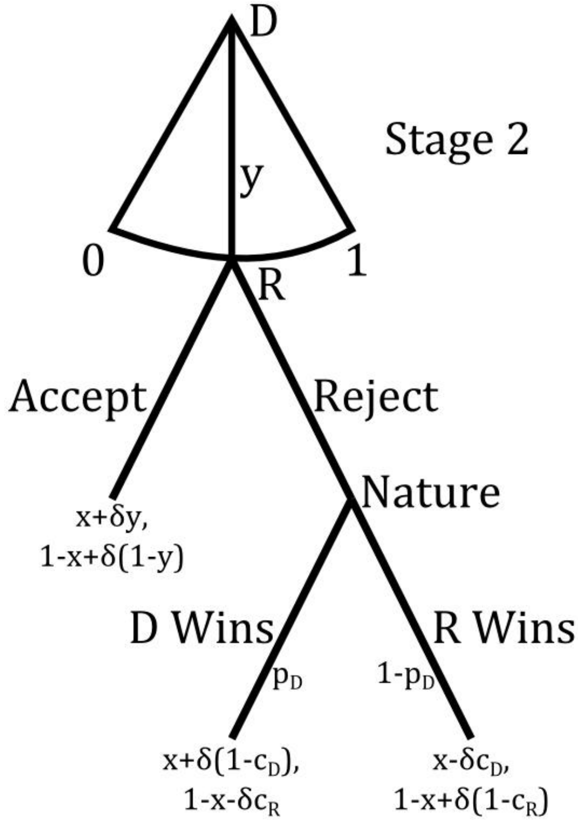
War payoffs from the first stage carry over into the second stage for both players. For instance, D wins with probability P_D and pays the cost c_D if it launches a preventive war at the start. Thus, it earns $P_D - c_D$ for the first period and $\delta(P_D - c_D)$ for the second. War, in effect, is game ending. The winner takes control of the entire good for the rest of the game while the other state receives none of it.

Note that the costs carry over into the second period. This may seem counterintuitive at first; after all, states can only spend money on a particular tank once, buildings can only be blown up once, and soldiers can only die once. Rather than thinking of the loss here, however, we ought to consider the alternatives. If a state spends money on a tank, it does not spend money on a park that its citizens could enjoy year after year. Likewise, after the opposing army reduces that building to rubble, its former occupants cannot receive the benefits of living in it every month. And a soldier's death is not tragic because he died—it is sad because his family will not be able to talk to him today, tomorrow, or any other day in the future. Consequently, although all of the destruction takes place during the war in the first period, the states still feel the aftereffects into the future.

As always, drawing the game tree helps. For ease of viewing, let's break the tree down into stage 1 and stage 2. Here is stage 1, which takes place *pre-power shift*:

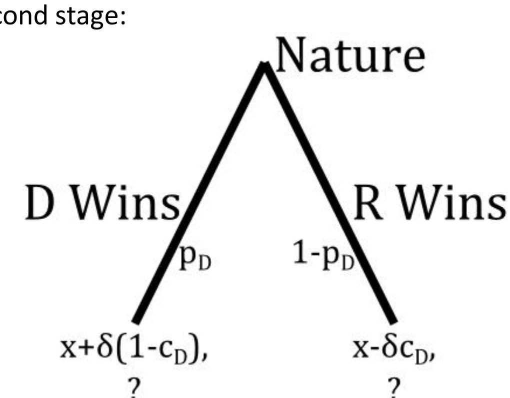


If R accepts D's offer, the states move to stage 2, which occurs *post-power shift*:



The actions of stage two should be familiar—they are exactly the same as in the simple bargaining game in section 2.3.

Since we will be considering many specific examples, we should work through the generalized war payoffs first; otherwise, we will have to calculate them repeatedly. To start, nature makes a bunch of moves in the game that we could simplify. Let's ignore R's payoffs for the moment and just consider D's possible war payoffs in the second stage:

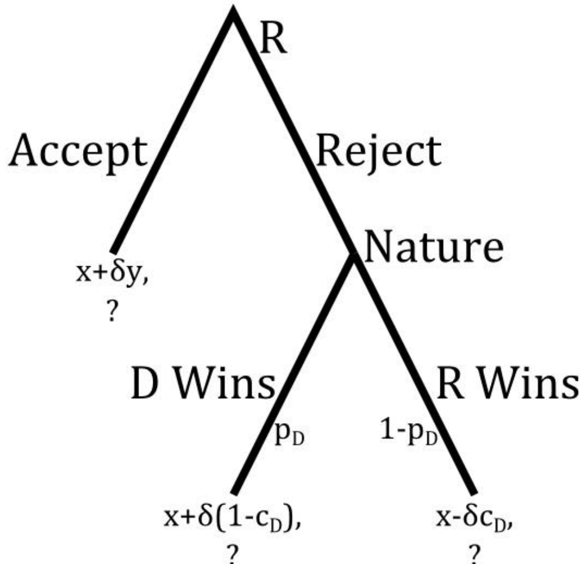


D wins the war with probability p_D and earns $x + \delta(1 – c_D)$. With probability $1 – p_D$, it loses the war and earns $x – \delta c_D$. As an equation:

$EU_D(\text{war post-shift}) = (p_D)[x + \delta(1 – c_D)] + (1 – p_D)(x – \delta c_D)$
$EU_D(\text{war post-shift}) = p_Dx + \delta p_D(1 – c_D) + x – \delta c_D – p_Dx + \delta p_Dc_D$
$EU_D(\text{war post-shift}) = \delta p_D(1 – c_D) + x – \delta c_D + \delta p_Dc_D$
$EU_D(\text{war post-shift}) = \delta p_D – \delta p_Dc_D + x – \delta c_D + \delta p_Dc_D$
$EU_D(\text{war post-shift}) = \delta p_D + x – \delta c_D$

EU_D(war post-shift) = $x + \delta(p_D - c_D)$

We can draw a parallel between this war payoff and a state's war payoff from the original bargaining game in section 2.3. Take a look at all of D's payoffs from the second stage:



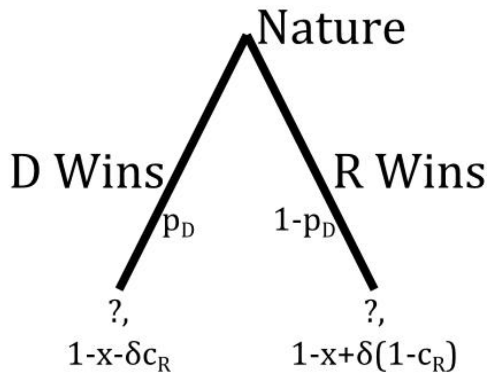
Note that they all begin with x and have a term multiplied by δ. Why the similarities? First, the value for x is leftover from the first stage. An economist would refer to this as a *sunk* value. D already has x as a payoff and cannot do anything to change that in the second period. As such, the value of x is inconsequential to D's decision-making process in the second stage.

Second, the δ goes in front of all of the second stage's payoffs for D, as we must factor in D's preferences over time. Since x is the only payoff leftover from the first stage, the δ interacts with everything but x.

Combined, these two factors imply that D functionally ignores x and δ once it arrives in the second stage. The past is the past. All D cares about is whether it can agree to a bargain in the second period that is better than the alternative of war. Hence, although R's expected utility for war in the second stage equals $x + \delta(p_D - c_D)$, only the $p_D - c_D$ matters for its final decision. Once again, this figure looks very similar to the expected utilities for war in the bargaining model from section 2.3, in which power did not shift. The only differences are that we have exchanged the A and B state labels for D and R.

Of course, once the states make it into the future, this game *is* the same as the original model. Power only shifts once in this interaction. Thus, after power has shifted, the states are in the same situation we explored in chapter 2. From there, it should be obvious that we will the same results here as we saw previously.

Let's verify these results. Continuing on, we need to isolate R's payoffs for war in the second stage:

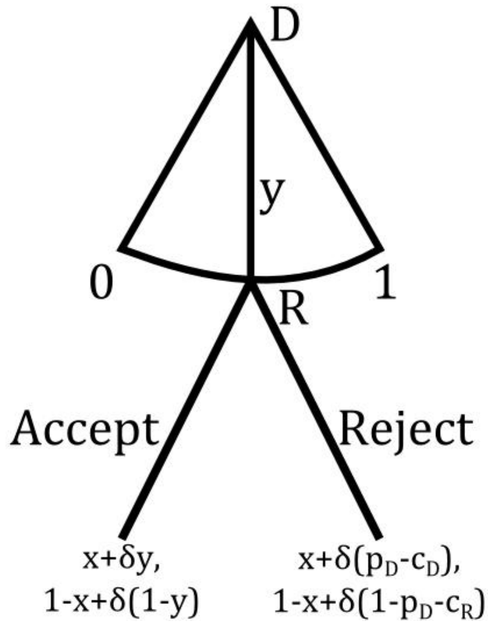


R wins the war with probability $1 - p_D$ and earns $1 - x + \delta(1 - c_R)$; the $1 - x$ is the sunk value from first period, while $\delta(1 - c_R)$ is from the second. With probability p_D, R loses and earns $1 - x - \delta c_R$; the $1 - x$ again comes from the first period, while the $-\delta c_R$ is from the second period. Thus, R's cumulative expected utility if it goes to war in the second stage equals:

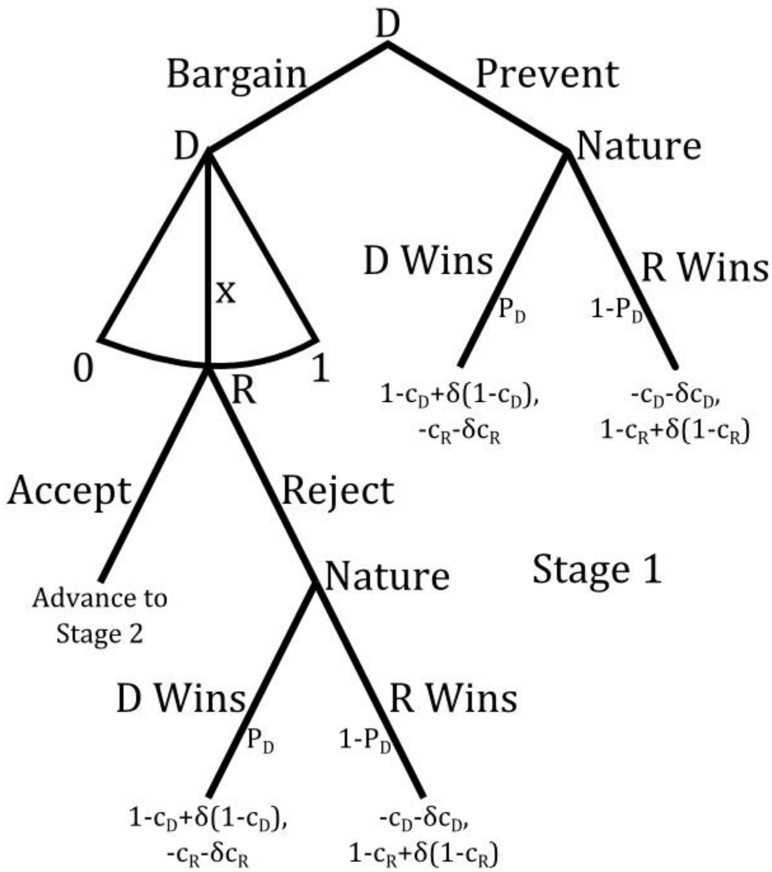
$EU_R(\text{war post-shift}) = (1 - p_D)[1 - x + \delta(1 - c_R)] + (p_D)(1 - x - \delta c_R)$
$EU_R(\text{war post-shift}) = 1 - x + \delta(1 - c_R) - p_D + p_D x - \delta p_D(1 - c_R) + p_D - p_D x - \delta p_D c_R$
$EU_R(\text{war post-shift}) = 1 - x + \delta(1 - c_R) - \delta p_D(1 - c_R) - \delta p_D c_R$
$EU_R(\text{war post-shift}) = 1 - x + \delta - \delta c_R - \delta p_D + \delta p_D c_R - \delta p_D c_R$
$EU_R(\text{war post-shift}) = 1 - x + \delta - \delta c_R - \delta p_D$
$EU_R(\text{war post-shift}) = 1 - x + \delta(1 - p_D - c_R)$

Again, R's possible payoffs in the second period show the sunk value of the first period. No matter what happens after the shift, it still earns $1 - x$ for the first stage. After factoring out δ, we see R's second period expected utility for war equals $1 - p_D - c_R$, which mirrors the static bargaining game.

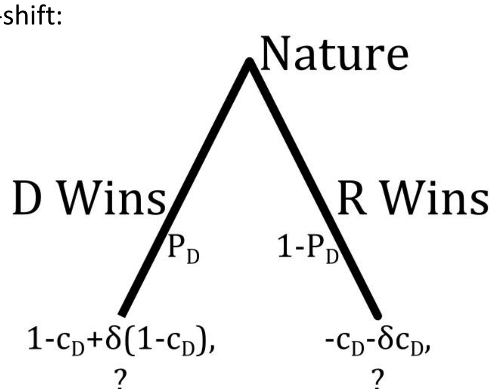
With both players' expected utilities for war in hand, we can remove nature's move from the second stage and simplify the game to this:



Let's turn back to the first stage. Note that war can occur in two places here:



These war outcomes are identical, so we only need to run through them once. First, let's calculate D's expected utility for war pre-shift:

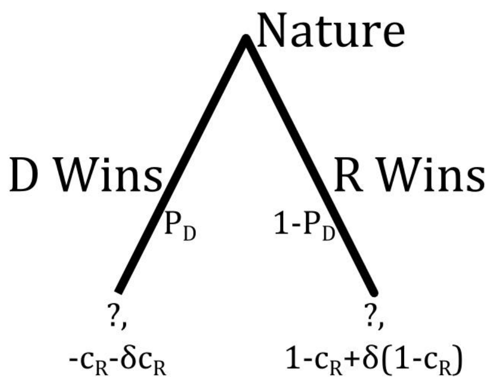


With probability P_D, D wins the war and earns $1 – c_D + \delta(1 – c_D)$; $1 – c_D$ represents D's payoff from the first stage while $\delta(1 – c_D)$ calculates D's locked-in war payoff for the second period. With probability $1 – P_D$, D loses and earns $-c_D + \delta(-c_D)$. As an equation:

$EU_D(\text{war pre-shift}) = (P_D)[1 – c_D + \delta(1 – c_D)] + (1 – P_D)[-c_D + \delta(-c_D)]$
$EU_D(\text{war pre-shift}) = P_D – P_Dc_D + \delta P_D – \delta P_Dc_D – c_D – \delta c_D + P_Dc_D + \delta P_Dc_D$
$EU_D(\text{war pre-shift}) = P_D + \delta P_D – c_D – \delta c_D$
$EU_D(\text{war pre-shift}) = P_D – c_D + \delta(P_D – c_D)$

Thus, D earns $P_D – c_D + \delta(P_D – c_D)$ on average if the states fight a war in the first period.

Let's switch to R's pre-shift war payoffs:

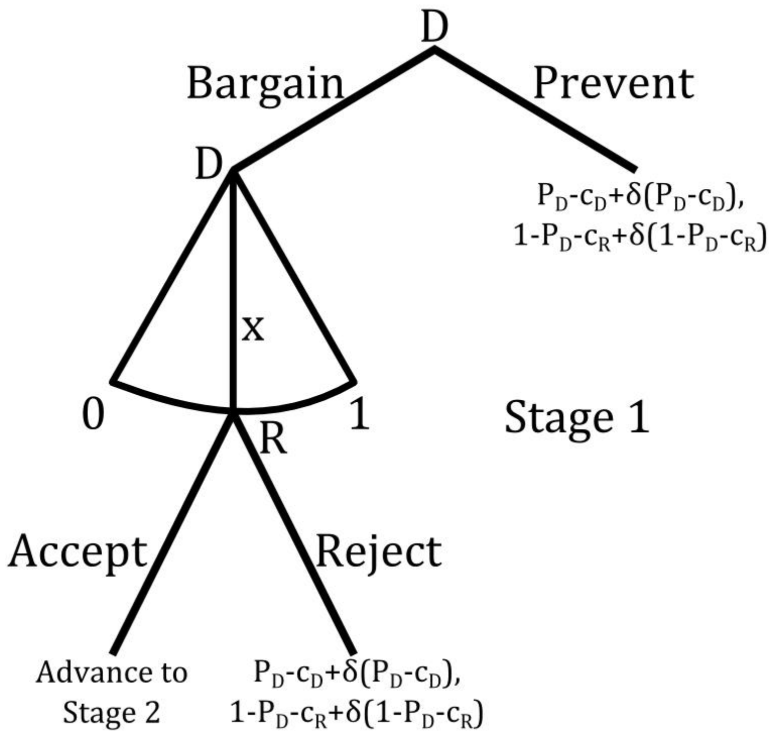


R loses the war with probability P_D and earns $-c_R + \delta(-c_R)$. Meanwhile, it wins the war with probability $1 - P_D$ and earns $1 - c_R + \delta(1 - c_R)$. As an equation:

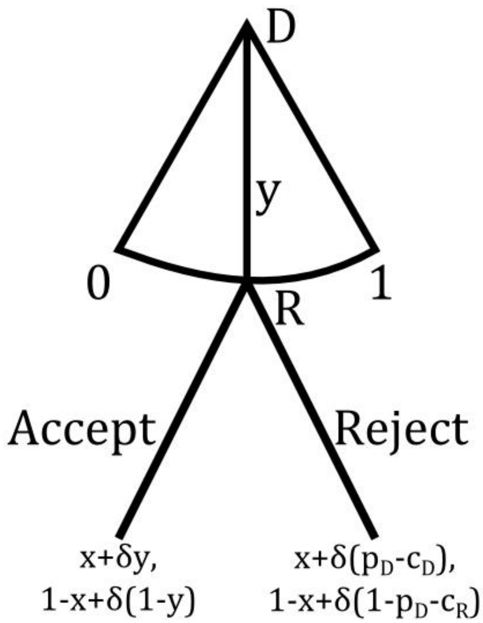
$EU_R(\text{war pre-shift}) = (P_D)[-c_R + \delta(-c_R)] + (1 - P_D)[1 - c_R + \delta(1 - c_R)]$
$EU_R(\text{war pre-shift}) = -P_Dc_R - \delta P_Dc_R + 1 - c_R + \delta - \delta c_R - P_D + P_Dc_R - \delta P_D + \delta P_Dc_R$
$EU_R(\text{war pre-shift}) = 1 - c_R + \delta - \delta c_R - P_D - \delta P_D$
$EU_R(\text{war pre-shift}) = 1 - P_D - c_R + \delta(1 - P_D - c_R)$

As such, R earns $1 - P_D - c_R + \delta(1 - P_D - c_R)$ on average for war in the first period.

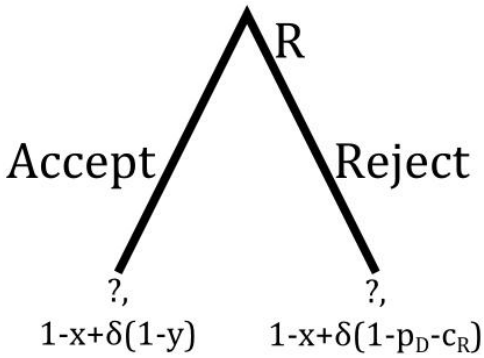
Using these expected war payoffs, we can remove nature from the game and simplify the first stage to this:



With nature removed, we are ready to begin solving the game. As always, we start at the end and work our way backward. Recall that the second stage looked like this:



Although we will look at specific numerical examples in a moment, we can work though the second stage with the variables intact. Let's start with R's decision to accept or reject:



If R accepts, it earns $1 - x + \delta(1 - y)$. If R rejects, it earns $1 - x + \delta(1 - p_D - c_R)$. So R accepts a bargain y if:

$EU_R(\text{accept } y) \geq EU_R(\text{war post-shift})$
$1 - x + \delta(1 - y) \geq 1 - x + \delta(1 - p_D - c_R)$
$\delta(1 - y) \geq \delta(1 - p_D - c_R)$
$1 - y \geq 1 - p_D - c_R$
$-y \geq -p_D - c_R$
$y \leq p_D + c_R$

Thus, R accepts any demand less than or equal to $p_D + c_R$. Such a demand leaves $1 - p_D - c_R$ leftover for R, which is R's expected utility for war. If D demands a value for y greater than $p_D + c_R$, R receives more by fighting and thus rejects the offer.

Now consider D's demand size. In general, D has two choices: (1) demand a great amount to induce R to fight or (2) demand a small amount to induce R to accept.

Let's start with the great demand. If D demands $y > 1 - p_D - c_R$, R rejects, and D earns its war payoff:

$EU_D(y > 1 - p_D - c_R) = x + \delta(p_D - c_D)$

Note that any value of y greater than $1 - p_D - c_R$ produces the same payoff for D; its choice for y is irrelevant if R chooses to fight.

Alternatively, D can offer some y less than or equal to $p_D + c_R$, which R accepts. In this case, D earns its payoff for a peaceful settlement in the second stage:

$$EU_D(y \leq p_D + c_R) = x + \delta y$$

Note that D's payoff here increases as y increases. Thus, the optimal acceptable demand for D is the greatest size of y that R will not reject. Fortunately, we know R accepts any y less than or equal to $p_D + c_R$. As such, the largest value D can take without inducing war is $y = p_D + c_R$. Substituting $p_D + c_R$ for y in D's expected utility, we arrive at the most D can possibly earn from an acceptable demand:

$$EU_D(y \leq p_D + c_R) = x + \delta y$$
$$y = p_D + c_R$$
$$EU_D(y = p_D + c_R) = x + \delta(p_D + c_R)$$

We now know D's best option is either to demand $y = p_D + c_R$ or demand any amount greater than that and force R to fight. Therefore, D makes the optimal acceptable offer if $y = p_D + c_R$ yields a greater expected payoff than inducing war:

$$x + \delta(p_D + c_R) \geq x + \delta(p_D - c_D)$$
$$\delta(p_D + c_R) \geq \delta(p_D - c_D)$$
$$p_D + c_R \geq p_D - c_D$$
$$c_R \geq -c_D$$
$$c_D + c_R \geq 0$$

Since each state's cost of war is greater than zero, their sum is also greater than zero. Therefore, D optimally demands $y = p_D + c_R$ to R in the second stage. R accepts and earns $1 - x + \delta(1 - p_D - c_R)$ while D receives $x + \delta(p_D + c_R)$. All told, the states resolve the bargaining problem peacefully in the second stage.

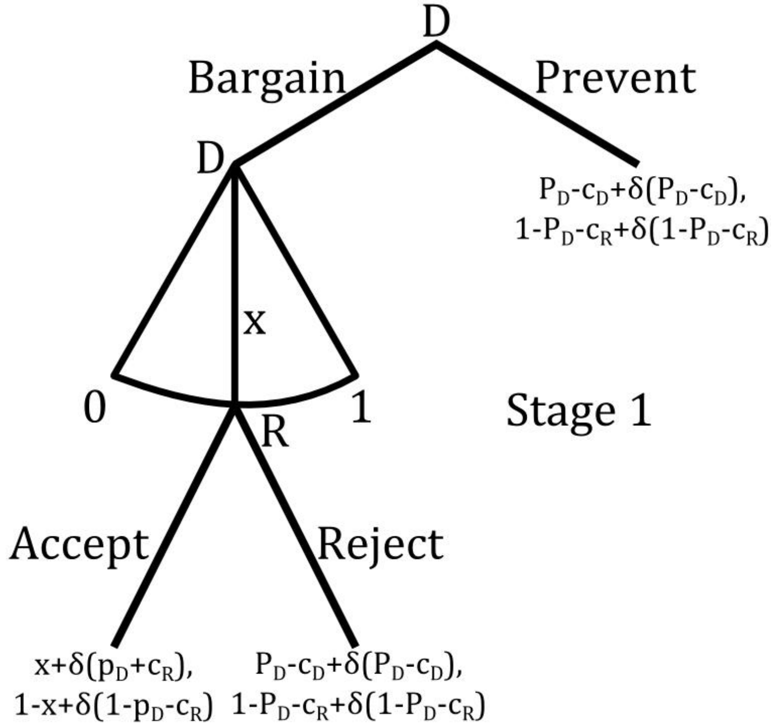
This result fundamentally altered the way political scientists think about shifting power. Many long running theories claimed that rising states, upon ascending to power, started wars to take advantage of their newfound strength. That is, rising powers must initiate conflict to receive any concessions.

However, the results from the second stage show that such theories do not hold up under formal scrutiny. After the shift transpires, the declining state could try shortchanging the rising state or it could recognize the new status quo. If it tries shortchanging, the rising state declares war, and the states pay the inefficient costs of fighting. If the declining state recognizes the new status quo, it can offer just enough concessions to satisfy the rising state. This also benefits the declining state, as it keeps the value of the costs of war to itself. (Recall that D's equilibrium share of the good was $1 - p_D + c_R$, meaning it earned its probability of victory plus the *rising* state's cost of fighting.) Consequently, bargaining is much more attractive to the declining state. As a result, the declining state wisely (if begrudgingly) calculates its demands with the rising state's new power in mind.

Before moving on, let's quickly apply this finding to the Israel and Iran situation. Israel is scared of Iran obtaining a weapon. But is it scared of Iran actually using it? Unless a rogue faction steals a nuke from the government, Israel should not be. After all, no country has used nuclear weapons against another country since they were first introduced on the world stage, and Iran would have to worry about a very destructive nuclear counterstrike from Israel.

Nevertheless, Israel should not take a nuclear Iran lightly. While war would be unlikely in a world in which Iran had nuclear weapons, Israel's primary concern should be how much it would have to concede to Iran to keep Iran satisfied. Put yet another way, Israel does not worry about getting nuked so much as it fears how much it will have to concede to Iran to avoid getting nuked. Just because a world is peaceful does not mean it is advantageous for Israel.

Let's turn back to the game. Given that D earns $x + \delta(p_D + c_R)$ and R earns $1 - x + \delta(1 - p_D - c_R)$ in the second stage, we can plug these expected utilities into the end branch of the first stage:



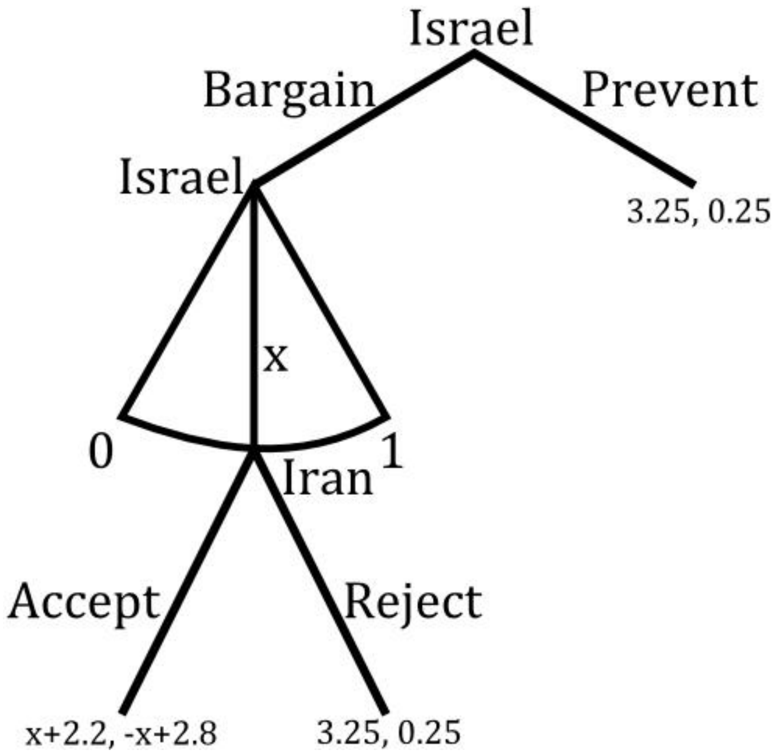
This substitution makes our life much easier. We know the second stage ends in an agreement, so the two stage bargaining game collapses into a one stage bargaining game. The tension remaining is whether the declining state prefers reaching that unfavorable (but peaceful) settlement to fighting a costly preventive war to lock in its share of the good before the shift.

To answer that, we must still work backward. However, the general results from the first stage will not be as crystal clear as the general results from the second stage. Thus, we will transition to a few specific examples. Rather than continue using variables, we will replace them with exact numbers. We can then see how the outcome of the interaction changes when we manipulate important parameters.

To put things in perspective, let's continue framing the bargaining game as Israel's interaction with Iran today. The international community believes Iran is converting uranium from civilian nuclear power plants into fuel for an atomic bomb. As a result, Israel is considering launching preventive raid on Iran to end its nuclear weapons program. Since any conflict between these two countries will be costly, the situation follows our model's framework.

To begin our analysis, let's designate Israel as the declining state and Iran as the rising state. Suppose $P_{Israel} = .75$, $p_{Israel} = .35$, $c_{Israel} = .1$, $c_{Iran} = .2$, and $\delta = 4$. Having numbers is helpful here, as we can substitute them for the variables in the game tree. For example, Israel's payoff for preventive war was $P_D - c_D + \delta(P_D - c_D)$. After making the substitutions, that large expression collapses to simply 3.25.

Continuing the conversion process for all of the payoffs leaves us with this:



Note that if peace prevails, the *largest* payoff Israel can obtain is 3.2. To reach that amount, Israel must demand x = 1 and R must accept. However, Israel can launch preventive war instead and earn 3.25. Since 3.25 is slightly greater than 3.2, Israel must fight during the first stage. Thus, we have encountered our first rationalist explanation for war.

Interestingly, this outcome is unfortunate for *both* parties. Note that Israel earns 3.25 and Iran earns 0.25 through fighting, for a sum of 3.5. In contrast, the game has 5 units of the good to be distributed throughout—1 from the first period and 1 multiplied by 4 (the discount factor) from the second period. Consequently, there exist bargained resolutions through time that both states prefer to preventive war. 3.25 units satisfy Israel while 0.25 units satisfy Iran. Therefore, any split of the additional 1.5 units satisfies both parties.

However, time interferes with the bargaining process. During the first stage, Israel and Iran can only split 1 unit, which represents 100% of the good. And no matter how they divide that good at first, the states know how the second stage of bargaining will end: the rising state must receive its war payoff at minimum. But because Iran has nuclear weapons in the second period, its war payoff is greater at that point. Thus, Israel cannot demand as much in the future. On the other hand, Israel knows it can lock in an attractive war payoff in the first period. If preventive war is sufficiently tempting because the power shift will be too great (as is the case in the example), Israel prefers to fight.

In game theory, we call this a *commitment problem*. If Iran could credibly commit to not demanding more of the good after it acquires nuclear weapons, Israel has no need to launch preventive war. In Western democracies, citizens can sign contracts that bind them to similar types of agreements. Unfortunately, contracts on the international stage hold no such power. Once Iran proliferates, if it breaks the contract, no police force will go into the country and "arrest" it as would be the case in a democratic country. Recognizing that Iran will undoubtedly want to break any ostensibly benign agreement, Israel knows it must intervene today or accept a terribly disadvantageous peace in the future.

Still, we have only looked at a set of specific values for the variables. If we picked a different arrangement, perhaps the interaction would end in peace rather than war. Indeed, we can arrive at a peaceful outcome by manipulating many of the parameters in the model. If the shift in power increases, the risk of war increases. If the declining state's cost of war increases, the risk of war also decreases. Perhaps unexpectedly, if the rising state's cost of war increases, the risk of war decreases. Finally, if the states place greater value on the future (that is, as δ increases), the risk of war increases.

This chart provides an easy reference:

How Increasing Variables Affects Outcomes	
Variable	Risk of War
Magnitude of Power Shift	Increases
Declining State's War Cost	Decreases
Rising State's War Cost	Decreases
Value of the Future	Increases

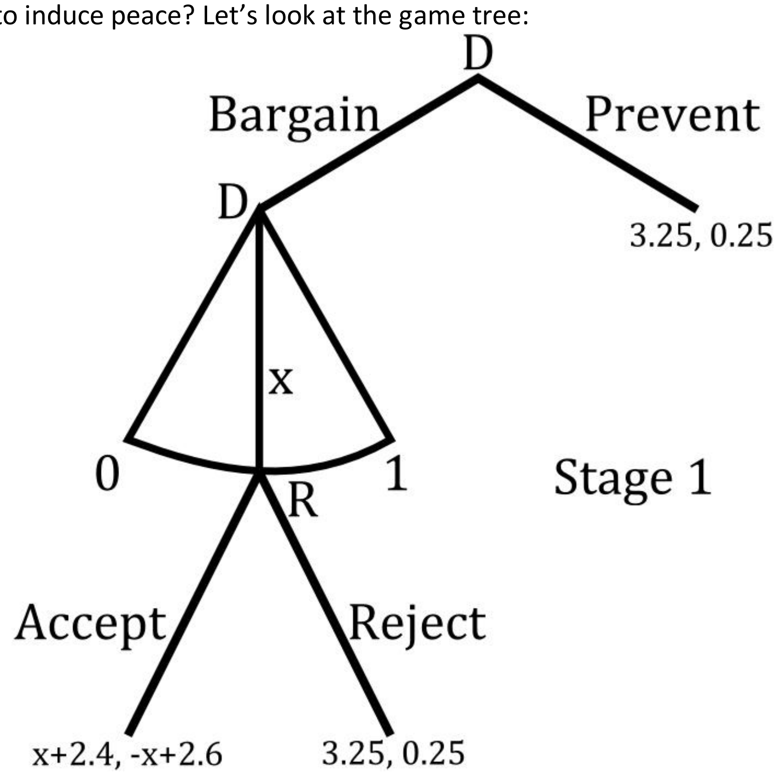
Note that given any specific set of variables, the outcome is *always* peace or *always* war. So when we say "the risk of war is increasing in δ," we mean that if the outcome of a particular set of variables is peace, if we keep increasing δ, we may reach a critical value that switches the outcome to war.

To illustrate how manipulating these variables changes the outcome of the game, we will now look at four variations of the Israel/Iran example.

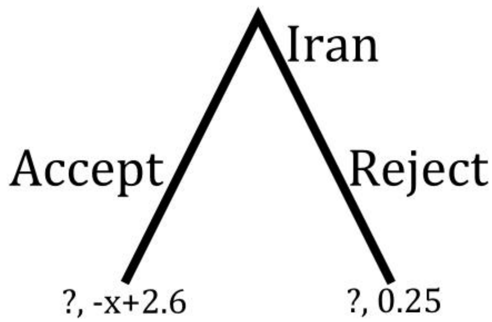
When the Shift Is Minimal

Recall that the original parameters were $P_{Israel} = .75$, $p_{Israel} = .35$, $c_{Israel} = .1$, $c_{Iran} = .2$, and $\delta = 4$. As the magnitude of a power shift increases, the risk of war increases. Thus, if we decrease the magnitude of the shift, the states could possibly find a peaceful resolution.

As such, suppose instead that $p_{Israel} = .4$. Israel now faces a shift that is .05 smaller. Is that tiny difference enough to induce peace? Let's look at the game tree:

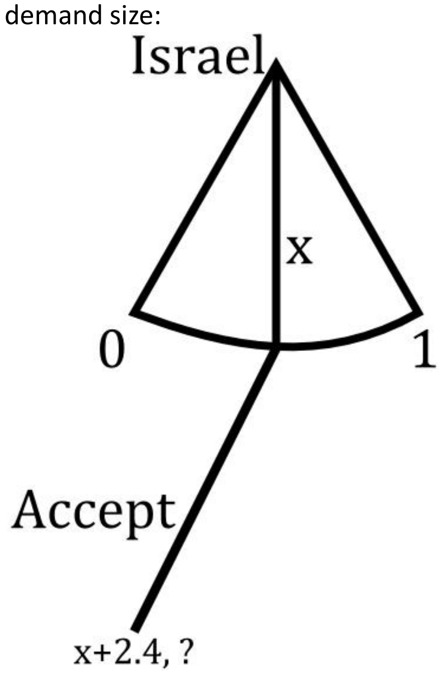


Consider Iran's decision to accept or reject Israel's demand:



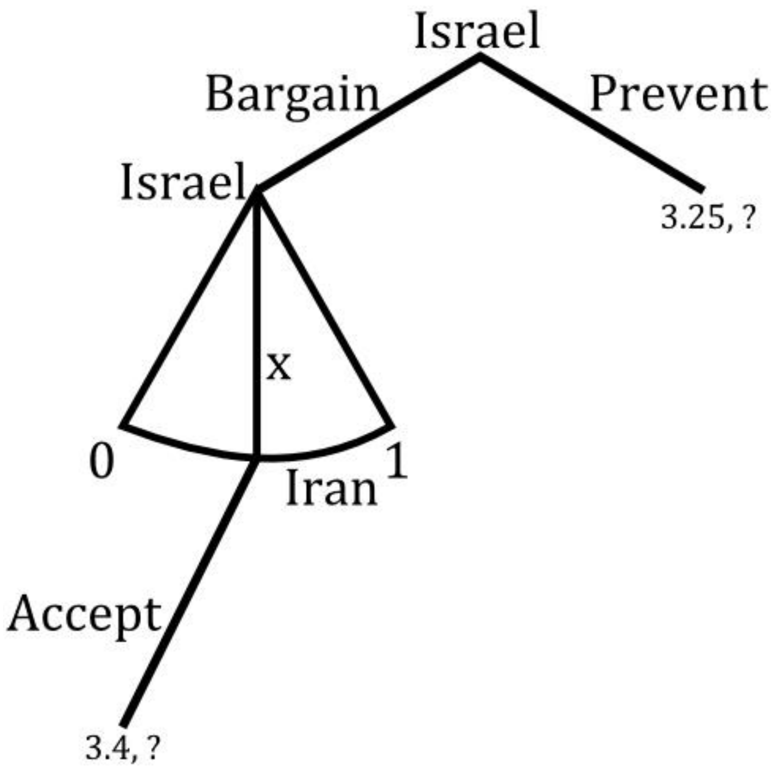
In the worst case scenario for Iran, Israel demands all of the good, or x = 1. However, Iran still wants to accept in that scenario; it earns 1.6 accepting but only 0.25 for rejecting. Consequently, Iran will accept any demand Israel makes.

Now consider Israel's optimal demand size:



Israel knows Iran will accept any demand it issues. Since Israel's payoff increases as a function of x, it wants to demand all 1 of it. Thus, Israel selects x = 1 and Iran accepts.

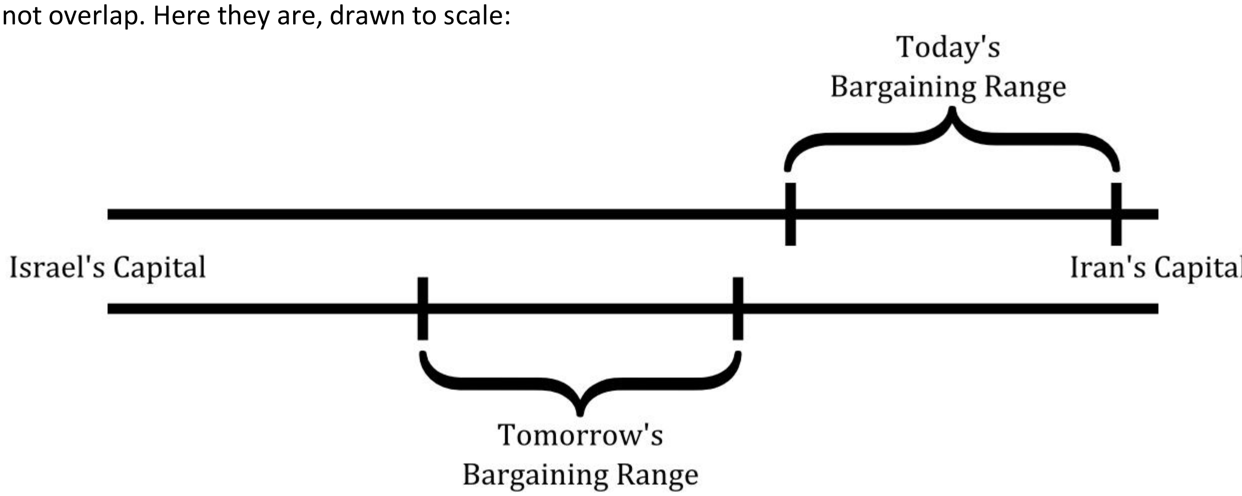
Now we can check whether Israel prefers advancing to the bargaining stage or preventing at the start:



Israel earns 3.4 for bargaining and 3.25 for preventing. Therefore, Israel bargains.

Why does reducing the extent of the power shift alter Israel's optimal strategy? The bigger the power shift, the worse the declining state's bargaining leverage is post-shift. Although Israel paid a cost upfront to fight a preventive war in the original example, it preferred conflict to a poor bargained settlement later on. Here, however, the shift is not great enough to justify paying those costs of war.

Note that the bargaining ranges do not overlap in this example, yet peace prevails. In the first stage, Israel's power equals .75 and its cost of fighting is .1, while Iran's cost is .2. Thus, if no power shift were to occur, the mutually preferable bargained settlements give Israel at least .65 of the good but no more than .95. In the second stage, Israel's power equals .4, while both sides' costs remain the same. Here, Israel needs at least .3 but no more than .6 to maintain the peace. The intervals .3 to .6 and .65 to .95 do not overlap. Here they are, drawn to scale:

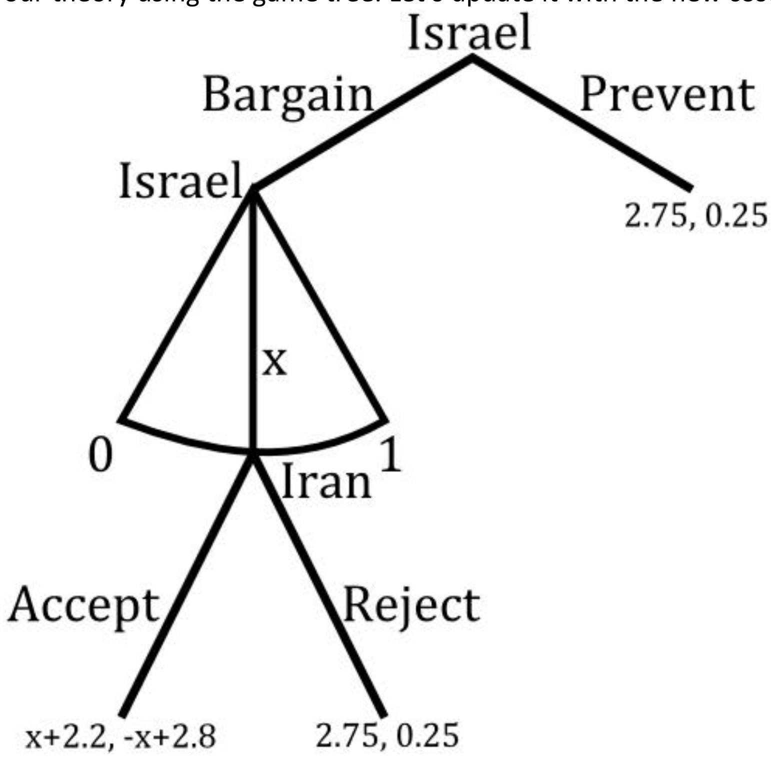


Despite this, Israel does not want to fight because it takes all of the good through bargaining during the first stage. Israel cannot count on Iran to give Israel a good deal in the future. However, Israel also knows that Iran really wants to advance to the second stage, as Iran earns 1.6 for that half of the game alone. In contrast, if Israel prevents or Iran rejects Israel's initial offer x, Iran earns a pitiful 0.25. Israel leverages Iran's poor bargaining position early on to steal all of the good at first before conceding some of it to Iran later. Iran, left with no better alternative, accepts Israel's initial demand. Fortuitously, because Israel receives so much early on, it does not want to start a war in the first period either. As a result, the states maintain the peace despite their seemingly insurmountable war trap.

When the Declining State Faces High Costs

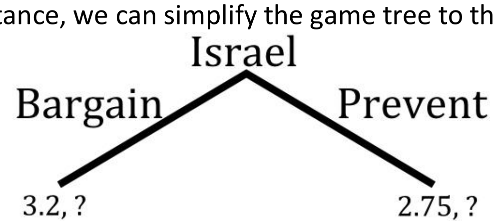
Let's move to the next example. Again, recall that the original parameters were P_{Israel} = .75, p_{Israel} = .35, c_{Israel} = .1, c_{Iran} = .2, and δ = 4. Let's tweak Israel's cost of war to .2. Intuitively, we should think this will also switch the outcome from war to peace because the bargaining ranges overlap here: the first stage's range requires Israel receive at least .55 ($P_{Israel} - c_{Israel}$) but no more than .95 ($P_{Israel} + c_{Iran}$), while the second stage's range requires Israel receive at least .15 ($p_{Israel} - c_{Israel}$) but no more than .55 ($p_{Israel} + c_{Iran}$). Consequently, settling at .55 satisfies both sides before and after the power shift, so the states should be able to avoid war.

We can confirm our theory using the game tree. Let's update it with the new cost of war:



Once again, Iran accepts any demand x Israel makes; even if Israel demands everything, or x = 1, Iran optimally accepts because 1.8 is greater than 0.25. In turn, Israel knows it can demand everything and still induce Iran to accept, so its optimal demand is x = 1.

From there, Israel only needs to decide whether bargaining is better than preventing. Substituting x = 1 and foreseeing Iran's acceptance, we can simplify the game tree to this:



Israel earns 3.2 for bargaining but only 2.75 for launching preventive war. Therefore, it pursues peace. Iran accepts its offer, and the peace continues through the second stage.

Why does increasing the declining state's cost of fighting decentivize preventive war? The idea is clearest when taken to the extreme. Suppose Israel's expected utility for war in the first period was some *negative* amount. Intervening is clearly Israel's worst option, as Israel could instead offer Iran everything in both the first and second period, receive nothing from the entire game, and still perform better.

A similar story holds when Israel's expected utility for war in the first period is some tiny amount. Israel could demand just a tiny amount, Iran would be inclined to accept, and Israel's overall payoff would beat its preventive war payoff. But when costs are near zero, preventive war becomes a viable option, particularly if the shift in power is large and will force the declining state to make great concessions in the second period. That being the case, some cost value must be the tipping point; crossing it switches Israel's optimal strategy. Consequently, as costs increase, the likelihood of preventive war decreases.

This model helps us understand why Iran took its nuclear program underground—literally. On June 7, 1981, Israel initiated *Operation Opera*. In broad daylight, an Israeli air force fleet zoomed through Saudi Arabia and headed toward Baghdad. Just outside the city's borders, Iraq maintained a nuclear facility called Osirak. The planes dropped their payload of bombs and scrammed.

Although the *Operation Opera* took less than three hours, the attack was a resounding success. Every pilot touched down safely in Israel. As the United States found out the hard way more than two decades later, Iraq's nuclear weapons program was never the same.

Twenty-six years later, on September 6, 2007, Israel launched a similar attack in the Dier ez-Zor region of Syria. Dubbed *Operation Orchard*, the mission lasted a blink of an eye but obliterated a Syrian nuclear facility. The pilots were again unharmed.

In short, Israel's costs of prevention in Iraq and Syria were virtually nothing; the country paid a tiny amount of money for some jet fuel and bombs yet summarily annihilated two nuclear programs. As our model indicates, declining states ought to seize the initiative if their costs of war are so low.

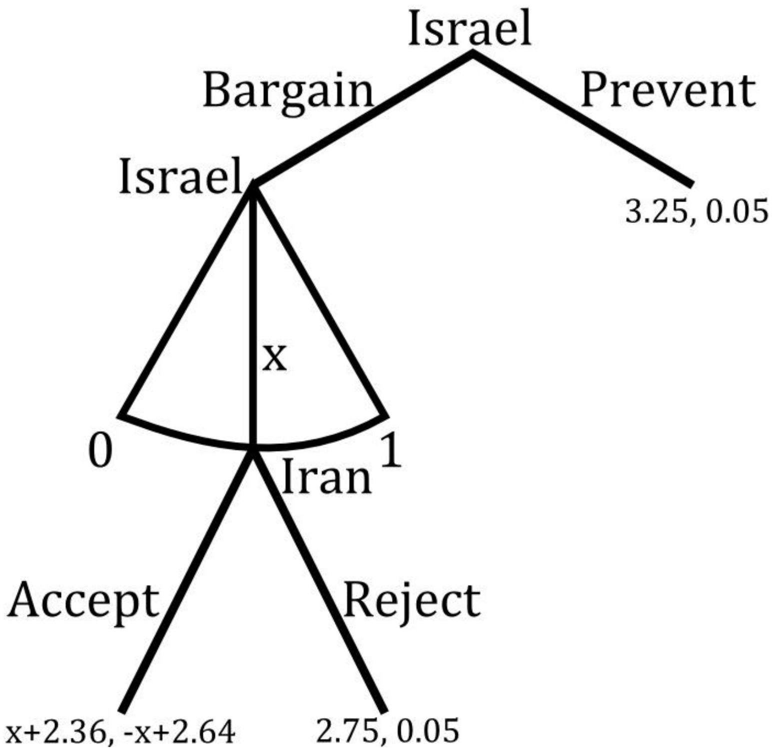
Iran took notice. The lesson was clear: if an Israeli rival leaves nuclear facilities out in the open, the Israeli air force will play target practice. Hence, Iran has moved its development below the surface. For now, Israel has countered with more creative methods, ranging from the assassinations of Iranian nuclear scientists using various forms of carbombs to the Stuxnet computer virus.

Game theory can only take us so far in our ability to predict the outcome of the Iranian/Israeli nuclear dilemma. We do not have access to Israel's or Iran's military intelligence. As such, we cannot know whether preventive war is Israel's best course of action if the carbombs and viruses fail. But we can say two things with certainty. First, Iran's underground strategy changes Israel's cost/benefit analysis. And second, if Israel decides to launch a full-scale assault on Iran, the operation will be far costlier and less effective than the air raids in Iraq and Syria.

When the Rising State Faces High Costs

Raising the rising state's cost of war also reduces the likelihood of conflict, though the reason is not as clear. After all, the declining state's war payoff does not change regardless of the rising state's war cost. However, the declining state's payoff for bargaining increases as the rising state's war cost increases, since the declining state can demand more without inducing the rising state to reject. In turn, war becomes less attractive because bargaining becomes more advantageous. If the rising state's costs are large enough, then the declining state prefers a peaceful resolution.

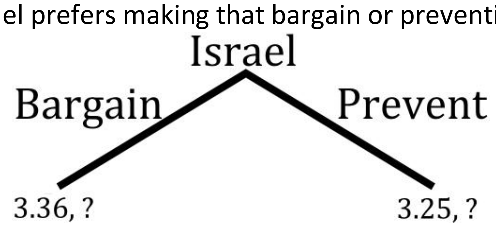
To see the logic in action, recall once more that the original parameters were $P_{Israel} = .75$, $p_{Israel} = .35$, $c_{Israel} = .1$, $c_{Iran} = .2$, and $\delta = 4$. Let's increase Iran's cost of war to .24 and investigate whether the change leads to peace. We begin by altering the game tree to fit the new case:



In the original example, Israel's payoff from the second period was 2.2. Now it has increased to 2.36. The small difference of 0.16 is enough to change Israel's optimal strategy.

We can begin again by noting that Iran accepts any demand Israel makes; even if Israel chooses x = 1, Iran earns 1.64 for accepting versus 0.05 for rejecting. As such, Iran accepts all demands. Knowing that, Israel demands the most it possibly can and therefore sets x equal to 1.

Now we check whether Israel prefers making that bargain or preventing:



The additional 0.16 Israel earns in the second stage is enough to turn the tide. Israel's optimal choice is to bargain, as 3.36 is greater than 3.25. The states complete the interaction peacefully.

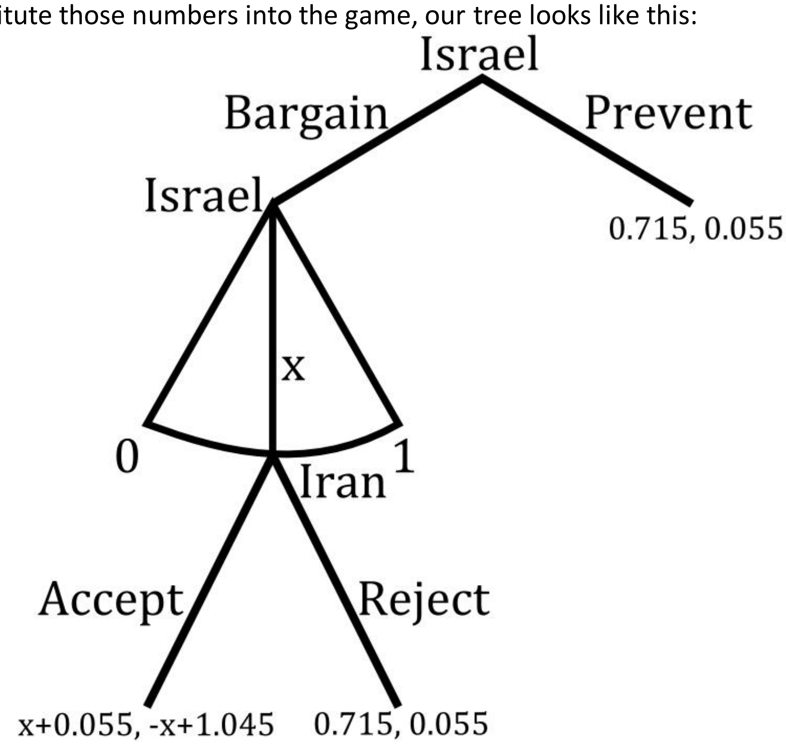
Once again, we can see why increasing the rising state's cost of war facilitates peace by considering the extreme case. Imagine the rising state had such high costs of war that its expected utility for rejecting an offer was always negative both before and after the power transition. Then the declining state could always demand the entire good, which means setting the demand equal to 1. But if the declining state could successfully demand everything all the time, war serves no purpose. Why would the declining state ever want to fight when it can achieve its ideal outcome peacefully?

In contrast, if the rising state has virtually no cost for war, the declining state can no longer set its demand at 1. Rather, the declining state must demand something closer to p_D. Since the declining state knows it will be unable to extract as much of the good later on, preventive war looks more attractive at the start.

When the Future Is Unimportant

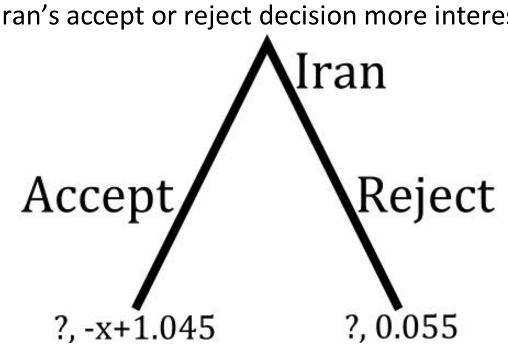
Finally, war is unlikely if the declining state cares mostly about the present. The original parameters were $P_{Israel} = .75$, $p_{Israel} = .35$, $c_{Israel} = .1$, $c_{Iran} = .2$, and $\delta = 4$. The value of δ meant the states placed four times as much value on the future as they do on the present. Let's shrink that to δ = .1 instead. Now the states only value the future to be worth a tenth of the value of the present. In other words, the states care a lot about the first stage's payoffs and virtually ignore the second stage's payoffs.

After we substitute those numbers into the game, our tree looks like this:



These numbers may appear jarringly miniscule compared to the previous versions. The small value of δ is the reason. When δ = 4, the total value of the good over time was 5, or 1 from the first stage and 4 from the second. While the states still battle for 1 in the first stage, the δ value of .1 means the good is only worth .1 in the second period. Consequently, 1.1 is the most the states can collectively earn in this game.

Changing δ has also made Iran's accept or reject decision more interesting:



Previously, Iran always accepted regardless of what Israel offered. Here, Iran earns 0.055 for rejecting and going to war versus -x + 1.045 for accepting an offer x. But if x = 1, Iran earns 0.045 for accepting, which is less than its payoff for war. As such, Iran only accepts if its war payoff is at least as great as its expected utility for bargaining:

$EU_{Iran}(accept) \geq EU_{Iran}(reject)$
$EU_{Iran}(accept) = -x + 1.055$
$EU_{Iran}(reject) = 0.055$
$-x + 1.045 \geq 0.055$

$-x + 1.045 \geq 0.055$
$x \leq 0.99$

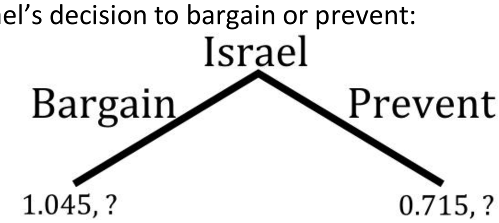
Thus, Iran accepts any demand x less than or equal to 0.99 and rejects anything greater.

In turn, Israel has two choices. If it makes an offer greater than 0.99, Iran rejects and Israel earns its war payoff of 0.715. Alternatively, if it makes an offer less than or equal to 0.99, Iran accepts, and Israel earns x + 0.055. Since Israel's payoff is increasing in x, its optimal acceptable demand is the most Iran is willing to tolerate without rejecting, or x = 0.99. Israel is happy making that optimal acceptable demand if its expected utility for doing so is greater than or equal to its expected utility for war. Thus, Israel selects x = 0.99 if:

$EU_{Israel}(x = 0.99) \geq EU_{Israel}(x > 0.99)$
$EU_{Israel}(x = 0.99) = 0.99 + 0.055$
$EU_{Israel}(x > 0.99) = 0.715$
$0.99 + 0.055 \geq 0.715$
$1.045 \geq 0.715$

The inequality holds, so Israel demands 0.99, which induces Iran to accept. D earns 1.045 for this outcome.

Lastly, we must look at Israel's decision to bargain or prevent:



Israel's decision is redundant here. It earns the same payoff for preventing as it earns if it induces Iran to reject the demand and start the war. We already know Israel prefers having Iran accept its demand of x = 0.99, so we also know that Israel prefers bargaining to preventing. The game ends peacefully once more.

The extreme case reveals the declining state's strategic logic in this circumstance. When δ becomes very small—perhaps even 0—the game converges to the one stage bargaining problem from section 2.3. But we know what happens in a one stage bargaining problem—there exist peaceful settlements that simultaneously satisfy both parties. The declining state's incentive for preventive war throughout this section is its ability to lock-in an appealing payoff for the long-term. Yet, when δ is extremely small, the long-term is irrelevant. As a result, the states can agree on one of those mutually satisfactory settlements.

As a final note, this example illuminates an extremely counterintuitive result. On the surface, we might think that the power shift must allow the rising state to earn more than what it would receive if it just fought a war in the first period. Our intuition is wrong here. In equilibrium, Israel demands 0.99 and Iran accepts, leaving Iran with a payoff of 0.01 for the first stage and 0.045 for the second stage, for a total of 0.055. Yet this is exactly the same amount Iran earns from fighting in the first stage!

Israel was extremely clever with its offer here. At first, we might have thought that Israel needed to offer Iran its war payoff in the first stage. Instead, Iran receives virtually nothing at the beginning. Israel can get away with this because the offer is leveraging Iran's future power against Iran's power today. Iran accepts the offer because it cannot improve its payoff by fighting. The only difference is that Israel receives a lot more of the good in the first stage and a lot less of it in the second stage.