Crisis Bargaining Worksheet

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Part I
Introduction to Crisis Bargaining and War

This first problem follows the logic of Fearon 1995's framing of crisis bargaining and war. The goal of this first part is to get you up to speed on how this framing works. In other words: forget about private/incomplete information and commitment problems for now: we'll get to that later, we need to establish the groundwork first.

Note: you have a few assignments that rely on this logic, so please make sure you are comfortable with what is going on! Additionally, I will give you some excel worksheets to help you with the calculations/will help with the assignment.

0.1 Verbal Intuition of crisis bargaining

Here's some verbal intuition. Assume I just bought a nice $10 Super Mario figurine to make my office window exciting. Then one morning, it's gone. I look all over my office, and it isn't anywhere. Then I spot it: it's in my office-neighbor Brenton Kenkel's window! I figure there is some kind of confusion, so I go over and talk to Brenton. So I do, and boy that didn't go well. Brenton tells me that he'll give me Mario back if I give him $3. I think about my options here. I could take Brenton to small claims court or get the police involved, but don't want to spend a bunch of time on this. Would it be easier if I just strike the deal right there?

That's the logic of crisis bargaining right there. There is some sort of transaction, asset, or policy that you are in dispute over. Your rival looks at the situation, and tries to extract surplus from you based on your costs of pursuing a non-peaceful transfer. In this situation, the asset was the Mario, and the non-peaceful transfer costs are the costs from suing Brenton or getting the police involved. Brenton figured he could extract some surplus ($3) from me because I'm too busy to deal with those outside options. When insurgents and governments argue over policy or assets, it's kind of like that, only the outside option there is war.

Part II
One-Round, Complete Information Crisis Bargaining Model

1 Assumptions

Consider two actors, a Rebel (R) and a Government (G). I will sometimes refer to the rebel group as an insurgent group. Note that this is me making an assumption: I'm going to keep track of it as such.

Setup Assumption: *Two actors, G and R, are in a crisis over a policy or asset of normalized value 1. The policy or asset is fully divisible and zero sum.*

This assumption is already doing a lot. I'm going to talk about this below.

First, we are only considering two actors. It could be that the two actors are (a) a rebel/insurgent group and a government, (b) a cluster of rebels/insurgent groups and the government, (c) an insurgent group and the government and its allies, etc. Regardless, there are only two actors making choices here. For ease, I will sometimes call "G" the "Government" and "R" the "Rebels".

Second, we assume the two actors are fighting over a policy or asset of value 1. The "fully divisible" term

means actors can split the asset any way they desire. So the asset could be a 20%-80% split, a 50%-50% split, a 0%-100% split, etc etc. The "zero sum" term means that both actors care about the policy or asset (asset from here on out), where a loss for one side is perfectly offset by a win for the other side. To give some intuition: imagine G and R are in a dispute over Greenland. This assumption is that both sides uniformly value Greenland at 1 util. That the game is zero sum means if Actor G gets 1 util from what is decided over Greenland, Actor R gets 0 utils. So if Actor G gets all of Greenland, then Actor G gets 1 util, leaving Actor R with 0 utils. Or, actors could decide to split Greenland 70%-30%. If Actor G gets 0.7 utils from what is decided, Actor R gets 0.3 utils; if Actor G gets 2 utils from what is decided... this isn't possible! The asset is of value 1 util, and so you cannot have more than this or less than 0 amount of the asset. *Note: this may seems silly, but this will play a role later.*

War Assumptions: *When either state declares war, war occurs, and ends with G winning and R losing, or with R winning and G losing. The value $0 \leq p \leq 1$ is the likelihood that G wins in a war. The values $c_R > 0$ and $c_G > 0$ are R's and G's costs from war. Whoever wins in war has full control of the asset. Assume actors are risk neutral.*

The War Assumptions consider when war occurs, which can be unilaterally triggered. Think about this in terms of expected utility. When war happens, G wins with probability p and loses with probability $1-p$. Similarly, R wins with probability $1-p$, and R loses with probability p. What informs the value that p takes? Put another way, imagine the United States and a small, anti-Federal government militia group fought over North Dakota. Do you think this would be a 50% chance the US army wins? Larger? Smaller? Why?

Additionally, war has costs (c_R and c_G) for each actor. These costs stem from war being destructive. This assumption is formalizing the "war is a costly for of politics" discussion, or the "war as a costly black box" idea. More grounded, if the US and the militia group went to war over North Dakota, this would undoubtedly be more costly to both sides than if the US gifted North Dakota to the militia group. Therefore, R faces a cost that is greater than zero, and so does G. For ease, these costs of war are fixed and are incurred whether G and R win or lose the war. What would result in the costs of war being greater or less?

The final assumptions, that whoever wins has full control over the asset and risk neutrality, implies that we can express the expected utility from war in reasonable terms.[1] Consider G's utility. With probability p, G wins the war, and gains full control over the asset. In this situation, G would fully exploit the asset to give G 1 util. With probability $1-p$, G loses the war, and loses all control over the asset. In this situation, R would fully exploit the asset, leaving G with 0 utils. Letting $EU_G(war)$ and $EU_R(war)$ denote G's and R's Expected Utility (hence "EU") from going to war, I can say

$$EU_G(war) = Pr(G\,wins) * U_G(war|G\,wins) + Pr(R\,wins) * U_G(war|R\,wins)$$

$$EU_R(war) = Pr(R\,wins) * U_R(war|R\,wins) + Pr(G\,wins) * U_R(war|G\,wins)$$

Taking the top line, this is the expected utility formulation that we discussed in the second class: this is the probability G wins in war ($Pr(G\,wins)$) multiplied by the utility that G gets from G winning ($U_G(war|G\,wins)$) plus the probability that R wins in war ($U_G(war|R\,wins)$) multiplied by the utility that G gets from R winning. A similar exercise is done for R's expected utility from war.

[1] You may, at some point, have heard that human beings are "risk adverse." We are not dealing with that here because it makes things considerably messier (it involves making actor's utility functions concave rather than having the nice "70% of asset means 0.7 utils" formalization.

I can then substitute the values that we discussed above. This gives the formula

$$EU_G(war) = p * (1 - c_G) + (1 - p) * (0 - c_G)$$

$$EU_R(war) = (1 - p) * (1 - c_R) + p * (0 - c_R)$$

Or more simply

$$EU_G(war) = p - c_G$$

$$EU_R(war) = 1 - p - c_R$$

Thus, when G goes to war, G expects to attain $p - c_G$ utils, and R can attain $1 - p - c_R$ utils.

Peace Assumptions: *Assume that G makes an offer of value $1 - x$ to R, where $x \geq 0$ and $x \leq 1$. If no one declares war (i.e. in peace), G gets value x and R gets value $1 - x$.*

This is a deceptively important assumption. If you've taken any classes on American or Comparative institutional politics, you hopefully have heard about "proposal power." Here I'm assuming that G has the ability to make a "take it or leave it" offer to R that R cannot renegotiate or counter. You could interpret this as G controlling the asset, and offering R some portion of the asset $(1-x)$, but it's even a little stronger than that.[2]

Intuitively, you might expect if G offers R a very small portion of Greenland (like $1 - x = 0.001$), R may want to go to war because R's expected utility from going to war could exceed such a small offer. On the other hand, you could imagine if G made R a very large offer (like $1 - x = 0.99999$), R would accept and war would not occur, but G maybe could have made a lower offer to R and still not had war occur.

Indifference Assumption: *I assume that if either actor is indifferent between accepting an offer and going to war, they will accept the offer.*

Here is how to think about this assumption. War gives R some expected payoff. Assume (hypothetically) this expected payoff is 0.3 utils. G could also offer R a peace offer of 0.3 utils. We assume that here R will opt for peace.

2 The Crisis Bargaining framework in action

I assume the following order of moves.

- First, G offers R some value $1 - x$. Assume x can take on all values between 0 and 1 (inclusive)
- Second, R "accepts" the offer, resulting in the peace payoff, or declares "war," resulting in both states going to war and achieving their war payoffs.[3]

Let's discuss what happens when I assign some values to the parameters. Assume $p = 0.5$, implying that both sides have a 50%-50% probability of winning in war. Also assume that $c_R = 0.2$ and $c_G = 0.3$.

What does this imply? First, we can calculate each actor's expected utility from war. I can use the formulas

[2] If you are interested in what this looks like as a back-and-forth, consider reading: Rubinstein, Ariel. "Perfect equilibrium in a bargaining model." Econometrica: Journal of the Econometric Society (1982): 97-109.

[3] You might be wondering from this game form: what about G?? Can't G declare war? Technically, a lot of the time, G could essentially get war to happen by making R a really crummy offer $(1 - x = 0)$.

$EU_G(war) = p - c_G$ and $EU_R(war) = 1 - p - c_R$. Plugging in the respective values gives

$$EU_G(war) = 0.2$$

$$EU_R(war) = 0.3$$

Note that the sum of these values is less than 1. So I now know each actor's expected utility from going to war. Why does this matter? Well, I will need to check out how the offer x is relative to R's expected utility from going to war. What does this look like?

Assume that G makes an offer of $1 - x = 0.1$. In this case, R's utility from peace is $U_R(peace) = 0.1$. Comparing R's peace utility to R's wartime utility of $EU_R(war) = 0.3$ tells us something. Because R has the option to go to war, when faced with an offer of $1 - x = 0.1$, R would do worse "accepting" and getting their peace payoff relative to going to war and getting, in expectation from going to war 0.3. Thus here, R would want to go to war.

Now assume that G makes an offer of $1 - x = 0.3$. What happens here?

This logic can be expressed graphically.

[Insert bargaining range]

Overall, for any offers $1 - x > 0.3$, R will always accept. For any offers $1 - x < 0.3$, R will always reject. At an offer of $1 - x = 0.3$, R is indifferent between their war and peace payoff, and might as well always accept (and will do so by the above assumption).[4]

What does G do in this situation? Assume G makes an offer $1 - x = 0.6$. By the intuition above, this results in R "accepting." This also leaves G with $U_R(peace) = 1 - x = 0.4$, which is better than G's expected utility from going to war (which is $EU_G(war) = 0.2$). So G is happy with this. But, G could be happier – like if G made an offer of $1 - x = 0.5$. Or even better, $1 - x = 0.4$. Essentially, this logic will drive the offer to $1 - x = 0.3$, where an indifferent G will accept.

So what happens in this one period game? G can look to what R would attain from war, which is derived from R's likelihood of winning $(1 - p)$ and costs from war (c_R) and tailor an offer that would make R indifferent between going to war and accepting. In other words, G sets $1 - x = EU_R(war) = 1 - p - c_R$. And this is always fine for G! Because G is left with x, you can math this out to see that G gets $p + c_R$, which is always greater that R's expected utility from going to war.

Wait: where did $p + c_R$ come from???

[4] For those curious, the logic is slightly more complicated than this; if R goes to war with any probability $\pi > 0$ at $1 - x = 0.3$, then G will never offer it, and this can never be an equilibrium.

So to summarize: in these one period games, the actor with proposal power (here G) looks at their opponent, and gives them the smallest offer they can that will avoid war because this is the best that they can do. Thus, they are avoiding war because it's inefficient, and a bargained offer can yield better outcomes for all.

There's some nice lessons in here for you when you are engaging in negotiations in the future: having a better outside option is always helpful. Often times, the best way to get a raise is to start applying elsewhere.

You will have a chance to work with the complete information model through the exercises oriented around the excel worksheets. Please note: I denote c_R and c_G as c_R and c_G (respectively) in the excel.

2.1 In the weeds: what happens when $p + c_R > 1$?

We've been pretty loose about what parameters are allowed. However, you might be wondering: what happens if $p - c_G < 0$? Or what if $p + c_R > 1$? Or both?

Here's how to think about this for the bargaining range. The bargaining range characterizes x values that will result in peace. If you are in the case where $p - c_G < 0$, then G would be happy to accept any feasible x, so any $x \geq 0$. These negative values aren't relevant here because, based on the Peace Assumptions, negative offers are not allowed. Similarly, if $p + c_R > 1$, then R would be willing to accept any feasible offer, but we wouldn't say, for example if $p + c_R = 1.5$, R would accept an offer of $x = 1.1$.

This matters for the offers that G makes to R. If $1 - p - c_R < 0$, then it's not as if G can make an offer where $1 - x < 0$. Essentially, the offer made to R will have a floor at $1 - x = 0$, and cannot go any lower. This will be reflected in the excel worksheet.

Part III
One Round, Private Information Crisis Bargaining Model

Here we will introduce uncertainty into the model. We've talked a bit about uncertainty in the discussions on expected utility: war could end with peace or war, states don't really know going in. We also discussed this in the discussion on Rationality, when I was trying to decide if I should get an apple or orange (the apple could be mealy with some probability, or the apple could be great with the remaining probability). This uncertainty is a bit different because it is one sided. What do I mean by that? It's like the card game we did in class.[5] Each player had some bit of information that the other player did not have. In other words, they had some "private information," or the information structure of the game was asymmetric. Note that this is different than how we've discussed war: in the previous discussion of war, no one knew who would actually win or lose, they just knew the probabilities.

Returning to the Brenton Kenel example. I may have some private information that Brenton doesn't know that would be relevant to the situation. I could have grown disillusioned with Mario and like it less. Alternatively, I may have a dear friend who is a cop. This would make it very easy to use law enforcement to get the Mario back. Or, it could be that I am incredibly busy and dearly miss the Mario. Any of these examples could be true, but Brenton might not know about it.

[5] This assumes we were able to do the card game in class.

For this exercise, specifically, we treat R as having private costs to war. Why would the Rebel have private costs to conducting war?

We will formalize this in the following way. What's changed is the first step.

- First, R's costs of war are determined. R's costs of war are either c_{R1} or c_{R2}. R has costs of war c_{R1} with probability ω where $0 \leq \omega \leq 1$, or R has costs of war c_{R2} with probability $1 - \omega$. R is aware of it's own war costs, but G does not know R's war costs. However, G does know that R has costs c_{R1} with probability ω and costs c_{R2} with probability $1 - \omega$. Throughout this model, I will assume that $c_{R1} < c_{R2}$.
- Second, G offers R some value $1 - x$. Assume x can take on all values between 0 and 1 (inclusive)
- Third, R "accepts" the offer, resulting in the peace payoff, or declares "war," resulting in both states going to war and achieving their war payoffs.

As it was in the previous model, we are keeping the "Setup Assumptions," the "Peace Assumptions," and the "Indifference Assumptions." The one (small) change is to the "War Assumptions." We now assume that R's with cost of war c_{R1} have expected war payoffs $EU_{R1}(war) = 1 - p - c_{R1}$, and R's with costs of war c_{R2} have expected war payoffs $EU_{R2}(war) = 1 - p - c_{R2}$. Note that from the above assumptions that $c_{R1} < c_{R2}$, it must be that $1 - p - c_{R1} > 1 - p - c_{R2}$. From this, we can draw a new kind of bargaining range.

G behaves as G did above in the complete information model. Any $x \geq p - c_G$ will be accepted.

R will behave slightly differently because R could have low or high costs to war.

- For the **most generous** offers to R, it will be the case that $1 - x \geq 1 - p - c_{R1}$ and $1 - x \geq 1 - p - c_{R2}$. This means that R has no incentive to fight, and will accept the offer.
- For the **least generous** offers to R, it will be the case that $1 - x < 1 - p - c_{R1}$ and $1 - x < 1 - p - c_{R2}$. This means that R always has incentives to fight, and will reject the offer.
- Lastly, for **intermediate** offers to R, it will be the case that $1 - x < 1 - p - c_{R1}$ and $1 - x \geq 1 - p - c_{R2}$. This means that type c_{R1} R's have incentives to fight, and type c_{R2} R's have incentives to not fight.

This should get you thinking. G may want to always avoid war (trust me on this for now). To do this in a way that is most productive for G, G will select the offer $1 - x'$, where $1 - x' = 1 - p - c_{R1}$. Where did this come from? We know that $1 - x'$ will keep type c_{R1} R's from going to war; the offer $1 - x'$ equals type c_{R1}'s expected utility from war, so this is a done deal. Also recall that $1 - p - c_{R1} > 1 - p - c_{R2}$. By transitivity, $1 - x' > 1 - p - c_{R2}$, so type c_{R2} gets an offer that is greater than their wartime utility. In summary, G may offer $1 - x' = 1 - p - c_{R1}$, G will get payoff $p + c_{R1}$, and both types of R will get payoff $1 - p - c_{R1}$. This is summarized in the table below.

But, there's now a new strategic tension in the game. Verbally, the above plan may be playing it too safe for G's preference. G may prefer risking war sometimes in order to do better against R when R does

not declare war. Formally, G may want to make an offer of $1 - x''$, where $1 - x'' = 1 - p - c_{R2}$. There are "pros" and "cons" to doing this. As the "con," the offer $1 - x''$ would provoke type c_{R1} R's to go to war. As the "pro," type c_{R2} R's would accept the offer, and G would be left with payoff $p + c_{R2}$ (which is larger than $p + c_{R1}$) when the offer is accepted. The final payoffs from offer $1 - x''$ are more complicated. Type c_{R2} R's would accept the offer and get $1 - p - c_{R2}$. Type c_{R1} R's would go to war over the offer and get $1 - p - c_{R1}$. G's payoffs depend on the likelihood that R has costs c_{R1} (which is probability ω) and the likelihood that R has costs c_{R2} (which is probability $1 - \omega$). Together, from offer $1 - x''$, G will get payoff $\omega * (p - c_G) + (1 - \omega)(p + c_{R2})$. This is also summarized in the table below.

This stuff is hard and subtle. To test your comprehension, consider the following, and tell me why it is not correct: "Peter, why wouldn't G just offer R some split of the difference? For example, $1 - x''' = \omega * (1 - p - c_{R1}) + (1 - \omega)(1 - p - c_{R2})$? Based on the expected utility discussion, this is what R expects to get from going to war?"

G's Offer	Does war ever happen?	G's payoff	c_{R1} R's payoff	c_{R2} R's Payoff
$1 - x' = 1 - p - c_{R1}$	No	$p + c_{R1}$	$1 - p - c_{R1}$	$1 - p - c_{R1}$
$1 - x'' = 1 - p - c_{R2}$	Yes (with c_{R1})	$\omega * (p - c_G) + (1 - \omega)(p + c_{R2})$	$1 - p - c_{R1}$	$1 - p - c_{R2}$

To know whether or not G will go to war, you can start plugging in values and see whether x' or x'' will result in a greater payoff for G. This is where you can use the Excel.

Part IV
Two-Period, Complete Information Crisis Bargaining Model (Commitment Problems)

Lets continue the verbal logic above. Remember when Brenton took my Mario and I gave him \$3? Let's replay that. Brenton still took my Mario. Brenton is still coming to me and asking \$3 for it. But now have some other information. I know that Brenton has been looking into getting a fancy security system and would put the \$3 towards that. And I know that Brenton has been in talks to hire a fancy lawyer pending an sudden influx of cash (like the \$3). And, I know that Brenton has no scruples about bribing a local police department with the \$3. So what does this all imply?

Brenton is on his way towards making it very hard for me to pursue an outside option like suing, me stealing, or going to the police to get my Mario back. This means that if I give Brenton \$3 now and then Brenton steals my Mario again, Brenton could then come back and start charging me even more money – \$4, \$5, maybe even \$6.

Faced with this new option, the shadow of a future where Brenton is asking me for \$6 for my Mario looms. So here, instead of me coughing up the \$3 today, I decide to take him to small claims court. This is bad for me, but it's not as bad as what my future looks like where I'm giving Brenton all my cash.

3 Setup to the Model

In this model, we are going to consider a power shift that occurs across two periods. Between periods 1 and 2, G is a rising power, while R is shrinking in power. In terms of parameters, this means that p, which is G's likelihood of winning a war, rises across periods. To parameterize this shift, I'm going to call these likelihoods p_1 (for the first period) and p_2 (for the second period). I will assume $p_1 < p_2$.

There are several ways to justify this treatment. It could be that G is building up G's army, which would

make them more powerful in the future. It could be that G is on their way to form an alliance that would help in a war against R. It could be that R has been fighting a war, and choosing a peaceful path in the first period would result in R losing some of their capabilities (like handing over their arms or demobilizing troops)

A few things before introducing the model. First, there's more subscripts. I let $1 - x_1 \geq 0$ and $1 - x_1 \leq 1$ represent the offer made in the first period (from G to R), and $1 - x_2 \geq 0$ and $1 - x_2 \leq 1$ represent offers made in the second period. Second, I assume costs are the same across periods.

- (Start of Round 1) First, the government G offers the rebel R $1 - x_1$, where $1 - x_1 \geq 0$ and $1 - x_1 \leq 1$.
- Next, the rebel R either accepts the offer, resulting in the "peace" payoff for that round, or rejects the offer, resulting in the "war payoff." If R accepts, then G receives x_1, R receives payoff $1 - x_1$, and the game moves forward to the third bullet point. If R declares war, then both players receive their expected war payoffs and the game does not proceed. In other words, when war happens in the first round, the winning party controls the asset minus the costs of war *for two rounds.* I let p_1 denote the likelihood that G wins in war in round 1, and c_G and c_R denote G's and R's costs of war. Together, G's total expected utility from war in round 1 is $EU_G(war\,in\,round\,1) = 2*(p_1 - c_G)$ and R's expected utility from war at this point $EU_R(war\,in\,round\,1) = 2*(1 - p_1 - c_R)$.
- (Start of Round 2) Next, G offers R $1 - x_2$, where $1 - x_2 \geq 0$ and $1 - x_2 \leq 1$.
- Finally, R either accepts the offer, resulting in the "peace" payoff for that round, or rejects the offer, resulting in the "war payoff." If R accepts, then G receives x_2, and R receives payoff $1 - x_2$. If R declares war, then both players receive their expected war payoff. Here the winning party controls the asset minus the costs of war for one round. I let p_2 denote G's likelihood of winning in war in round 2, and c_{G2} and c_{I2} denote G's and R's costs of war in round 2. Together, G's expected utility from war in round 2 is $EU_G(war\,in\,round\,2) = p_2 - c_G$, and R's expected utility from war in round 2 is $EU_R(war\,in\,round\,2) = 1 - p_2 - c_R$. (note- this is not R's or G's total utility from the game. See below).

To summarize the payoffs:

Actions	**G's total expected utility**	**R's total expected utility**
R goes to war in first round	$2*(p_1 - c_G)$	$2*(1 - p_1 - c_R)$
R accepts offers in both rounds	$x_1 + x_2$	$2 - x_1 - x_2$
R accepts 1st offer, G goes to war in second round	$x_1 + p_2 - c_G$	$1 - x_1 + (1 - p_2 - c_R)$

Note that R cannot go to war in the first round then accept in the second round because war resolves the crisis.

Now is when we finally get the payoff: how commitment problems work in the crisis bargaining framework!

4 Two-Period Model: No Power shift

This "baseline" model represents a world where nothing is changing. Let $p_1 = 0.1$, $p_2 = 0.1$, $c_G = 0.2$, $c_R = 0.2$.

In the second round, R's expected utility from going to war is $EU_R(war\,in\,round\,2) = 1 - p_2 - c_R = 1 - 0.1 - 0.2 = 0.7$. G knows this, and G will offer R as little as possible to prevent war, which is $1 - x_2 = 0.7$. This is a critical point: if G doesn't want to go to war, G will offer R as little as possible to prevent R from declaring war. In the second round, G will base the offer on R's second round expected utility, and R cannot ****commit**** to do otherwise in the first round.

Consider R's and G's utilities in the second round. From peace, R has payoff 0.7 and G has payoff 0.3 (i.e.

$1-(1-x) = x = 0.3$). From war, R would receive expected payoff $EU_R(war\,in\,round\,2) = 1 - p_2 - c_R = 0.7$ and G would receive expected payoff $EU_G(war\,in\,round\,2) = p_2 - c_G = -0.1$. Consider these values when answering the questions below.

Q. What is R's total expected utility from going to war in the first round? (hint: use the formula in the table above)

Q. If G wants peace in both rounds, G will offer R $1 - x_1 = 0.7$ in the first round. What is R's total utility from accepting this offer (hint: this requires you to take into account what happens in the second round)?

Q. Will war occur in the this model without a power shift in either round?

Next, we will consider a scenario with a shifting power.

5 Two-Period Model With a Rising Power

Now let's consider a power shift. Let $p_1 = 0.1$, $p_2 = 0.7$, $c_G = 0.2$, $c_R = 0.2$. In other words, here G is getting much stronger, and R is getting much weaker.

In the second round, R's expected utility from going to war is $EU_R(war\,in\,round\,2) = 1 - p_2 - c_R = 1 - 0.7 - 0.2 = 0.1$. G knows this, and G will offer R as little as possible to prevent war in the second round, which is $1 - x_2 = 0.1$. Note, this is a lot less for R than it was in the baseline model.

Now consider the following:

Q. What is R's total expected utility from going to war in the first round? (hint: use the formula in the table above)

Q. How many utils would it take in the first round to make R indifferent between going to war and accepting?

Q. Is it possible to prevent war in this case?

Q. What is G's expected utility from going to war in the first round.

Q. If G could commit to some larger second period offer, would G want to do so?

This set of questions illustrates the core aspects of commitment problems. War is inefficient. States can come up with many peaceful offers that are better than going to war. However, when a power shift like the above occurs, the state that will be weaker in the future cannot trust the rival state to commit to an agreement out of the goodness of their heart. Even if the rival state promises not to lower their second round offer in the first round, once the second round actually arises, there are no real ramifications for doing so because the declining state really does not want to go to war in the second round.