Grand Bargains: A Theory of Strategic Offers During Power Transitions

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Abstract

Bargaining theory expects that declining powers offer the minimum to avoid war as power shifts. But through history, declining powers have made surprisingly generous offers in to reach a lasting compromise and stable status quo. Are these generous offers rational, or should declining powers make the smallest offer they can, adjusting as power shifts? I show that generous offers backed by the promise of no further concessions—which I call grand bargains—are rational in a bargaining model with shifting power when the rising power's militarization is costly, power transitions are long and the rising power's value for domestic versus foreign policy issues is high. Rising powers get large present day offers. Declining powers get stability in the status quo. I show that grand bargains are not only rational, they also solve many of the worst problems associated with major power war and commitment problems: accidental conflict, uncertainty, indivisibilities and rapidly shifting power with an immovable status quo. I also explain the puzzling timing of delayed grand bargains through history and large swings in strategy from incredibly small low-ball offers, to grand bargains. The results clarify emerging debates in Sino-American relations and explain puzzling aspects of Anglo-American and Anglo-Russian bargaining circa 1900.

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1 Introduction

Over the last two decades, China's rapid economic development has heightened concerns about great power conflict (Allison, 2017). American and Chinese policy-makers want to avoid war (Johnston & Ross, 1999; Goh, 2008; Swaine, 2010). Yet shifting economic potential and military power threatens peace and stability between great powers (Krainin, 2017; Yoder, 2019a; Powell, 2006; Leventolu & Slantchev, 2007). Recently, Glaser (2015) has proposed a Sino-American grand bargain: large reciprocal concessions backed by a mutual promise to abide by the status quo.[1] But this proposal overstates the advantages of large offers and ignore the costs. From a bargaining stand-point, it is unclear if declining powers ever prefer to make one large concession instead of small, incremental concessions over time (Organski & Kugler, 1980; Powell, 1999). Further, it is unclear how large present-day offers commit rising powers to cease future military investment (Powell, 2006). These concerns lead some policy-focused researchers to question if a Sino-American grand bargain will work (cf Silove, 2016; Easley, Kim, & Glaser, 2016). But others believe it has the largest chance of securing peace for Taiwan (Liao & Lin, 2015), Japan (Wilkins, 2016) and possibly Asia broadly (Yuan, 2016). This policy discussion raises a broader theoretical question: Can declining powers use offers strategically during power transitions?

There is surprisingly little research on the size and timing of offers during power transitions.[2] Early research questioned if declining powers should make concessions at all (Mearsheimer, 2001; Powell, 1996; Rock, 2000). Modern research suggests the size of offers is a function of the bargaining protocol, and the rate of shifting power, rather than a strategic decision worthy of study. Both power transition theorists (Organski & Kugler, 1980; Kugler & Lemke, 1996; Reed, 2003) and bargaining theorists that study shifting power (Krainin, 2017; Leventolu & Slantchev, 2007; Bell & Wolford, 2014) believe that the best offer is defined by the rising power's point of indifference with war.[3]

[1] For a similar argument see White (2013).

[2] One exception, discussed bellow is Treisman (2004).

[3] Declining power's face a risk-return trade-off when they are uncertain, leading them to offer, in practice,

Yet policy-makers through history have tried to use large foreign policy concessions to achieve peace with an emerging threat. For example, the British sought rapprochement with the United States and Russia circa 1900 leading to a stable peace in both cases. In 1945, the United States and Britain offered the Soviets spheres of influence to secure world peace.[4]

I argue that declining powers can use offers to induce stability in the balance of power. Declining powers make large concessions (much larger than the rising power's minimum demand as power is shifting) in exchange for the rising power's promise to consume her surplus resources henceforth. The rising power gets a larger present-day offer. The declining power gets a promise of stability in the balance of power. I call this offer a grand bargain.

To flesh out the logic I analyze an infinite horizon bargaining model of war (Powell, 1999) with the added assumption that the rising power's military investment is endogenous, similar to a guns-butter model (Mintz & Huang, 1991). Each period, the rising power chooses to invest his surplus in the military or consume it for a profit. To stack the deck against strategic offers, I study a complete information game where the declining power holds the bargaining power. In these settings bargaining theorists expect that if the declining powers wants to bargain, he will offer just enough to avoid war and make small incremental concessions over time (Krainin, 2017; Yoder, 2019a).

I show that when power transitions are long and domestic spending is attractive to the rising power, a grand bargain dominates incremental offers that just avoid war. Grand bargains work because they capitalize on the rising powers' desire to consume. Rising powers that invest in their military improve their foreign policy position at the expense of welfare spending and patronage. If their military investment will not produce sufficient foreign policy concessions they prefer to consume those resources instead. Knowing this, declining powers make large present day offers backed by the promise that they will not concede more in the future. This promise is credible because the present-day offer is larger than the minimum to

something other than the rising power's minimum demand. But their goal is to offer the rising power's minimum demand given the information they have (Yoder, 2019a; Powell, 1999).

[4]This strategy failed. But the British and the Americans still offered large concessions in the hopes of securing a grand bargain.

avoid war even if the rising power continues to militarize for a while.

My argument is consistent with the grand bargain suggested by China-focused researchers (Glaser, 2015). However, formalization helps clarify two differences. First, existing accounts claim that grand bargains require two-sided concessions. I show that unilateral concessions will lead to a more effective grand bargain because the offer must be large enough to make the status quo attractive to the rising power. Second, existing accounts argue grand bargains help states reassure each other of their benign intentions (Ripsman & Levy, 2008).[5] Thus, we should expect them when the rising power has private information about her interests. I show that grand bargains can be rational under complete information when the rising power has expansive aims.

Formalization also helps explain the puzzling sequence of offers leading up to a grand bargains we observe in real-world cases. For example, in the decade before Britain developed a "special relationship" with the United States, they came to the brink of war twice. In 1898, President McKinley demanded Britain cede Alaskan colonies to the United States. When the British refused, McKinley deployed forces. As the crisis escalated, the British stood firm: prime minister Salisbury insisted on international arbitration to delay concessions for four more years. Only after four years of hard bargaining did the British withdraw from the American continent in full, leading to long-lasting Anglo-American peace. Historical researchers have argued that Britain's refusal to negotiate and instead run, in their view, enormous risks of major war, calls into question the democratic peace (Layne, 1994). Given all the advantages of a grand bargain, why would Britain delay their generous offer, and why would they low-ball the United States over issues it barely cared about risking war, before shifting to large concessions and a stable peace?

When the rising power anticipates an unusually generous offer tomorrow, she is willing to accept a low-ball offer today. If declining powers made large offers straight away, they could not exploit these low-ball offer first. Declining powers delay peace and stability to capitalize

[5] Yoder (2019a) makes a similar argument about adjusting levels of military power (not offers) to screen types.

on short-term benefits. Thus, when we observe grand bargains late, my theory predicts surprisingly tense and hard bargaining right before great powers strike a grand bargain and a lasting peace.

Great powers face many hazards that are not included in my baseline model. China-watchers worry about, and theoretical researcher believe, that several hazards may exacerbate the effects of shifting power and drive the United States and China to war: indivisibilities (Toft, 2006; Fearon, 1995), sudden shocks to the rate of shifting power (Bas & Coe, 2016; Krainin, 2017), random accidents (Wu & Bueno De Mesquita, 1994; Schelling, 1957), and an immovable status quo plus rapidly shifting power (Powell, 1999). If these hazards are present, grand bargains may not be relevant because the US and China may wind up in a major war before they get the opportunity to forge a grand bargain.

I extend my model four times, each time adding in one of these hazards. I show these hazards lead to war under fewer conditions than existing research expects because states choose grand bargains over war. There are slightly different mechanisms depending on the hazard. But most share a common logic: Declining powers anticipate pending hazards (e.g. an indivisible issue that they will soon have to confront) and, rather than accept war tomorrow is inevitable, offer a grand bargain today instead. Thus, the hazards that most concern policy-makers may actually drive the United States and China to a stable compromise that avoids shifting power altogether.

These extensions provide a critique of the common causes of war between completely informed states. Fearon (1995) identified causes of war under the assumption that states started to contest an issue for the first time. But it is hard to imagine how states with decades of peaceful relations would all of a sudden confront an indivisibility or a commitment problem absent some underlying change in the strategic setting. Researchers believe that shifting power can force states to confront hazards that induce major war after decades of peaceful relations (Powell, 1999). As a result, we now view war as a mechanism to prevent power from shifting (Powell, 2006; Debs & Monteiro, 2014; Gilpin, 1983; Organski & Kugler, 1980; Slantchev, 2003). But I show that there is another way states prevent power from shifting: large offers. In every setting where war is more attractive than small offers, large offers are also more attractive than small offers. When militarization or war is expensive enough, a grand bargain wins out over preventative war. It turns out that many of the hazards we thought were causes of war are not enough. It requires a complex combination of them for war to be better than a grand bargain.

My theory also provides a rational foundation for the fair division of surplus. Economists (Brams & Taylor, 1996; Massoud, 2000) and political psychologists (Kertzer & Rathbun, 2015; Kapstein, 2008) attribute fair division to preferences for fairness and environmental constraints that prevent actors from maximizing their interests. I argue that large offers may be born out of a desire for stability across time.

1.1 Bargaining in bargaining models of war and shifting power

Although there are many ways to study power transitions (cf Powell, 1996), I use the infinite horizon spatial bargaining framework (a-la Yoder, 2019a; Krainin, 2017) because it realistically reflects the strategic problem of power transitions and allows me to emphasize negotiations in great power diplomacy. In spatial bargaining models, states selfishly pursue their foreign policy interests under anarchy; all concessions are valuable, so one state's gain is another's loss; and states can choose not to bargain and instead fight to secure their foreign policy preferences. In bargaining theory, war is an outside option that sets each player's minimum demand from a peaceful settlement (Binmore, Rubinstein, & Wolinsky, 1986). As the rising power's military power increases incrementally over time, so too does her expected value from fighting. She exploits this increasing value from war to demand incrementally larger foreign policy concessions.

I want to analyze how the declining power strategically manipulates his offer to induce different responses from the rising power. Thus, I chose a bargaining protocol that gives the declining power flexibility in making offers but realistically reflects the declining powers options. Following Powell (1999), I chose a take-it-or-leave-it protocol with an immovable status quo. The take-it-or-leave-it protocol ensures that the declining power can always set an offer at the rising power's minimum demand as power shifts. This protocol is a tough test of my theory because the declining power always wants to maximize the size of her surplus. If the declining power can set the size of the offer, he should make the smallest offer he can and maximize the present-day share of the surplus given his expectations about shifting power and the rising power's minimum demand from fighting (Slantchev, 2003; Binmore et al., 1986).

In practice, once a rising power captures territory, deploys forces and starts to govern, they are unlikely to give it up. For example, it is implausible that China would concede Xing Jiang province to the United States for a decade as a way to compensate the US for expectations about large future demands. To get at this dynamic I assume a status quo bias such that once the declining power concedes a territory he cannot take it back. Not only is an immovable status-quo realistic, but research expects that it induces a credible commitment problem that leads to preventive war if power shifts fast enough (Powell, 1999; Yoder, 2019b). To show that a grand bargain is realistic, it is important to show that it can survive hazards like an immovable status quo and is not a result that I derive just in cases where war would be the actual outcome.

The protocol also has several technical advantages. It can produce a unique equilibrium result (Powell, 1999) that would survive as one of many possible equilibria given a more general bargaining procedure (Powell, 1988; Moulin, 1984; Muthoo, 1999). Since the purpose of this paper is to establish that a grand bargain can be rational, it is important to show it is rational in a context that others have found only a single equilibrium survives, that also generalizes to more complex bargaining procedures.[6]

I make one change to canonical model: I introduce a guns/butter trade-off (Mintz & Huang, 1991; Domke, Eichenberg, & Kelleher, 1983). I assume that the rising power chooses

[6] I find a grand bargain equilibrium if I use, for example, a Rubinstein protocol.

between investing her surplus in the military or consuming it for a profit. Others have modeled the guns/butter trade-off within the context of shifting power to understand how the declining power's threat of preventive war influences the rising power's decision to militarize. Genicot & Skaperdas (2002) argue that even when states face preventative war they still invest in their military. However, Debs & Monteiro (2014) show that when military investment leads to a delayed shift in military power (say in the context of nuclear weapons investment), then the threat of war can prevent states from investing. They argue that uncertainty about militarization (or the capacity to militarize in secret) is necessary to generate preventative war.[7]

Even though these studies assume militarization is costly they do not find a grand bargain equilibrium.[8] Two features of my model allow for a grand bargain to emerge. First, I assume that rising powers have access to surplus resources for many, rather than two, periods and can invest incrementally in their military. This models a setting where rising powers invest in conventional forces and can adjust their force posture over time. Second, I assume that rising powers benefit from not investing in their military (i.e. they get a payoff from consumption) rather than pay a cost for investing in their military.

Treisman (2004) presents a similar mechanism to mine in the context of multi-actor bargaining. He argues that declining powers who face multiple rising powers compromise with one to deter the other. Thus, multi-actor bargaining can sometimes induce states to make grand bargains, so they can focus their war fighting potential on different rivals. This mechanism is consistent with the grand bargain I describe but requires multiple states. I show that a grand bargain is rationalizable in the dyadic context.

[7] Recently, Krainin (2017) has argued it may not be necessary.

[8] Debs & Monteiro (2014) implicitly find a similar condition. However, they do not explore it.

2 Theory

I study a strategic dynamic between a rising (R, feminine) and declining (D, masculine) power that bargain for control over a foreign policy issue in the shadow of war. These states bargain to split a pie of size 1 in every period $t \in \{1, 2, ...\}$. If these states agree to a bargain q_t in period t, then R receives a payoff q_t from her foreign policy position[9] and D receives a payoff $1 - q_t$. Both states discount the future at a constant rate $\delta \in (0, 1)$.

Both players have an outside option called war that they can revert to if they do not like the consequences of bargaining. I assume that war is as a game-ending costly lottery.[10] War is a lottery because states are uncertain about who will win it. However, they believe that their underlying military power is a good predictor. To model this uncertain process, let R's relative military power $p_t \in [0, 1]$ be the probability that R wins war in period t and $1 - p_t$ be the probability that D wins. If war is selected in period t, players enter this lottery in that period, and the winner gets to impose his or her preferred settlement in period t and all subsequent periods. When players enter sub-game war, a common cost $w > 0$ is subtracted from both player's payoff in any period that war is selected and all future periods.

What makes this model a power transition, is that the relative military power (p_t) between R and D can shift in R's favor over the course of the game. Each period, R is allocated a surplus of resources $M \in \mathbb{R}^+$ that she can either invest in her military or consume. Whether power shifts, depends on how the rising power spends her surplus. Let $m_t \in [0, M]$ be the amount R invests in her military in period t. Then R's relative military power in any period is $p_t = \max\left[p_0 + \frac{\Delta}{M}\sum_{i=1}^{t} m_i, 1\right]$. Here, p_0 represents R's military capabilities before R invests any surplus in her military. The summation term measures the cumulative impact of R's military investment over t periods. The equation is normalized such that if R invests the entire surplus in the military, a one period shift in the distribution of power is

[9] I write this to emphasize that R will also accrue a payoff depending on how much she invests in the military.

[10] Some recent work considers war as lasting only a few periods (Leventolu & Slantchev, 2007). My results are the same if I make this assumption.

$(p_t - p_{t-1}|m_t = M) : \Delta$. Later, I will show that military investment comes at an opportunity cost: it denies R the ability to consume her surplus for an immediate profit. Thus, R's choice to invest in her military has two effects: it increases the chance that R will prevail if war happens; and it costs R the resources that R invested in her military program, which she could have otherwise consumed.

To be clear, I assume that power shifts at a constant rate $(\Delta_{t=1} = \Delta_{t=2}|m_1 = m_2)$ and that the rising power has a renewed surplus each period (the power transition lasts forever). These simplifying assumptions do not alter the result if I change them to something more realistic. I reach the same findings if I assume any transition function with diminishing marginal returns: $p_t = f(m_0 + \sum_{i=1}^{t} m_i)$ where $f' \geq 0$ $f'' \leq 0$ and $p_0 = f(m_0)$, or if the power transition lasts for a fixed number of periods.[11] Later we will explicitly alter this assumption to study the impact of rapid increases in the rate of shifting power. To emphasize my baseline assumption so I can relax it later:

$$\mathcal{A}_1 : p_t = f(m_0 + \sum_{i=1}^{t} m_i), f' = \frac{\Delta}{M}, f'' = 0$$

I include a status quo bias such that D cannot take away territory that has already been conceded to R. I assume that if in period t, R accepts an offer q_t, then in period $t+1$ D's offer is restricted to $q_{t+1} \in [q_t, 1]$. Before the first period begins, I assume that the game starts with an initial status quo q_0. Later on we'll revisit the long-standing argument that an initial, immovable status quo combined with rapidly shifting power is a cause of war (cf Powell, 1999). But for now, we'll ignore this possibility to study a case where D has complete flexibility in making offers. To emphasize my baseline assumption so I can relax it later:

$$\mathcal{A}_2 : q_0 = 0$$

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[11] In fact, a grand bargain emerges under more conditions.

I make two other assumptions that increase D's flexibility to make offers:

$$\mathcal{A}_3 : p_0 + \Delta - \frac{\delta\Delta}{1-\delta} - w + \delta\mu M > 0$$

$$\mathcal{A}_4 : p_0 + 3\Delta < 1$$

$\mathcal{A}_3$ helps me avoid corner conditions where D would like to offer R a negative value, but D is unable to offer less than $q_1 = 0$. Thus, it ensures D has maximum flexibility in choosing offers. $\mathcal{A}_4$ ensures that the power transition can last at least 3 periods. That is, even if R invests her full surplus in the military each period she cannot achieve $p_3 = 1$.

The sequence of moves each period is:

1. R invests $m_t \in [0, M]$ in the military shifting power from $p_{t-1} \to p_t | m_t$.
2. D either selects war, or makes a take-it-or-leave-it offer $q_t \in [q_{t-1}, 1]$.
   - If D selects war, enter sub-game war. Otherwise, the period continues.
3. R either accepts D's offer as the settlement q_t, or selects war.
   - If R selects war, enter sub-game war.
   - Otherwise, the period ends and period-payoffs are realized conditional on the settlement reached.

Given the game form, a strategy for R $s^R(m, r^R)$ is a sequence of military investments for each period $m\,\{m_t\}$ and a sequence of war rules $r^R\,\{r_t^R\}$ that defines the condition in which R selects war. A strategy for D $s^D(q, r^D)$ is a sequence of offers $q\,\{q_t\}$ each period, and a sequence of war rules $r^D\,\{r_t^D\}$ that define the condition in which D selects war in each period.

Turning to player's utilities. D's expected benefit depends on the outcome of the foreign policy bargain or selection into war. If period t ends in a peaceful bargain, D's one-period payoff is $U_t^D(accept|q_t) : 1 - q_t$.[12] Starting in period t, D's total present and future expected utility from a stream of offers that R accepts is: $EU_t^D(accept\ \forall\ t|q) : 1 - q_t + \sum_{i=1}^{\infty} \delta^i(1 - q_{t+i})$.

If period t ends in war, D's period pay-off is $U_t^D(war|p_t) : 1 - p_t - w$. The term $1 - p_t$ captures D's expectation that he wins the lottery and D's value for taking the entire pie in the case that he wins. The term w captures D's cost of fighting which he suffers no matter what the outcome is. In the round that war occurs, D anticipate receiving this pay-off for all future periods. Thus, D's total expected value for war at t is:

$$EU_t^D(war|p_t) : 1 - p_t - w + \sum_{i=1}^{\infty} \delta^i(1 - p_t - w) = \frac{1 - p_t - w}{1 - \delta} \qquad (1)$$

R's expected benefit depends on the outcome of foreign policy and how R chooses to spend her resources. R's one-period payoff from accepting an offer in an arbitrary period t is $U_t^R(accept|m_t, q_t) : q_t + \mu(M - m_t)$. Where μ mediates R's value for consumption. When μ is high, it implies that R's value for domestic issues relative to foreign policy issues is high. m_t is how much R invested in her military in period t. Thus, the term $\mu(M - m_t)$ captures R's opportunity cost for military investment compared to consumption. Starting in period t, R's total present and future expected utility from a stream of peaceful bargains is: $EU_t^R(accepts\ t, t+1...|m\left\{m_t\right\}, q\left\{q_t\right\}) : q_t + \mu(M - m_t) + \sum_{i=1}^{\infty} \delta^i(q_{t+i} + \mu(M - m_t))$. R's payoff from a bargain highlights a fact often overlooked in power-transition models: militarization is inefficient. Each time R invests in her military, R loses μm_t utility and D gets no benefit. The less R invests m_t in her military, the more aggregate utility player's receive. However, inefficient militarization is necessary if R wants to increase her bargaining leverage over the contested foreign policy issue.

R's utility from war includes what R expects from contesting the foreign policy issue in a war, as well as R's expected value from consuming her surplus in all subsequent periods. R's total expected utility from fighting a war in period t is:

[12] We adopt the notation $U_{period}^{player}(war/bargain|sub - game\ actions)$ for one period utility throughout the paper.

$$EU_t^R(war|p_t, m_t, m_{t+1} = 0) : p_t - w + \mu(M - m_t) + \sum_{i=1}^{\infty} \delta^i (p_t - w + \mu M) = \frac{p_t - w + \delta\mu M}{1 - \delta} + \mu(M - m_t) \tag{2}$$

The first representation separates R's period t pay-off from R's expected future pay-off. R's period t value includes what R expects from fighting and winning the war $p_t - w$ plus R's value for the resources it did not consume that period: $\mu(M - m_t)$. R's discounted future value assumes that R never again invests in her military.[13] Thus, each period after the war has determined the outcome of foreign policy issues, R get her discounted expected value from fighting in period t plus her value from domestic consumption: $p_t - w + \mu M$.

R's bargaining leverage comes from the threat of fighting a costly war. Thus, R's value for fighting at t, written in equation 2, sets R's minimum demand. R will only accept an offer q_t at t if R's expected value from that offer and her anticipated future benefits in all subsequent periods is as least as large as her expected utility in war.

2.1 Analysis

The solution concept is a Sub-game Perfect Nash Equilibrium (SPNE). I argue that D can use offers strategically to achieve different objectives. Thus, I focus my analysis on the two types of offers that D makes on the equilibrium path: appeasement and a grand bargain.

Following the bargaining literature, I define an offering strategy of appeasement as the smallest offer D can make each period that leaves R indifferent with fighting, given a mutual expectation that R will militarize each period, and D will offer R her minimum demand each period. My definition of appeasement requires a common expectation that R will invest in her military in future periods. This feature is implicit in past studies because power shifted exogenously. But when power shifts endogenously, appeasement describes a

[13] Strictly speaking, R has the option of military investment even after war has occurred. However, since war has determined the foreign policy bargain, there is no need for further militarization. It follows that once war has happened, $m_{t+k} = 0$ strictly dominates any $m_{t+k} > 0$ for any period $t + k > t$.

strategic interaction conditional on both players' common expectations about R's rational incentives to militarize in future period. This will depend on two factors: (1) whether or not militarization shifts the balance of power;[14] and (2) both player's expectations about future investments and offers.

Define a period T as the smallest number of investments R must make to achieve $p = 1$. Thus $p_0 + \Delta(T-1) < 1 \leq p_0 + \Delta(T)$. If R invests $m_t = M$ in all periods, $t = T+1$ is the first period where R cannot shift the balance of power further even if R invests in her military.[15] Let m_T^* be the amount that R must invest in period T such that $p_T = 1$: $p_0 + \Delta(T-1) + \frac{m_T^*}{M} = 1 \equiv m_T^* = M[1 - p_0 - \Delta(T-1)] \leq M$.

Definition Appeasement is a specific sequence of offers, $q^* \{q_t^*\}$, and militarization choices, $m^* \{m_t^*\}$. D's sequence of offers each period is:

- $t < T-1$, $q_t^* = p_t - w - \frac{\delta\Delta}{1-\delta} + \delta\mu M$
- $t = T-1$, $q_{T-1}^* = p_{T-1} - w$
- $t \geq T$, $q_t^* = p_T - w = 1 - w$.

R's sequence of militarization choices is:

- $t < T$, $m_t^* = M$
- $t = T$, $m_t^* = m_t^*$ such that $p_T = 1$.
- $t > T$, $m_t^* = 0$.

Appendix A.1 confirms this sequence of offers leaves R indifferent with her war pay-off each period under the assumption that R will militarize every period until T, and D will offer R her minimum demand every period. The result is similar to bargaining models with exogenously shifting power. I derive it by locating R's minimum demand in periods once power stops shifting, then working backwards to see what R would accept given expectations about the future.

[14] This defines a limit of investment since p is bounded by 1.

[15] This relies on the transition function I assumed. However, using different transition functions does not alter my conclusions. For example, if I assume a transition function $p_t = f(m_0 + \sum_{i=1}^{t} m_i)$ where $f' \geq 0$ $f'' \leq 0$ and $p_0 = f(m_0)$, period T emerges at the point where R's gains from future militarization are no longer worth the opportunity cost of consumption. However, I can simply treat the period that R stops militarizing as T and I reach identical conclusions. Similarly, if power only shifts for a fixed number of periods, I get identical results by calling T the fixed number of periods.

Once power stops shifting, (periods $t > T$) R's minimum demand is equal to her war pay-off. The reason is that the underlying strategic setting is stationary. This implies R's minimum demand each period is her single-period war pay-off.

Working backwards (periods $t < T$), R's minimum demand factors in R's expectations about shifting power. Consistent with past studies, R is willing to accept $\frac{\delta\Delta}{1-\delta}$ less than her present value for war because R anticipates a bargaining power will increase next period. This increased power implies that R can demand Δ more next period if she waits rather than fights straight away. R expectation about her increasing bargaining leverage makes her patient.

Inconsistent with past studies, R is able to extract an additional $\mu M\delta$ from D each period. The reason R can extract this additional offer is that militarization deprives R the opportunity to consume her surplus. Under appeasement, R expects to spend her surplus every period on militarization. However, once R fights a war to settle foreign policy issues, she gains no advantage from future military investments. Thus, if R chooses to fight at t, she can consume her surplus in all future periods no matter what D does or what the outcome of conflict is. To avoid war, D must compensate R an additional $\mu M\delta$ for this opportunity to consume resources in the next round. R could derive μM utility from directly consuming her resources. However, R exploits the threat of war to extract the same amount from D through concessions. D's expected utility from appeasement must factor in these additional concessions each period. It follows that for periods $t < T$, D's expected value from making a stream of appeasement offers that are accepted is:

$$EU_t^D(appease|t < T-1) : \frac{1-p_t+w}{1-\delta} - \sum_{i=1}^{i=T-t+1} \delta^i \mu M = \frac{1-p_t+w-\mu M(\delta-\delta^{T-t})}{1-\delta} \quad (3)$$

and R's is:

$$EU_t^R(appease|t < T-1, p_t) : \frac{p_t - w}{1-\delta} + \sum_{i=1}^{i=\infty} \delta^i \mu M = \frac{p_t - w + \mu M \delta(1-\delta)}{1-\delta} = EU_t^R(war|t < T-1, p_t) \tag{4}$$

The conventional wisdom is that appeasement is the best D can do from bargaining because it maximizes D's share of the pie in every possible period. It is widely thought that if D does not want to fight, appeasement is the offering strategy D will choose.

The central claim of this paper, however, is that D can use offers to do more than barely avoid war as R militarizes. In particular, D sometimes prefers to make unusually large offers to entice R to accept the status quo and stop shifting power. By unusually large, I mean that the offers are larger than appeasement. Informally, a grand bargain is an offer that is so large R prefers to accept it forever and consume her surplus rather than invest in her military.

Many have argued that grand bargains are not rational offers because the rising power faces a credible commitment problem. Nothing prevents rising powers from accepting a large offer in the present and then keep investing in their military to coerce even more concessions. The commitment problem is overcome by two factors: (1) Militarization costs R the opportunity to consume surplus resources; (2) D can credibly promise to revert to appeasement if R keeps investing in her military. With sufficiently large offers at t, D can promise that she will not increase the offer in $t+1$ even if R invests in her military.

More precisely, notate a period $t = \tau$ such that $1 \leq \tau < T$. I say that period τ is the period in which D makes a grand bargain offer. At τ, R invests in her military. Then an offer at τ would entice R not to invest again if:

$$\tilde{q_\tau} + \sum_{1}^{\infty} \delta^i(\tilde{q_\tau} + \mu M) > \tilde{q_\tau} + \frac{\delta(p_\tau + \Delta - w + \delta M)}{1-\delta} \tag{5}$$

The left hand side is R's value from accepting $\tilde{q_\tau}$ in the current period, then accepting it in every subsequent period and consuming her surplus. The right hand side is R's value from accepting $\tilde{q_\tau}$ in the current period, then investing in the next period and D and R reverting to appeasement at $t = \tau + 1$.

Solving this inequality:

$$\tilde{q_\tau} = p_\tau + \Delta - w - \mu M(1 - \delta) \tag{6}$$

I refer to $\tilde{q_\tau}$ as the grand bargain offer, which occurs in period τ.[16] There are two important differences between $\tilde{q_\tau}$ and q^*_τ. First, $\tilde{q_\tau}$ is increasing in the rate of shifting power (Δ) rather than decreasing. Second, $\tilde{q_\tau}$ is decreasing in R's value from domestic consumption (μ) rather than increasing. These differences arise because R faces different opportunity costs from her military investment choices when faced with these offers. Under appeasement, R's minimum demand stems from her threat of war if the present day offer is not large enough. In war, R consumes her surplus in an earlier period than she would under appeasement. R exploits the promise of immediate consumption following war to extract a larger present day concessions. Thus the offer that satisfied her minimum demand was decreasing in Δ and increasing in μ. In contrast, R's minimum demand under a grand bargain stems from her credible threat to militarize and extract more concessions in the future if the present day offer is not large enough. Unlike war, R's credible threat of militarization promises to delay consumption an additional period to increase her offers tomorrow, thus it is decreasing in μ. But for the grand bargain to work, it must be so large that it would take several military investments for her to increase her bargaining leverage enough to shift the offer again. As R's rate of shifting power increases, it is easier for R to militarize enough to demand more. Thus, the offer that entices R to accept a grand bargain must be is increasing in Δ.

Like appeasement, we can think about a grand bargain as a pair of strategies.

Definition A grand bargain is a sequence of offers $\tilde{q}\,\{\tilde{q_t}\}$ and corresponding militarization choices $\tilde{m}\,\{\tilde{m_t}\}$. The sequence of offers must contain a sub-sequence starting in some period $\tau < T$:

[16] To be clear, this part of a sequence $\tilde{q}$ that includes other offers. But in period τ, D offers something $\tilde{q} > q^*$ to induce stability in the status quo.

- $t = \tau$, $\tilde{q}_\tau = p_\tau + \Delta - w - \mu M(1-\delta) > q^*_\tau$.
- $t > \tau$, $\tilde{q}_t = \tilde{q}_\tau = \tilde{q_{t+1}}$

The sequence of militarization choices must include a corresponding subsequence:

- $t \leq \tau$, $\tilde{m}_t = M$
- $t > \tau$, $\tilde{m}_t = 0$ such that $p_t < 1$.

Notice some important differences between a grand bargain and appeasement. First, the grand bargain offer at τ is larger than the offer D would have made under appeasement. Second, a grand bargain must lead the game to converge to a stable state where the level of relative power is constant at a value for p_t lower than it would have been if D played appeasement.

It turns out that D sometimes has trouble making a credible promise to offer a grand bargain. D can resolve this issue, D sometimes relies on his competing preferences between offering a grand bargain and appeasement. Define a period z as the last period where D's total expected utility from a grand bargain exceeds D's utility from appeasement. That is in a sub-game starting at z that assumes $m_t = M \forall t \leq z$, $EU^D_z(\tilde{q}, \tau = z) > EU^D_z(q^*)$. However, in the next period $EU^D_{z+1}(q^*) > EU^D_z(\tilde{q}, \tau = z)$. For a more technical description of period z, see Appendix A.1.1.

Proposition 2.1 *Existence: A grand bargain is a SPNE if:*

$$\frac{\Delta}{1-\delta^T} < \mu M < \frac{\Delta}{1-\delta} \tag{7}$$

$$\frac{\Delta - 2w}{1-\delta} < \mu M \tag{8}$$

is satisfied. On the path, D sets a period τ to make the grand bargain offer. R militarizes $m_t = M$ for all periods $t \leq \tau$ and does not militarizes in all subsequent periods. Off the path, if R deviates from $\tilde{m}_t = 0$ at $t > \tau$, D reverts to a sequence of offers q^* for sub-game starting at $\tau + 1$. If D deviates with any offer $q_t < \tilde{q}_t$ for $t < \tau$, R selects war. If D deviates with any offer $q^*_\tau < q_\tau < \tilde{q}_\tau$, R reverts to a sequence of offers m^*_t for subgame $t > \tau$.

Timing: In any grand bargain equilibrium, the large grand bargain offer $\tilde{q}_\tau$ can only emerge in one of two places. If

$$\mu M < \frac{\Delta}{1-\delta^z} \tag{9}$$

is satisfied, D makes the grand bargain offer in the first period $\tau = 1$. On the path, D repeats this offer every period. R plays militarization strategy $\tilde{m}_1 = M$, then for all $t > 1$, $\tilde{m}_t = 0$.

If inequality 9 is not satisfied, D sets $\tau = z$ and plays a sequence of offers $\tilde{q}||\tau = z$:

- *if $t < z - 1$, $\tilde{q}_t = q^*_t$*
- *if $t = z - 1$, $\tilde{q}_{z-1} = \tilde{q}_{z-1} = p_{z-1} - w - \frac{2\Delta\delta}{1-\delta} + 2\delta\mu < q^*_{z-1}$*
- *if $t \geq z$, D repeats offer $\tilde{q}_z = p_z + \Delta - w - \mu M(1 - \delta) > q^*_z$ in every period.*

R plays militarization strategy $\tilde{m}$:

- *if $t \leq z$, $\tilde{m}_t = M$*
- *if $t > z$, $\tilde{m}_t = 0$*

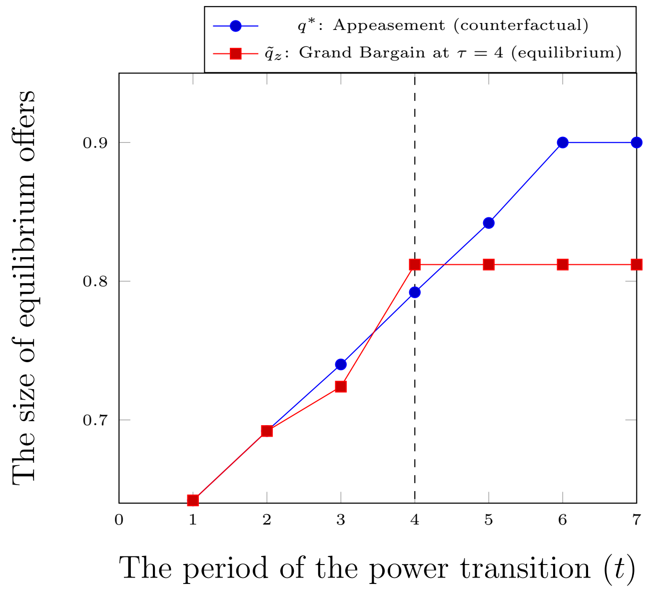
The proof is in Appendix A.2. When power is assumed to shifts exogenously, declining powers make the smallest offer they can each period and accept that power will shift. In my theory, D could maximize his share of the present surplus, but he prefers to make larger offers that create incentives for R to consume her surplus and accept the status quo. D can only achieve this by giving up valuable foreign policy issues earlier than he must. That is, in period τ D cedes $\tilde{q}_\tau$ which is $\frac{\Delta}{1-\delta} - \mu M$ larger than q^*_τ.[17]

D is willing to do this because he anticipates that appeasement offers must confront R's opportunity cost of fighting. Under appeasement, D makes an additional $\mu M\delta$ concession to R for T periods. When D anticipates making these repeated concessions for many periods, D prefers to offer a grand bargain and stop the power transition straight away.

Given that D's preference for a grand bargain over appeasement stems from the fear of a long sequence of increasing offers, we might expect that D makes the grand bargain offer straight away. Afterall, the number of increasing offers is largest in the first period and D, therefore, has the most to lose. My result supports this intuition to some extent. When inequality 9 is satisfied, D sets $\tau = 1$ and offers a grand bargain straight away. Yet D sometimes delays his grand bargain offer until period z. That is, the very last moment that he prefers a grand bargain to appeasement. Why would D ever delay a grand bargain?

[17]This is always positive given the equilibrium conditions 7, 8.

Figure 1: Equilibrium results when war is induced



The figure plots the size of D's offers at each round of the game. The plot assumes $p_0 = .7$, $\Delta = .05$, $\mu = .24$, $\delta = .8$, $w = .1$. At these values τ (plotted as a dashed line) emerges in period 4, and T emerges in period 6.

D delays a grand bargain today to exploit the promise of a grand bargain tomorrow. In past studies, q^* defines the smallest offer D can make to avoid war. But in a delayed grand bargain, D offers R $\tilde{q}_{z-1}$ which is $\delta\left(\frac{\Delta}{1-\delta} - \mu M\right)$ less than q^*_{z-1}. D can make this unusually small offer because R anticipates getting a very large offer in the next period. D exploits his credible promise to offer $\tilde{q}_z$ to make a very small offer the period before. I call this offer a low-ball offer.

To contrast my results with past studies, I visualize the sequence of equilibrium offers in Figure 1. The equilibrium sequence of offers (red squares) is a grand bargain where $\tau = 4$. For contrast, I plot the sequence of appeasement offers as blue circles. As you can see, the generous grand bargain offer is preceded by an unusually frugal low-ball offer. D could have offered a grand bargain in the first period. But if he did, he could not profit from this low-ball offer.

In a perfect world (for D), D would delay the grand bargain offer one period and set $\tau = 2$. But D faces a credible commitment problem: He wants to exploit the promise of a grand bargain tomorrow to make a low-ball offer today. But when tomorrow comes, he is unwilling to make that grand bargain offer. Instead, he wants to delay a grand bargain one more period to make another low-ball offer. Anticipating this problem, R is unwilling to accept a low-ball offers straight away.

This commitment problem is resolved in period z. The reason is that D prefers appeasement over a grand bargain at $z+1$. It follows that D can promise to offer a grand bargain at z, because it is the last period he prefers it to appeasement. Inequality 9 defines D's point of indifference in the first period between offering a grand bargain straight away, and D's expected value for waiting z periods to offer a grand bargain.

This sequence tracks well with surprising facts about how U.S. policy-makers think about making concessions to China. After all, if grand bargains are so attractive, and they have so many positive properties, why have the United States and China not struck one yet? The United States has been concerned about China's rise since at least 1990 but only recently has the notion of a grand bargain been raised. Many analysts argue that the US strategy seems to be the opposite of a grand bargain: The United States resisted Chinese expansion into territories that are peripheral to US national security but central to China's national interests. For example, the US has stood with Japan on the Senkaku Islands dispute and resisted China's attempts to expand influence in the South China Sea.

Bargaining theory tells us that the United States should make incremental concession that reflect changes in the distribution of power. But the United States has been slow to make concessions at all.[18] As a result of this hard bargaining, the US and China have recently engaged in risk-taking exercises in the Asia Pacific. These risks could easily spiral into major conflict. For many, it appears that the US is trying to make fewer, not more, concessions than it must to avoid war.

My theory provides a logic for why the US did not consider a grand bargain with China for decades. It also explains the tense, and unusually risky bargaining strategy the US has pursued in recent years. Of course, the US and China have not yet reached a stable

[18] This pattern is more consistent with power transition theory suggested by Organski & Kugler (1980); Reed (2003) and others.

compromise. So we do not yet know if the current period of tension will give way to a stable peace. However, I'll now turn to historical evidence to illustrate how world leaders use low-ball offers in the years before switching to generous grand bargain offers and a stable peace.

2.1.1 Historical Illustration: Anglo-American Bargaining (1895-1903)

Starting in the mid-1800s, the United States sought expansive influence in the Western Hemisphere. As American power grew, the US increasingly sought influence in its region; usually without too much resistance from Britain. In 1903, the British secured rapprochement with the United States; which recognized US hegemony in the Western hemisphere. That year Britain resolved its last territorial dispute with the United States and pledged to defer to US interests in South America. These compromises paved the way for long-lasting peace and cooperation between the United States and Great Britain.

But in the decade before Rapprochement the British bargained surprisingly hard. In 1895 Britain and the United States came dangerously close to war because the British refused to make concessions in Venezuela. For more than a decade, London and Caracas had disputed the Venezuelan border with British Guiana. Britain had administrative control over the territory in dispute. In 1893, Britain offered territorial concessions at the mouth of the Orinoco River, in exchange for Venezuela's recognition of Britain control elsewhere. But Venezuela refused these offers (Eggert, 1974).

In 1895, the US entered the negotiation on the side of Venezuela. "The controversy was a welcome pretext for asserting America's claim to geopolitical primacy in the Western hemisphere. It was for this reason that the United States provoked a showdown on the Anglo-Venezuelan border dispute (Layne, 1994)." In February, the American Ambassador in London put the demands directly to British Foreign Secretary Kimberly: relinquish the claim or the United States will intervene. But Kimberly refused to negotiate. Not only did he refuse to negotiate, but the US entry into the debate caused Britain to withdraw any offers they had made. Britain would no longer make concessions at the mouth of the Orinoco River (Nevins, 1933, pp629-631).

In reply, President McKinley and Secretary Onley then published a threat in the New York Herald which claimed the United States was "on the verge of war." The threat promised actions if Britain did not respond in 90 days (Bailey, 1980, p482). Prime minister Salisbury's reply arrived 6 months later (3 months after the ultimatum expired). In it, Salisbury refused to make any concessions at all (Eggert, 1974). In November, senator Chandler wrote an article in the Monitory that claimed war was inevitable (Nevins, 1933, p637). Over the next three years, American threats mounted. Americans sent military vessels into the waters of British Guyana to demonstrate their resolve. But the Britain refused to negotiate at all.

Britain's fierce bargaining is puzzling from the perspective of bargaining theory. After all the United States was considerably more powerful than Venezuela. When the US entered on Venezuela's side, the British should have realized that the minimum demand was larger than they previously thought. This should have driving Britain to increase their offer. Yet Britain did the opposite. They withdrew offers that they previously had made. Even as the US amassed audience costs to demonstrate their resolve, the British continued to low-ball the United States.

Britain's fierce bargaining has also puzzled historical researchers. British elites believed the United States' foreign policy objectives were confined to the Western Hemisphere and largely consistent with British interests (Grenville, 1970). British interests in South America were much smaller than their interests in Asia, Africa and Europe and the long distance to the Americas meant that the British could only defend their interests there at great cost. Finally, shared norms and values, including democratic governance, and extensive trade ties meant that Britain was optimistic that they shared compatible incentives with the United States (Owen, 1994). Under these conditions, scholars would expect the British to cut a deal with the United States and focus their resources and attention in Europe (Treisman, 2004). They should have avoided risky escalation or spirals of mistrust with the United States

(Glaser, 2010; Jervis, 1978) and opted instead for confidence building measures (Axelrod & Keohane, 1985).

My theory explains why Britain may have bargained so hard right before making very large concessions. Knowing a grand bargain was coming, Britain knew that the United States would accept a smaller concession. Prime minister Salisbury understood this logic well. In response to the American ultimatum over Venezuela he chose not to make any concessions at all "because he did not believe the danger to Britain would be serious. The country and empire would have united in defence of British possessions, and in the face of their determination he believed the United States would give way (p65 Grenville, 1970)." Ultimately, Salisbury believed that Venezuela was not the United States' business and the US had too much to lose elsewhere in South America by following through on this threat (Bailey, 1980, p485).[19]

3 A grand bargain as a solution to the causes of war.

China and the United States are burdened by many challenges that exacerbate the effects of shifting power. Many analysts are skeptical about a grand bargain with China because these hazards loom large. They believe that a grand bargain may not be the United States' best strategy because these more complex strategic challenges will trigger war anyway.

In this section I introduce into my model the four causes of war that scholars and policy-makers worry may exacerbate the pressures of shifting power: rapidly shifting power plus an immovable status quo, accidents, indivisibilities, and dramatic increases in the rate of shifting power. I focus specifically on the conditions under which existing scholarship believes these hazards should lead to conflict. That is, I search for conditions where if power was to shift exogenously then the equilibrium result would be major war. However, I find that when militarization is costly, these hazards produce war under fewer conditions because declining powers anticipate these hazards and offer grand bargains instead. Thus, I find that grand

[19] Also see Eggert (1974).

bargains not only survive in the face of war-causing hazards, but may explain why we observe so much peace in a complex world where these hazards abound.

In section 3.5 I provide evidence that declining powers switch to grand bargains when the hazards of war are thrust upon them.

3.1 An immovable status quo, rapidly shifting power and preventive war.

An important insight from bargaining theory is that rapidly shifting power alone is insufficient to produce preventive war at the onset of power transition. States locked in power transitions weigh the total cost of war in the present against the gains/losses from future bargains. R's expected future gains create incentives for her to avoid war in the present. As a result, when R knows power will shift in her favor, she is willing to accept a smaller offer today. Even though D anticipates future concessions, the amount R is willing to compensate D in the present is enough to off-set D's future losses. As a result, if R is given the opportunity to compensate D today for tomorrow's concessions then rapidly shifting power is not enough to cause war.

The trouble starts when the rising power is unable to make large present day offers. An immovable status quo that favors R implies that R is unable to compensate D enough in the present to off-set D's expected future losses as power shifts. To get at this logic, I replace assumption $\mathcal{A}_2$ with:

$$\mathcal{A}_{2B} : p_0 - w < q_0 < p_0 + w$$

The bounds on q_0 cover all rationalizable values under the assumption that the power transition was preceded by a period of stability. For example, the United States and China never held perfectly aligned preferences even before China's future rise was obvious. During that period of stability, these states were able to sustain peace because they had struck a deal that was mutually acceptable. That compromise must have lay in the bargaining range defined in $\mathcal{A}_{2b}$.[20]

Past studies have found that as the status quo increasingly favors R (q_0 increases) D's incentives for preventive war increase. These dynamics are at play in my model as well. Suppose D observes R's military investment in the first period. D faces a choice between preventive war in the first period, or offering R q_0, and then reverting to appeasement ($q_t^*, t \geq 2$). D's prefers preventive war over appeasement when:

$$1 - q_0 + \frac{1 - p_1 - \Delta + w}{1 - \delta} - \mu M \sum_{i=2}^{T} \delta^i < \frac{1 - p_1 - w}{1 - \delta} \tag{10}$$

$$q_0 > p_0 + \frac{w(1 + \delta) - \delta\Delta - \mu M(1 - \delta^T)}{1 - \delta} \tag{11}$$

Consistent with past research, D's preference for war over an appeasement offer is strictly increasing on q_0. At some point, q_0 is sufficiently large that D prefers to fight.[21]

Proposition 3.1 *Under the assumption $\mathcal{A}_{2B}$, the immovable status quo cannot be a cause of war for any Δ, w.*

I prove proposition 3.1 in Appendix B.1. In theories where power shifts exogenously, an immovable status quo produces incentives for preventive war because R could not compensate D sufficiently in the present given D's expectation about future bargaining. But any immovable status quo favorable to R (q_0 is sufficiently high), also implies that R's military power must increase a lot for R's minimum demand to exceed q_0. When power shifts exogenously, this issue is obscured. However, if R must pay to shift the balance of power, R's incentives to militarize diminish as R's immovable share of the status quo increases. It turns out that whenever R has a large enough immovable share of the status quo that D would prefer to fight a preventive war, R is happy enough with the status quo that militarization

[20] To be clear, I still exclude side-payments. R is not allowed to share any of her surplus with D.
[21] The same is true for all other feasible offers.

is not worth the cost.

To be clear, values of $q_0 > p_0 + w$ could drive D to select war. However, such a settlement could not have been stable in a stable period before the power transition started.

3.2 Accidental Conflict

Policy-makers worry that a small accident may spiral into a major war. In the South China Sea, American and Chinese patrol boats navigate the same waters. American policy-makers worry that these ships may collide, or that a mis-communication may trigger an exchange of fire. Accidents such as these may escalate into a crisis or even all-out war.

The process of militarization and shifting power creates the risk of an accident because China and the United States are forced to encounter each other in new circumstances where the rules of engagement are unclear. When China (or the United States) uses a new weapons system, or deploys forces into a new territory local commanders do not know how to engage each other. Such interactions have led to near misses in the past. For example, in 2001 an American reconnaissance aircraft operating in Chinese airspace collided with a Chinese military jet and crash-landed in Chinese territory. The Chinese pilot was killed instantly. The American crew survived but were taken captive, along with the wreckage, by the Chinese government. For three weeks the Chinese refused to return the American crew or the wreckage. Further, the United States refused to apologize for either flying in Chinese airspace or their role in the Chinese pilot's death. During that time there were heated diplomatic exchanges and opportunities for escalation that could have easily led to war.

Events like this worry policy-makers. As China and the United States increasingly encounter each other in new regions of the world it is difficult to anticipate all that can go wrong. When there is no protocol to deal with a crisis, it is possible that the crisis can devolve into war. In general, when rising powers contest the status quo, there is a high risk of an accident because these states frequently deploy their militaries in contested areas.

I show that the possibility of an accident can drive a grand bargain and stable peace.

My mechanism differs from Schelling (1957)'s mechanisms for risk-taking and accidental conflict. In Schelling (1957)'s account, R has private information about her resolve. High resolved types create opportunities for an accident to credibly signal high resolve. Thus, R generates a risk of an accident to credibly signal private information. My theory assumes that accidents are a natural feature of shifting power with complete information. Yet R can still exploit the risk of an accident to lock in a grand bargain when D would otherwise offer appeasement. The reason is that D prefers to avoid shifting power than accept even a small risk of an accident. As a result, D offers R unusually large offers to entice R into a stable grand bargain.

I model accidents by adding one additional step to each period after the rising power chooses to accept/reject D's offer and before payoffs are realized. In this new step, if power has shifted in that period $p_t \neq p_{t-1}$, nature forces sub-game war on both players with probability ψ. There is a $1-\psi$ probability that the players are allowed to continue bargaining. This assumption captures the idea that in the process of building new arms, deploying them and testing them, rising powers may trigger an accident. However, when states have stable military programs and are not seeking to increase their foreign policy gains, accidents are unlikely.[22]

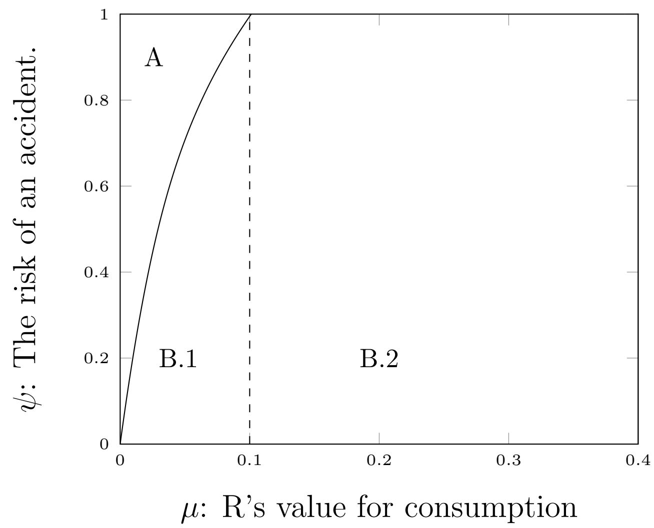
Proposition 3.2 *As the probability of an accident (ψ) increases, so to do the conditions under which a grand bargain appears in equilibrium.*

The proof is in Appendix B.2. I plot equilibrium results in Figure 2. The x-axis plots R's utility from consumption. The y-axis plots the risk of accidental conflict ($\psi = 1$ implies no chance of war). Equilibrium space A marks where D's best offer is appeasement. Intuitively, D only prefers appeasement when the risk of an accident is low and appeasement is much more attractive than a grand bargain.

Equilibrium space B marks the area where R invests in her military and D offers a first

[22] I get identical results if I assume that accidents can only occur if the status quo changes $q_t \neq q_{t-1}$. I get very similar results if I give R the option to trigger a risk of an accident in any round.

Figure 2: Equilibrium results when an accident is possible



Spaces are partitioned by solid lines. Lettered mark the following equilibrium strategies. A: appeasement. B: a grand bargain. B is partitioned into two areas marked by a dashed line. In B.1 D would have offered appeasement if there was rise of an accident. In B.2 D would have always offered a grand bargain if there was no risk of accident.

round grand bargain. The space is partitioned into two areas by a dashed line. Notably, B.1 marks the space where D would have appeased R if there was no risk of an accident. However, the prospect of an accident that triggers war drives D to make a grand bargain offer so that there is no future risk of war. In this way, D uses the grand bargain to avoid the possibility of accidents by inducing a stable peace.

3.3 Indivisible territories.

Some analysts argue that territorial control over Taiwan is indivisible: either Taiwan is part of China or it is not (Toft, 2006). The US and China have avoided a conflict over Taiwan by bargaining over other issues. But eventually these side payments will run out. China will grow strong enough that it will prefer to fight for total control over Taiwan rather than live without it. If Taiwan cannot be shared and China grows strong enough, a situation will arise where both the US and China prefer to fight for Taiwan, rather than to live without it. The conventional wisdom is that if shifting power is inevitable and Taiwan cannot be divided, then China's rise puts it on a collision course to war with the United States over Taiwan.

More formally, we can imagine a part of the pie is indivisible and restrict the possible offers R can make to $q_t \in \{[0,k],1\}$. This assumption implies that $1-k$ of the pie cannot be divided.[23] I further assume that $q_3^* < k$. This implies that if R militarizes every period, D can at least make three appeasement offers over the perfectly divisible part of the pie.

I focus on conditions where D's best reply in the baseline model would have been appeasement, creating incentives for R to invest in every period and D to offer R q^*. These conditions put R and D on a course to war. D prefers to appease R than offer a grand bargain at the beginning of the game and R prefers to keep militarizing D can appease R for a while. However, at some point (call it period t_w for war), R grows strong enough where D is forced to confront the indivisibility. It turns out that at that point a grand bargain emerges.

Proposition 3.3 *In the game with a partially indivisible pie, if:*

$$2w + \mu(1-\delta) > \Delta \tag{12}$$

is satisfied, then the game cannot end in war.

The proof is in Appendix B.3 but the intuition is simple. In period $t_w - 1$, D anticipates the pending indivisibility in the next period. D knows that if power shifts a little more that R's minimum demand from the allowed set of offers will be enormous. D does not want to make this large offer. To prevent it, D must stop the power transition somehow. In past models, war is the only way to stop power from shifting. In my model, D has two options: a grand bargain and war. Condition 12 implies that D always prefers a grand bargain to war so long as power doesn't shift faster than the full surplus from bargaining plus R's value for consumption.

[23] The results are considerably more general than this. I can restrict the possible bargain set to disjoint sub-intervals, for example. But the simple example of indivisibility demonstrates the point nicely.

3.4 Military technology discovery, and sudden shocks to the rate of shifting power

A different concern is that China's rate of growth is not constant. China is investing in new nuclear delivery systems, anti-access area denial capabilities and cyber technologies that will rapidly increase China's military capabilities. While these technologies are in development they do not effect the balance of power that much (Debs & Monteiro, 2014). Yet once China completes these projects there will be a discontinuous jump in the United States' expectations about how fast power will shift in the near future.

Based on this logic, some analysts recommend that United States should strike before China acquires these capabilities. A preventative war would cripple China's military and stall its growth before it fully develops these dangerous technologies. Although war is costly these analysts believe that China's soon to be rapid increase in military power will lead to enormous concessions in the future. A war with a weaker China today is a small price to pay for the world that will come if the United States does nothing. This logic is consistent with the insights of game theory. When the status quo is enforceable and the rate of shifting power is increasing, D switches to war in the middle of power transitions (Krainin, 2017).

I'll now show that a sudden increase in the rate of shifting power can drive D to offer a grand bargain. The logic is very similar to what I described in the case of indivisibility. D's objective is to prevent power from shifting rapidly. To do that, D can either fight, or make R an offer that entices R not to invest in her military at all. When the cost of war is high, D prefers to make a very large offer.

The extension clarifies an ongoing debate about deterrence and military investment in the face of preventative war (Genicot & Skaperdas, 2002; Krainin, 2017). Debs & Monteiro (2014) argue that under complete information if there is a delay between military investment and the rate in shifting power rising powers will not invest in their military. Yet many of China's investments have this delayed feature. I offer one possible reason that China might pursue these investments: they can trigger grand bargains.

I model sudden increases in the rate of shifting power by changing $\mathcal{A}_1$, which defined the transition function that maps R's military investment m onto p_t. Like the baseline model, I assume that when R is weak her military investments produce an increase in p such that $m_t = M \implies p_t = p_{t-1} + \Delta$. However, I now assume that once R has made enough investments such that $p_t \geq \rho$, then R's future investments produce a larger increase in power. In particular, define a period t_ρ as the first period such that $p_{t\rho} > \rho$. In all periods $t \geq t_\rho$, R's military investment produces an increase in p such that $m_t = M \implies p_t = p_{t-1} + x\Delta$. I assume that $x > 1$ and do not restrict the value of $x\Delta$ under $\mathcal{A}_3, \mathcal{A}_4$.[24]

Using x to alter the transition function creates the strongest possibility of preventive war: x represents a discontinuous jump in the rate of shifting power. Past studies have shown that if the discontinuity is sufficiently large, D prefers to fight in the periods leading up to t_ρ (Krainin, 2017).

Proposition 3.4 *In the game with a sudden increase in the rate of shifting power, if* $2w + \mu(1-\delta) > \Delta$ *then war is never an equilibrium no matter how large* x *is.*

The proposition implies that the consequences of dramatically raising the rate of shifting power only create a risk of war if the initial rate of shifting power was sufficiently large. However, if the initial rate of shifting power is low, declining powers can find a grand bargain and entice the declining power to terminate their military research. The logic is very similar to the indivisible case. D anticipates an enormous shift in power and weighs two options to prevent it: a grand bargain or war. When the cost of war is sufficiently high, D prefers a grand bargain.

3.5 Illustrative Example: Anglo-Russian Bargaining (1895-1907)

As Russia's economy developed in the early 1800s, Russia started to contest Britain for influence in Eurasia. This "Great Game" led to a series of small Anglo-Russian disputes.

[24] R's total power in any period $t > \rho$ is: $p_t = \max\left[p_0 + \frac{\Delta}{M}\left(\sum_{i=1}^{t\rho-1} m_i + x\sum_{i=t\rho-1}^{t} m_i\right), 1\right]$.

Britain sent forces to resist the Russians during the Crimean (1853-1856), and Caucuses (1828-59) Wars, assisted local Afghanistan and Persian governments resist Russian influence, and fought against Russian imposed regimes. Through the 1800s, Britain's response to Russia's expending influence reflected the logic of appeasement. Britain resisted Russian expansion where possible, but also made concessions that matched Russia's expending military capabilities rather than confront Russia on a mass scale.

In 1907, Britain and Russia signed the Anglo-Russian Convention. Britain ceded control over parts of Iran, Tibet and Afghanistan to Russia after decades of contesting these territories. In exchange, Russia recognized Britain's sphere of influence in India and Pakistan. Historians consider this a radical shift in British diplomacy towards a strategy for stability in Central Asia that lasted until the Russian Czar was overthrown (White, 1995).

This was not the first time that British had sought a stable compromise with Russia. "For the British, the Anglo-Russian Convention was the culmination of repeated efforts, first begun by Lord Salisbury's government in the 1880s, later reiterated by the ministry of Arthur Balfour after the turn of the century, to come to terms with Russia in Asia (Klein, 1971)." A vital difference between the Anglo-Russian Convention and past negotiations was what Britain was willing to offer. In prior agreements, Britain bargained hard to maximize their share under the status quo. For example, in 1885 Britain and Russia attempted to reach a stable compromise over disputed territories in Afghanistan. At that time, Britain held administrative control over Afghanistan's foreign affairs at the exclusion of other foreign powers. Yet since 1880, Russian forces had slowly advanced through the Afghan northwest frontier. During 1884, Russian forces captured Sary Yazy, Panjdeh and Zulfiqar.

In March 1885, Britain and Russia began negotiations to settle their differences in Afghanistan. The negotiations focused on demarcated a stable border in the northwest frontier that would avoid direct Anglo-Soviet conflict and prevent future Russian advances. In October, British and Russian diplomats reached an agreement. Russia would relinquish Zulfiqar but keep Pajdeh. Otherwise, the status quo would remain in place. The only complication was that there was no official map that demarcated this region and existing maps reported different borders for Panjded and Zulfiqar. Over the next few months, Russian and British diplomats met in London to finalize the border.[25] But during the demarcation process Britain produced a new map that dramatically expanded Zulfiqar. Critically, Britain's map placed an important trade route—the Heri Rud—in British hands.[26] Outraged, the Russians mobilized their military in preparation to scuttle the deal and invade.

In the end the Protocol was signed without a firm border in place. Rather, it was based on the understanding that the region would be demarcated at a later date with the stipulation that the frontier line should nowhere approach the heights bordering the Zulfiqar-Pass nearer than 1000 yards. But in 1888, the Russians violated the Protocol and renewed the Anglo-Russian contest in Afghanistan.[27]

The Anglo-Russian Convention was different because Britain made sizable concessions to Russia rather than demanding Russia concede territories. In 1885, Britain were only willing to settle with Russia if Russia made territorial concessions. But in 1907, Britain conceded new territories to Russia that held considerable "geographic and economic"[28] value.

Why was Britain willing to make large concessions in 1907 but not before? Their new-found generosity was motivated by the specter of rapid industrialization in Russia. Russia entered a new era of industrialization in the 1890s and it was only a matter of time before Russia would convert its economic development into military power. In 1905 Russia built high tonnage railway lines from Moscow to Afghanistan that the British described as "a tentacle for the absorption of Afghanistan and subsequent attack upon India.[29]" Russia also started to modernize its military forces in Central Asia. Observing these changes, the British assessed that "the purpose underlying Russia's patient and methodical advance and her vast expenditure upon unremunerated railway construction is obvious; without necessar-

[25]PP Central Asia No.5, (C.4413), pp.40-41 (1885)
[26]PP Central Asia No.4, (C.4389), p.6 (1885).
[27]PP Central Asia No.4, (C.4389), p.69 (1885)
[28]Quoted in the treaty.
[29]W.O. 33/419, p. 286

ily intending to conquer and absorb our Indian Empire, she aims at eventually making her frontier and that of India conterminous, or at least, bringing it so near that she may be in a position to strike effectively if Great Britain should, as in 1878, venture to thwart her policy elsewhere."[30]

In a letter endorsed by the War Office, Lord Kitchener assessed that within a few years, Russia would be sufficiently strong that "Herat could be captured and besieged within a week and that all northern Afghanistan, as far south as the Kabul-Kandahar alignment, Amir; one hundred and fifty thousand Russians reaching Kabul within a year. The Russians would then be in a position to occupy Afghan Turkestan indefinitely, without the British, whose military plans did not include forward action beyond the Kabul-Kandahar alignment, being able to prevent it."

It was not just that Russian capabilities were rapidly expanding. As Russian capabilities amassed in Central Asia their was a heightened risk that an accident would lead to a direct Anglo-Russian conflict. The War Office Noted that in this militarized environment "A border incident would be easy to arrange and the Russians could also put themselves in the right by blaming the Amir."[31]

Britain realized that if they did not soon reach a stable compromise with Russia, that Russia would rapidly expand and there was little Britain could do to stop them. The Foreign Office reasoned that a large settlement may entice Russia to accept the status quo and focus on foreign policy issues elsewhere.[32]

The difference between Britain's bargaining strategy in 1885 and 1907 is consistent with the logic of a grand bargain as a solution to the hazards of war. In 1885, Britain was willing to compromise with Russia as the Russian military advanced. However, they were unwilling to make extra offers in an effort to secure a stable peace. Their reasoning rested on the fact that Russian expansion was slow. Yet once Britain realized that Russian military might

[30]33 W.O. 33/419, p. 274. 1907. See also : Kitchener's note, Kitchener MS. P.R.O. 30/57.30
[31]War Office, Survey of the Military Resources of the Russian Empire (1907).
[32]FO 900/72: Telegram. Anglo-Russian Agreement (May 24, 1906); Anglo-Russian negotiations—Persia (Oct. 26, 1906); Anglo-Russian negotiations (Feb. 22 1907).

would grow rapidly, and this rapid development would create opportunities for an accidental conflict, the British sought a more permanent solution. It was only once the hazard of war loomed large that they switched from incremental offers to a grand bargain.

4 Conclusion

I have shown that rational declining powers can use concessions to do more than avoid war. When power transitions are long and the rate of shifting power is small they strategically manipulate their offers to entice rising powers into a grand bargain. By formalizing a grand bargain, I help settle a debate between China-focused researchers who wonder if a grand bargain can be rational (Silove, 2016; Easley et al., 2016). Furthermore, I provide a reason that it has taken so long for China-watchers to think about a grand bargain. In my theory, declining powers sometimes delay grand bargains to exploit low-ball offers right before they make enormous concessions. Thus, recent tension between the US and China may reflect compromises to come. These results tracked well with historical patterns of Anglo-American bargaining at the turn of the century.

I extended the model to include hazards that past theoretical research has concluded are causes of war between completely informed states. I found these hazards did not ruin the possibility for a peacefully grand bargain. Rather, hazards that we typically think lead to war, induce grand bargains and a stable peace under surprisingly general conditions.

There are many real world cases where the pressures of shifting power are exacerbated by complex strategic hazards that existing research predicts should drive conflict. Yet states often avoid major war. My theory may help explain the dearth of war even in the face of shifting power.

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A Appendix: Baseline Model

A.1 Definition 2.1 - Appearement is R's minimum demand under $s^R(m^*), s^D(q^*)$

In this section I show that a stream of offers q_t^* defines R's minimum demand under the assumption that R's investment follows m^*.

R's minimum demand follows from R's expectation about what will happen in future periods and what R can get from fighting today. Thus, I start at the point where power is stable. That is, the point were R no longer invests in her military and consumes resources henceforth. Given m^*, that's period $T+1$. I then work backwards three periods defining R's minimum demand and expected value. As we shall see, the interaction between R's investment choices across militarization and consumption creates some complications in periods $T-1, T$ that we must account for because R only invests part of her surplus at $t = T$. But once those are accounted for, I can use an inductive proof to generally describe R's minimum demand in all prior rounds.

Starting at period $T+1$, the sub-game is stationary because it is the first period in which $p_{T+1} = p_T = 1$ no matter how much R invests in her military. R's minimum demand is defined by $q_{T+1}^* + \frac{\delta(p_T - w)}{1-\delta} + \frac{\mu M}{1-\delta} = \frac{(p_T - w)}{1-\delta} + \frac{\mu M}{1-\delta} \implies q_{T+1}^* = p_{T+1} - w$. Since R expects to consume no matter what D does, the consumption term drops out. Otherwise, the result is identical to Powell (1999) and his proof is sufficient. Critically, this offer implies that $EU_{T+1}^R(accept\ q_{T+1}^*) = EU_{T+1}^R(War) = \frac{p_T - w + \mu M}{1-\delta}$.

This result informs R's minimum demand in the prior period. At $t = T$, R first invests m_T^*, shifting power to $p_T = 1 > p_{T-1}$. R then compares her value from accepting what D offers, factoring in her expectation from future offers and compares it to fighting: $q_T^* + \mu(M - m_T^*) + \delta(EU_{T+1}^R(accept\ q_{T+1}^*)) = p_T - w + \mu(M - m_T^*) + \delta(EU_{T+1}^R(War)) \implies q_T^* = p_T - w = p_{T+1} - w$ as desired. This offer leaves R with $EU_T^R(accept\ q_T^*) = p_T - w + \mu(M - m_T^*) + \frac{\delta(p_T - w + \mu M)}{1-\delta} = \frac{p_T - w + \mu M}{1-\delta} - \mu m_T^*$.

Turning to period $T-1$. First, I want to explicitly link together expectations about power across periods. So I write $p_T = p_{T-1} + \frac{\Delta m_T^*}{M}$. This assumes that R follows m^* and invests m_T^* in the next period. R's minimum demand satisfies: $q_{T-1}^* + \frac{\delta(p_{T-1}+\frac{\Delta m_T^*}{M}-w+\mu M)}{1-\delta} - \mu m_T^* > \frac{p_{T-1}-w+\delta\mu M}{1-\delta} \implies q_{T-1}^* = p_{T-1} - w - \frac{\delta\Delta m_T^*}{M(1-\delta)} + \mu m_T^*$. Subbing in q_{T-1}^* into R's expected utility, R's value from accepting an offer is: $EU_{T-1}^R(accept\ q_{T-1}^*) = \frac{p_{T-1}-w+\delta\mu M}{1-\delta} = EU_{T-1}^R(war)$. By design, this amount leaves R exactly indifferent with what she would get from fighting a war.

From here we can argue by induction working backwards from $T-1$. I'll show that at $T-2$ (or $T-1-1$) and in any arbitrary round $T-k, T-k-1$ for k that satisfies $T > k \geq 1$ that the smallest offer R will accept rather than reject is $q_{T-k}^* = p_{T-k} - w - \frac{\delta\Delta}{1-\delta} + \mu M\delta$ leaving R with expected utility of $EU_{T-k}^R(s^R(m^*), s^D(q^*) = \frac{p_{T-k}-w+\mu M\delta}{1-\delta}$.

Starting at $T-2$, we can follow the pattern above but now setting $m = M \implies p_{T-2} + \Delta = p_{T-1}$. This produces the relevant inequality: $q_{T-2}^* + \frac{\delta(p_{T-2}+\Delta-w+\mu M)}{1-\delta} > \frac{p_{T-2}-w+\delta\mu M}{1-\delta} \implies q_{T-2}^* = p_{T-1} - w - \frac{\delta\Delta}{1-\delta} + \mu M$. Subbing in q_{T-2}^* into R's expected utility, R's value from accepting an offer is: $EU_{T-2}^R(accept\ q_{T-2}^*) = \frac{p_{T-2}-w+\delta\mu M}{1-\delta} = EU_{T-2}^R(war)$.

In some arbitrary round $T-k$ R prefers to accept an offer rather than fight in the next if: $q_{T-k} + \frac{p_{T-k}+\Delta-w}{1-\delta} + \mu\delta^2 + ...\mu\delta^k > \frac{p_{T-k}-w}{1-\delta} + \mu\delta + ...\mu\delta^k$. Solving for $q_{T-k}^* = p_{T-k} - w + \frac{\delta\Delta}{1-\delta} + \mu\delta$.

Similarly, in some arbitrary round $T-k-1$ R prefers to accept an offer in this round rather than fight in the next if: $q_{T-k-1} + \frac{p_{T-k}-w}{1-\delta} + \mu\delta^2 + ...\mu\delta^k > \frac{p_{T-k-1}-w}{1-\delta} + \mu\delta + ...\mu\delta^k$. Solving for $q_{T-k-1}^* = p_{T-k-1} - w + \frac{\delta\Delta}{1-\delta} + \mu\delta$.

Thus, R's utility from accepting the offer q_t^* and waiting to fight in the next round is: $EU_t^R(accept, war) : \frac{p_t-w+\mu(\delta-\delta^{T-t})}{1-\delta}$. We've shown that in rounds $T-1, T-k, T-k-1$, R is indifferent to war with an offer $p_t - w + \frac{\delta\Delta}{1-\delta} + \mu\delta$.

Since the result holds for $k = 1$ as well as an arbitrary $k, k+1$, then it must hold for any period $t \in \{1, T-2\}$. This completes the proof and establishes R's minimum demand given an investment strategy m^*.

We can therefore define both player's expected utilities as a function of t, for $t \in \{1 : T-2\}$ given $q_t^* = p_t - w - \frac{\delta\Delta}{1-\delta} + \delta\mu M$ as expected utility equations 3, 4.

Before moving on, let's consider some facts about appeasement. First, if R plays strategy m^*, and rejects any offer less than her value for war, then q^* is D's best sequentially rational offer (it may not be better than war). The reason is that this offer maximizes D's expected value each period and R's strategy is invariant. If D cannot use offers to adjust R's behavior, the best D can do is minimize R's share

Second, and by design, if D plays q^*, then every period R's expected value from accepting q^* is equal to R's expected value from war.

Third, if D prefers appeasement to war in the first period, then D always prefers appeasement to war. In any period given a strategy of appeasement: D's expected value for war minus D's expected value for appeasement is: $EU_t^D(appease) - EU_t^D(WAR) = \frac{1-p_t+w}{1-\delta} - \mu M \sum_1^{T-t} \delta^i - \frac{1-p_t-w}{1-\delta} = \frac{2w}{1-\delta} - \mu M \sum_1^{T-t} \delta^i$. But in the next period, $EU_{t+1}^D(appease) - EU_{t+1}^D(WAR) = \frac{1-p_t-\Delta+w}{1-\delta} - \mu M \sum_1^{T-t-1} \delta^i - \frac{1-p_t-\Delta-w}{1-\delta} = \frac{2w}{1-\delta} - \mu M \sum_1^{T-t} \delta^i$. Taking the difference in these differences, $[EU_t^D(appease) - EU_t^D(WAR)] - [EU_{t+1}^D(appease) - EU_{t+1}^D(WAR)] = -\mu M \delta^{T-t}$. Negative for any $t < T$.

A.1.1 Defining period z

I define period z as the last period that D prefers to offer a grand bargain offer straight away, and accept the status quo for all subsequent periods, rather than offer R appeasement in all subsequent periods.

First, I establish that D's value for a grand bargain straight away less D's value for appeasement is decreasing in t. This result implies that if D starts the game with a preference for an immediate grand bargain, I can solve for z. For an arbitrary period $t < T$, in which R has invested $m_t = M$, suppose that if D offers $q_t = p_t + \Delta - w - \mu(1-\delta)$, R will accept it, and then set $m_{t+k} = 0$ for all $t + k > t$, and R will accept q_t for all future periods. Yet if D offered $q_t < p_t + \Delta - w - \mu(1-\delta)$, R would invest in her military in the next period.

D's value for a grand bargain relative to appeasement is decreasing in t. In any period t, D prefers an immediate grand bargain to appeasement if:

$$\frac{1 - p_t - \Delta + w}{1 - \delta} + \mu M > \frac{1 - p_t + w}{1 - \delta} - \mu M \sum_{i=1}^{T-t} \delta^i \tag{13}$$

$$\frac{\Delta}{1 - \delta^{T-t}} > \mu M \tag{14}$$

Notice that as t increases, this inequality is harder to satisfy. This implies that each period, D's value for making a grand bargain offer and stopping shifting power decreases relative to D's expected value for playing appeasement for all future periods. The reason that D's value for a grand bargain straight away relative to appeasement forever diminishes is that D's value for appeasement factors in making $T - t$ concessions that match R's opportunity cost. As the number of periods that D expects R to keep investing under appeasement decreases, D's opportunity costs diminish.

Since this inequality becomes more difficult to satisfy over time, define a period z such that D prefers to make the large offer and induce a stable status quo rather than make appeasement offers every period. That is, in period z:

$$\frac{1 - p_z - \Delta + w}{1 - \delta} + \mu M > \frac{1 - p_z + w}{1 - \delta} - \mu M \sum_{i=1}^{T-z} \delta^i \tag{15}$$

$$\frac{\Delta}{1 - \delta^{T-z}} < \mu M \tag{16}$$

However, in period $z + 1$:

$$\frac{1 - p_{z+1} - \Delta + w}{1 - \delta} + \mu M < \frac{1 - p_{z+1} + w}{1 - \delta} - \mu M \sum_{i=1}^{T-z-1} \delta^i \tag{17}$$

$$\frac{\Delta}{1 - \delta^{T-z-1}} > \mu M \tag{18}$$

Thus, we can define z as an integer that satisfies:

$$\frac{\Delta}{1-\delta^{T-z-1}} > \mu M > \frac{\Delta}{1-\delta^{T-z}} \tag{19}$$

A.2 Proposition 2.1: A grand bargain equilibrium.

Proposition 2.1 describes (1) two sequences of offers that can formed a grand bargain on the equilibrium path; (2) conditions under which we observe one sequence and not the other; (3) conditions under which a grand bargain is an equilibrium strategy.

First, I'll describe features of the two grand bargain offer sequences that can emerge on the equilibrium path. I'll describe both player's expected utilities in periods $\tau, \tau+1$. I'll show that grand bargain offers are designed to do two things: (1) leave R indifferent with her minimum demand in every period $t > \tau$ should R invest in her military; (2) leave R indifferent at $\tau + 1$ between militarization plus appeasement, and consuming the surplus plus accepting the status quo. However, to achieve both of these gaols for $t+1$, D must offer R an amount such that R's expected utility at τ is larger than her expected value from fighting. Thus, R's value from accepting a grand bargain at τ is large. I'll also describe features of the two grand bargain offer sequences that can emerge on the equilibrium path. I'll define player's expected utilities for every period $t < \tau$ when $\tau = z$.

Second, I'll define conditions under which D prefers to offer a grand bargain straight away or delay it. I'll then establish D's commitment problem to show that D can only credibly offer grand bargains in the first period or period z. I'll establish inequality 9 as D's point of indifference between a grand bargain in the first period and at z.

Third, I'll show that when equilibrium conditions 7, 8 are met both players prefer to play the grand bargain strategy described in proposition 2.1 dominates other strategies for every sub-game on the path.

In the text, I solve for the grand bargain offer $\tilde{q}_\tau$. I'll now use that value to identify each player's expected utilities from playing on path strategies at $\tau + 1$, τ and compare them to war. Suppose R accepts the grand bargain offer at τ, then at $\tau + 1$, R's value from on path play ($\tilde{m}_{\tau+1} = 0$) is:

$$EU^R_{\tau+1}(\tilde{q}, \tilde{m}) = \frac{\tilde{q}_\tau}{1-\delta} + \frac{\mu M}{1-\delta} = \frac{p_\tau + \Delta - w + \mu M \delta}{1-\delta} = EU^R_{\tau+1}(m_{\tau+1} = M, war)) \tag{20}$$

R is indifferent between accepting $\tilde{q}_\tau$ at $\tau + 1$ or investing in her military and fighting a war (by design it also leaves her indifferent with appeasement). Since R does not invest at $\tau + 1$, the strategic setting is identical in all future periods. It follows that R is indifferent between militarization and war, or consumption and accepting the status quo.

At τ, R's on-path expected utility is:

$$EU^R_\tau(\tilde{q}, \tilde{m}) = \frac{\tilde{q}_t}{1-\delta} + \frac{\delta \mu M}{1-\delta} = \frac{p_\tau + \Delta - w + \mu M(2\delta - 1)}{1-\delta} \tag{21}$$

R could reject this offer in favor of war. But that would only leave R indifferent with war if $\mu M > \frac{\Delta}{1-\delta}$. This is ruled out by equilibrium condition 7. This implies that D's grand bargain provides R with more than her minimum demand at τ.

D's expected utility from a grand bargain at $t > \tau$ is:

$$EU^D_\tau(\tilde{q}, \tilde{m} | \tau = 1) = \frac{1 - \tilde{q}_t}{1-\delta} = \frac{1 - p_\tau - \Delta + w + \mu(1-\delta)}{1-\delta} \tag{22}$$

If D offers a grand bargain in the first period, then we can simply replace $\tau = 1$ in the above expected utility equations. This describes the complete set of utilities for both players given that $\tau = 1$.

If $\tau = z$, there is a sequence of offers leading up to z that I reported in equilibrium 2.1. I'll now show that this sequence leaves R indifferent with her war pay-off in every period z under the assumption that a grand bargain offer is $\tau = z$.

To start, I'll assume that the strategies reported in the equilibrium that set $\tau = z$ are true. That is, I assume that at z, D makes a grand bargain offer $\tilde{q}_z = p_z + \Delta - w - \mu(1-\delta)$, R accepts it. R invests $m_{t\leq z} = M, m_{t>z} = 0$. I'll now show that the sequence of offers reported in equilibrium 2.1, leave R indifferent between fighting a war straight away, or accepting the offer given R's expectation about on-path play.

At $z-1$ the offer that leaves R indifferent with fighting factors in R's expectation about the large offer $\tilde{q}_z$:

$$\tilde{q}_{z-1} + \delta\frac{p_{z-1} + 2\Delta - w - \mu(1-\delta)}{1-\delta} + \mu\delta^2 + ...\mu\delta^\infty > \frac{p_{z-1} - w}{1-\delta} + \mu\delta + ...\mu\delta^\infty \tag{23}$$

$$\tilde{q}_{z-1} = p_{z-1} - w - \frac{2\Delta\delta}{1-\delta} + 2\delta\mu \tag{24}$$

Here the second term on the left hand side, is R's expected value for investing $m_z = M$ at z, not investing in any period $t > z$, and accepting $\tilde{q}_z$ forever discounted by δ. The RHS is R's war pay-off.

There are three important facts about $\tilde{q}_{z-1}$. First, given the equilibrium condition 7,[33] $\tilde{q}_{z-1}$ must be less than q^*_{z-1}. To see that, consider: $p_{z-1} - w - \frac{2\Delta\delta}{1-\delta} + 2\delta\mu M < p_{z-1} - w - \frac{\delta\Delta}{1-\delta} + \mu M\delta \implies \frac{\Delta}{1-\delta} > \mu$.

Second, $\tilde{q}_{z-1}$ is larger than q^*_{z-2}. Suppose it was not, then $p_{z-1} - w - \frac{2\Delta\delta}{1-\delta} + 2\delta\mu < p_{\tau-1} - \Delta - w - \frac{\delta\Delta}{1-\delta} + \mu M\delta$. This solves for $\frac{\mu M\delta}{2\delta-1} < \frac{\Delta}{1-\delta}$. We must be able to jointly satisfy this inequality and equilibrium condition 7: $\frac{\Delta}{1-\delta} > \mu$. Subbing that condition in, we get $\frac{\mu M\delta}{2\delta-1} > \mu \implies 1 < \delta$. But δ is a discount factor that must be less than 1 by assumption. A contradiction. It follows that for the conditions described in the equilibrium, $\tilde{q}_{z-1} > q^*_{z-2}$. This is important because it means that the status quo bias cannot prevent D from offering R her minimum demand. As a result, D can offer q^*_{z-2} in period $t = z-2$, then $\tilde{q}_{z-1}$ in period $t-1$.

Third, R's expected utility in period $z-1$ from playing an equilibrium $s^R(\tilde{m})|s^D(\tilde{q})$ is equal to R's war payoff.

[33] $\frac{\Delta}{1-\delta} > \mu M$

Turning to offers in periods $t < z-1$. In section A.1, we solved for R's minimum demand given a sub-sequence of investment choices $m_t = M$ leading up to a period where R would be offered her minimum demand. We used an inductive argument, working backwards, to show that R's minimum demand in every period of this sequence is $q_t^* = p_t - w - \frac{\Delta}{1-\delta} + \mu M$. We can apply the same inductive argument here because R anticipates her expected utility at $z-1$ is equal to her expected utility from war. Further, R militarizes in all periods $t < z-1$. Thus, $\tilde{q}_t = q_t^* \forall t < z-1$.

Given these offers D's expected utilities in each period $t < z$ are as follows.

In period $z-1$, D's utility is,

$$EU_{z-1}^D(s^D(\tilde{q})|s^R(\tilde{m}), \tau = z) = 1 - p_{z-1} + w + \frac{2\delta\Delta}{1-\delta} - 2\delta\mu M + \frac{\delta(1 - p_{z-1} - 2\Delta + w + \mu(1-\delta))}{1-\delta} \quad (25)$$

$$= \frac{1 - p_{z-1} + w}{1-\delta} - \delta\mu M \quad (26)$$

In this period, D's expected utility is abnormally high because D makes the low-ball offer $\tilde{q}_{z-1}$.

In periods $t < z-1$, I can summarize D's utility as a sequence of offers q_t^* for $1 < t < z-2$, then sub-in D's total expected value at $z-1$:

$$EU_{t<z-1}^D(s^D(\tilde{q})|s^R(\tilde{m}, \tau = z) : 1 - p_0 - t\Delta + \frac{\delta\Delta}{1-\delta} + w - \mu M\delta$$
$$+ \delta(1 - p_0 - (t+1)\Delta + \frac{\delta\Delta}{1-\delta} + w - \mu M\delta)...$$
$$+ \delta^{z-t-2}\left(1 - p_0 - (z-2)\Delta + \frac{\delta\Delta}{1-\delta} + w - \mu M\delta\right) + \delta^{z-t-1}\left(\frac{1 - p_0 - (z-1)\Delta + w}{1-\delta} - \delta\mu M\right) \quad (27)$$

This simplifies to

$$\frac{1 - p_t + w}{1-\delta} - \mu M \sum_1^{z-t} \delta^i \quad (28)$$

$$EU_{t<z-1}^D(s^D(\tilde{q})|s^R(\tilde{m}, \tau = z) : \frac{1 - p_t + w - \mu M\delta(1 - \delta^{z-t-1})}{1-\delta} \quad (29)$$

These values assume that D makes an unusually large offer in period z, but makes incremental concessions in prior periods.

In summary, I've shown that the sequence of offers $\tilde{q}$ leaves R indifferent with her war payoff in every sub-game on the equilibrium path. I've also solved for R and D's expected pay-offs each period. In particular, I have found a way to summarize D's values in every period.

The results so far assume that players agreed on setting $\tau = z, 1$. However, it is not obvious that they would do so. In section A.1.1, I argued that D's value for a grand bargain relative to appeasement is decreasing in t. This implies that as the game moves forward D's present value for offering a large offer straight away and locking in a stable status quo decreases relative to D's value for accepting appeasement and shifting power forever. We might think that this drives D to offer a grand bargain straight away.

D prefers to delay a grand bargain when he can credibly promise to offer a grand bargain in the next period. Suppose D can make credible promises to make grand bargains in future periods. Suppose in the first period, D promises to set $\tau = 2$. If R believes him, R will accept the low-ball offer $\tilde{q}_{\tau-1}$ in the first period, anticipating the grand bargain in the next period. Then D prefers to delay a grand bargain if:

$$\frac{1 - p_1 + w}{1 - \delta} - \delta\mu M > \frac{1 - p_1 - \Delta + w}{1 - \delta} + \mu M \tag{30}$$

$$\frac{\Delta}{1 - \delta^2} > \mu M \tag{31}$$

This is possible given the equilibrium conditions for a grand bargain. But the result relies on the fact that D can credibly promise to offer a grand bargain in period 2. In period 2, D deviates to promising a grand bargain in period 3 so he can make a second low-ball offer in period 2.

In an arbitrary period $t < z$, D's expected value from an immediate grand bargain is

$EU_t^D(s^D(\tilde{q})|s^R(\tilde{m}), t = \tau) = \frac{1-p_t+w}{1-\delta} - \mu M$. Suppose instead, D made a credible promise to make a grand bargain in the next period $t+1$. We've already seen that at $\tau - 1$, D gets to make a low-ball offer. This unusually small offer guarantees D an unusually small offer value in that period. In period t, D's expected utility from offering $q_t = \tilde{q}_{\tau-1}$ now, then offering $q_{t+1} = \tilde{q}_\tau$ in the next period is: $EU_t^D(s^D(\tilde{q})|s^R(\tilde{m}), t = \tau+1) = 1 - p_{\tau-1} + w + \frac{2\delta\Delta}{1-\delta} - 2\delta\mu M + \frac{\delta(1-p_{\tau-1}-2\Delta+w+\mu(1-\delta))}{1-\delta} = \frac{1-p_{\tau-1}+w}{1-\delta} - \delta\mu M$.

Comparing these two expected utilities, D's value for delaying a grand bargain one period is always larger if $\frac{\Delta}{1-\delta} > \mu M$. But this condition must hold given equilibrium condition 7. It follows that in any grand bargain equilibrium, D always prefers to delay a grand bargain one period, than offer one straight away.

The problem is that every period D prefers to delay a grand bargain. Under our conjecture, D can never credibly promise to set τ in $t+1$, because once $t+1$ arrives, D promises to set it at $t+2$ and makes a low-ball offer again. It follows that D cannot make credible a promise to set τ when he likes. If he could, he would repeatedly set that promise in the next period, every period.

This commitment problem is resolved at $t = z$. Since at $z+1$, D prefers appeasement forever to a grand bargain, D will always offer $q^*_{z+1}, q^*_{z+2}...$ if R invests at $z+1$. As a result, at $z+1$, D can credibly promise that if R militarizes, that D will revert to appeasement. Since D can credibly make this promise, a grand bargain at z is enforceable.

Of course, in any period $t > 1$ D could deviate and offer a grand bargain straight away. But if he did that, he could not capitalize on the low-ball offer. D's incentives to do that are defined by D's preferece from offering a grand bargain straight away versus waiting to offer one at z: $EU^D_{t<z-1}(s^D(\tilde{q})|s^R(\tilde{m}, \tau = t) > EU^D_{t<z-1}(s^D(\tilde{q})|s^R(\tilde{m}, \tau = z)$

$$\frac{1 - p_t - \Delta + w - \mu(1-\delta)}{1-\delta} > \frac{1 - p_t + w - \mu M\delta(1-\delta^{z-t-1})}{1-\delta} \tag{32}$$

$$\frac{\Delta}{1 - \delta^z - t - 1} > \mu M \tag{33}$$

Clearly, this condition is more difficult to satisfy as t increases. It follows that if D prefers to deviate to a large offer, he does so in the first period or not at all. It follows that if D is willing to wait in the first period to offer a grand bargain, he must be willing to wait until z.

I use this value to solve for the equilibrium condition 9 that determines whether a grand bargain emerges in the first period or period z. The equilibrium condition follows from subbing in $t = 1$ to inequality 33. When this is satisfied, it implies D prefers to offer a grand bargain in the first period, rather than waiting until z.

In summary, I've derived the condition where D prefers to offer a grand bargain at z or in the first period. I've shown that D's incentives to delay a grand bargain stem from D's value from exploiting low-ball offers at $\tau - 1$. However, D cannot exploit this low ball offer until period $z - 1$. I've shown that so long as D prefers to delay a grand bargain in the first period, D cannot profit by deviating to offering a grand bargain in any period $1 < t < z$. It follows that if D makes a large grand bargain offer, he does so in either $\tau = z, 1$.

Focusing on the sequence of offers for the delayed grand bargain. This sequence leaves R indifferent with her minimum demand in every period other than z. In periods $t < z - 1$, D could offer more than $\tilde{q}_t$, but this would cost D valuable foreign policy issues. D could offer less, but R would reject it in favor of war. Thus, D does not deviate from this sequence. It follows that if a grand bargain appears on the equilibrium path, it must follow one of the sequences of offers written in the equilibrium.

I'll now solve for the conditions where player's cannot profitably deviate to any other strategy in any sub-game. First, I'll consider D's incentives to deviate to another offer. Second, D's incentives to deviate to war. Third, R's incentives to alter her militarization choices.[34]

Instead of offering a grand bargain, D could deviate to a different offering strategy. I've already shown that D cannot profit from deviating to an offer that induces R to stop investing

[34]Trivially, R never selects war on the path. The offers are specifically designed to make R indifferent to war. These offers are stable in the sense that they survive a trembling hand. Suppose we draw a random variable $\epsilon_t \in [-\epsilon, \epsilon]$ supported on any continuous density function and perturb D's offer by that much each period. For ϵ sufficiently small, D increases his offer to account for the risk.

in her military in a period $\tau \neq z$. Thus, the only deviation to consider is to a strategy that assumes R will invest in every period. Appendix A.1 shows that q_t^* is the sequence of offers that leaves D with the largest expected utility each period given what D can can credibly promise to offer in subsequent periods. Thus, I need only consider a deviation from $\tilde{q}$ to q^*.

I'll show that when $\mu M > \frac{\Delta}{1-\delta^T}$ is satisfied, D prefers a grand bargain over appeasement. Suppose, D's best grand bargain sets $\tau = 1$. Then in the first period, D prefers to offer a grand bargain rather than appease if:

$$\frac{1 - p_1 - \Delta + w + \mu M(1-\delta)}{1-\delta} > \frac{1 - p_1 + w}{1-\delta} - \mu M \frac{i=1}{T}\delta^i \tag{34}$$

$$\frac{\Delta}{1-\delta^T} < \mu M \tag{35}$$

This is equilibrium condition 7 as desired. Consider the case where D prefers to delay a grand bargain rather than offer one straight away.

Suppose a case where D offers a delayed grand bargain at period z. I'll now show that so long as equilibrium condition 7 is satisfied, D prefers to offer a grand bargain in every on-path subgame.

First notice that if equilibrium condition 7 is satisfied then it must be that D prefers any grand bargain offer to appeasement. Suppose D prefers to delay a grand bargain till z rather than offer one straight away. Then D's value for a delayed grand bargain must exceed D's value for offering a grand bargain straight away. But equilibrium condition 7 implies D prefers to offer a grand bargain straight away.

Turning to periods $t > 1$. To start, conjecture period z exists. For periods $t < z - 1$, the offers $\tilde{q}_t, q_t^*$ are identical. Thus, there is no deviation to consider. In period $z - 1$ the low-ball offer guarantees D's expected utility is larger from a grand bargain. By definition of period z, D must prefers a grand bargain straight away in this period to appeasement.

Thus, the only thing to check is that a period $z \geq 1$ exists, and that over time, D will arrive at it. In section A.1.1 I showed that that D's value for a grand bargain over appeasement is decreasing in t, and D's offers for $t < z - 1$ are identical for strategies $q^*, \tilde{q}$. It follows that if D prefers a grand bargain in the first period, I must be able to solve for a period z where D makes a large grand bargain offer. However, if the game starts out such that D prefers appeasement to a grand bargain from the outset, then D will make incremental offers each period. D prefers a grand bargain in the first period away to appeasement if $\frac{1-p_1-\Delta+w}{1-\delta} + \mu M > \frac{1-p_1+w}{1-\delta} - \mu M \sum_1^{T-1} \delta^i$. This solves for: $\mu M > \frac{\Delta}{1-\delta^T}$ as written in the right most inequality of equilibrium condition 7.

Second, I'll show that when $\frac{\Delta-2w}{1-\delta} < \mu M$ is satisfied (equilibrium condition 8) D always prefers a grand bargain rather than fight a war. Using equation 29, we can analyze D's preference in any period from offering a grand bargain straight away relative to fighting a war straight away. $EU_t^D(\tilde{q}, \tilde{m} | \tau = t) > EU_t^D(war)$

$$\frac{1 - p_t - \Delta + w + \mu M(1-\delta)}{1-\delta} > \frac{1 - p_t - w}{1-\delta} \tag{36}$$

$$\frac{\Delta - 2w}{1-\delta} < \mu M \tag{37}$$

Notice this does not depend on p_t or even the history of R's investment choices. As a result, we can apply this inequality to any period. So long as it is satisfied, D prefers a grand bargain straight away to war in any period.

Finally, I'll show that R cannot profit by altering her military investment strategy. By construction of $\tilde{q}_\tau$, R cannot profit from investing at $t > \tau$. Thus, I focus my analysis on periods $t \leq z$.

In fact, I'l solve for the condition where R chooses to invest in her military in every period and show that it defines equilibrium condition 7. By solving for it, it is clear that R will always invest when equilibrium condition 7 is met and D's offer otherwise will not increase R's utility beyond her minimum demand.

Lemma A.1 *There is a no rise equilibrium in which R plays an investment strategy* $m_t = 0 \forall t$*, D offers R* $q_t = p_0 - w \forall t$*. R accepts every offer and the game passes peacefully. Off the path, if R invests, D plays* q^* *in every period. Off the path, if D offers* $q_t < p_0 - w$*, R selects war. The equilibrium emerges if*

$$\frac{\Delta}{1-\delta} < \mu M. \tag{38}$$

If inequality

Notice that in any period, D can find an offer that leaves R indifferent with war. When R expects any offer that is worth her minimum demand, then she sets m_t to maximize $\frac{p_{t-1}+\Delta m_t/M-w}{1-\delta} + \mu(M - m_t)$. Taking the partial with respect to m_t, R's marginal return is a constant: $\frac{\Delta}{M(1-\delta)} - \mu/M$. It follows that R invests $m_t = M$ if $\frac{\Delta}{1-\delta} > \mu$ and $m_t = 0$ otherwise. Notice that if R's best reply is to set $m_t = 0$, then her strategic incentives in $t + 1$ are identical than they were at t. It follows, that if $\frac{\Delta}{1-\delta} < \mu$ is satisfied R does not invest in any period. We've already shown that if R will not invest, then the smallest offer she will accept is $p_t - w \forall t$. Clearly, D cannot do better by offering more because concessions are valuable. If D offers less, he gets a war-payoff, also worse.

Equilibrium condition 38 is identical to the right-most equilibrium condition in 7 as desired. This condition defines the point of indifference between when R invests in her military or not. When it is not satisfied, R will invest in the first period and every period that an investment produces an increase in total expected utility that is at least μM.

In summary, we've shown that given equilibrium conditions, D cannot profit from deviating to another offer or war at any stage of the game. Further, R cannot profit from consuming her surplus rather than investing in a period $t \leq \tau$. There are no more deviations to consider.

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B Grand Bargain with the hazards of war

B.1 Prop. 3.1: An immovable status quo

R's expected value for accepting the status quo forever and never investing in the military is:

$$EU_t^R(m = 0\forall t)\frac{q_0 + \mu M}{1-\delta} \tag{39}$$

R prefers to do this than to militarize in the first period and face war if $EU_1^R(m = 0\forall t) < EU_1^R(m_1 = M, m_{t>1} = 0, r_1^D = WAR)$:

$$\frac{q_0 + \mu M}{1-\delta} < \frac{p_0 + \Delta - w + \mu M\delta}{1-\delta} \tag{40}$$

$$q_0 < p_0 + \Delta - w + \mu M(1-\delta) \tag{41}$$

Plugging in our restriction $q_0 < p_0 + w$, we can only find condition for R to invest and face war if:

$$\Delta + \mu M(1-\delta) < 2w \tag{42}$$

Turning to D's incentives, I've already shown that D prefers war in the first period to a first period grand bargain if and only if:

$$\Delta + \mu M(1-\delta) > 2w \tag{43}$$

Clearly, these two inequalities cannot be jointly satisfied. It follows that no $q_0 < p_0 + w$ can induce war because there is no condition where if R invests, D can credibly promise to fight.

I need not consider any case $q_0 < q_1^*$ because R's military investment implies D can set the sequences $\tilde{q}, q^*$. Thus, I focus my attention on the case where $q_0 > q_1^*$.

R's value from investment

For R to set $m_1 > 0$, q_0 must be sufficiently small that R prefers to militarize knowing that the status won't change. That is:

$$q_0 + \frac{\delta(p_0 + 2\Delta - w)}{1-\delta} + \mu M \sum_{2}^{T-1} \tag{44}$$

B.2 Prop. 3.2: Miscalculation

The sequence of moves during the power transition phase is:

1. R invests $m \in [0, M]$ in the military.
2. D decides to go to war, contain, or makes an offer $q_t \in [0, 1]$.
3. R either accepts D's offer, rejects it in favor of the prior settlement q_{t-1} or goes to war.
4. If R invests $m > 0$, Nature triggers war with probability ψ. If R invests $m = 0$, there is no risk of war.

Since a grand bargain and appeasement leave R indifferent with war in the current round, R's choice between investment and no investment does not change. Also, since Nature's lottery triggers war, then the offers R will accept are the same because they are defined based on what makes R indifferent with war. Finally, since nature triggers war, it must be that D would have preferred to make an offer to war. Thus, I do not need to consider the inequalities for one offer relative to war.

As a result of these facts, I focus on D's value for a grand bargain and appeasement. Consider that if R invests, then D's utility from a first round ground bargain is:

$$EU_1^D(GB|accident\ prone) = (1-\psi)\frac{1-\tilde{q}}{1-\delta} + \psi\frac{1-p_1-w}{1-\delta} \equiv \\ \frac{1-p_1}{1-\delta} - \frac{w(1-2\psi)}{1-\delta} - \frac{\Delta\psi}{1-\delta} + \mu\psi$$

D's utility from appeasement is:

$$(1-\psi)(1-q_1^*)+\delta(1-\psi)^2(1-q_2^*)...+(1-\psi)^T\delta^{T-1}(1-q_T^*)\left(\delta+\delta^2..\delta^\infty\right)$$
$$+\frac{1-p_1-w}{1-\delta}\psi\left(1+\delta(1-\psi)+\delta^2(1-\psi)^2...(1-\psi)^{T-1}\delta^{T-1}\right)$$

It follows that:

$$EU_1^D(Appease|accident\ prone)=\frac{1-p_1}{1-\delta}-\frac{w(1-2\psi+\delta\psi-2(\delta\psi)^T+2\delta^T\psi^{T+1})}{(1-\delta)(1-\delta\psi)}-\frac{\mu\delta\psi(1-(\delta\psi)^{T-1})}{1-\delta\psi}$$

A Grand Bragain defeats appease when:

$$\frac{\Delta}{1-\delta}<\frac{\mu(1+\delta-\delta\psi-\delta^T\psi^{T-1})}{1-\delta\psi}+\frac{2w\delta(1-(\delta\psi)^{T-1})(1-\psi)}{(1-\delta)(1-\delta\psi)} \tag{45}$$

The first thing to note is that both parts of the RHS must be positive numbers for $0<\psi<1$ and $0<\delta<1$. Thus, the RHS is increasing in both μ and w. Similarly, the two elements on the RHS are increasing in δ and the rate of that increase is moderated by ψ. It follows that the effects of ψ are most adverse as $\delta\to 1$.

Taking the partial of the RHS (this is ok because the LHS has no ψ) we get two components:

$$\frac{\mu\left(\delta^2\psi^2+\psi^T\left(\left(\delta^{T+1}T-2\delta^{T+1}\right)\psi-\delta^T T+\delta^T\right)\right)}{\psi^2\left(\delta\psi-1\right)^2}$$

$$\frac{2w\left(\left(\delta\psi\right)^T\left(\left(\delta T-\delta\right)\psi^2+\left(\left(-\delta-1\right)T+2\delta\right)\psi+T-1\right)+\left(\delta-\delta^2\right)\psi^2\right)}{\left(\delta-1\right)\psi^2\left(\delta\psi-1\right)^2}$$

In both cases, as $\delta\to 1$ from below, the root of the equations approaches 0 as ψ approaches 1 from above. Thus, I can say for values of $0<\delta<1$, increasing ψ will lead to an increasing derivative

B.3 Prop. 3.3: Indivisibility

The result follows from comparing D's preferences for a grand bargain now or appeasement followed by war at $\tau-1$: $\frac{1-p_{\tau-1}-\Delta+w+\mu(1-\delta)}{1-\delta}>1-p_{\tau-1}+\frac{\delta\Delta}{1-\delta}-\mu\delta+w+\frac{\delta(1-p_{\tau-1}-\Delta-w)}{1-\delta}$.

The LHS assumes that $\Delta < 1/2$ and therefore D's best outcome is war rather than an offer of 1 at τ. The result in the proposition follows from this inequality. Notice that when it is satisfied, D also never prefers war in the first round.

This proof obviously extends to proposition 3.4.