IGA-222M / Session 05
Conventional and Interstate Warfare

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Today's objectives

1. *Define*: concept of "victory" in war
   a) Is "military victory" possible?
   b) What is alternative?
2. *Review*: bargaining model of war
   a) How bargaining failures lead to war
   b) How war is a continuation of bargaining process
3. *Consider*: competing explanations of military effectiveness
   a) Numerical preponderance
   b) Technology
   c) Force employment

War is Bargaining by Other Means

Definitions

1. *Victory in war*
   a) attainment of political aims for which one went to war
   b) can be obtained through force or coercive diplomacy
2. *Military victory*
   a) imposition of political terms by rendering one's enemy incapable of resistance
   b) can be obtained only through force

Figure 1: Is this victory?

Is Military Victory Possible?

Pure "military victories" almost never happen

1. Strategic level
   a) extremely rare for losing army to be fully (or even mostly) destroyed in war
2. Tactical level
   a) military formations are almost never fully annihilated in combat

Ending war is a choice

- abstain/exit from combat
  or
- continue to fight

Figure 2: Not happening

Personnel losses in interstate wars since 1816

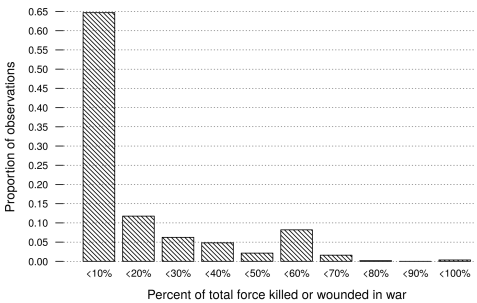

Figure 3: Total casualties per war

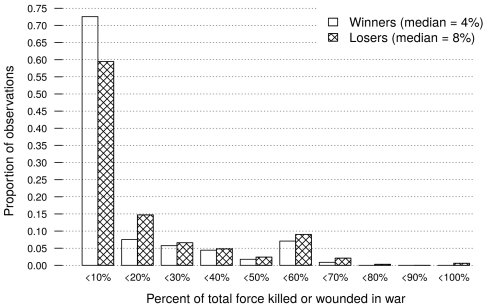

Figure 4: War winners vs. losers

Almost all **wars end** before belligerents exhaust military potential

- loss rates higher for median war loser than for winner, but...
- most belligerents since 1816 lost less than 10% of armed forces
- median war participant lost 4.5% of overall force strength

Personnel losses in conventional ground battles since 1939

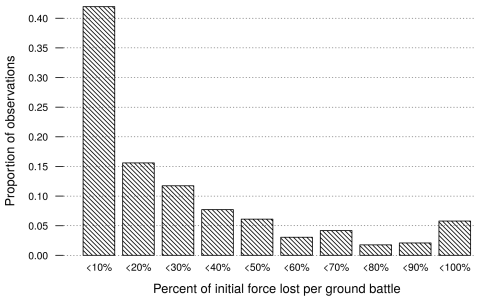

Figure 5: Casualties per battle

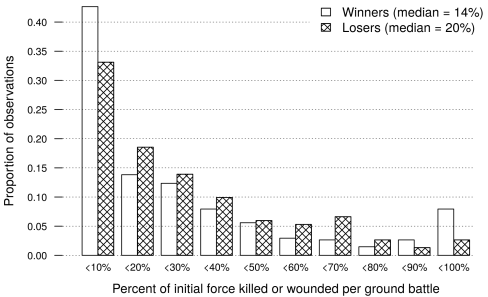

Figure 6: War winners vs. losers

Most **battles end** before belligerents exhaust military potential

- high losses more common in battles than in wars, but...
- median battle participant lost only 14% of available forces
- loss rates not (strongly) predictive of strategic-level outcomes

Bargaining While Fighting

Bargaining model of war

1. Almost all military outcomes, at all levels of war, are choices that reflect (tacit) bargaining
2. War begins if sides can't reach deal
3. Fighting reveals information about capabilities & resolve, updating perceptions of bargaining leverage
4. War ends when these perceptions converge, and yield agreement on terms of deal

Purpose of violence

1. Establish credibility of threats
2. ... not to neutralize enemy's capacity to resist

Figure 7: How it starts/ends

Illustration: Sides A (blue) and B (red) are **bargaining** over a disputed territory. They can resolve this dispute peacefully or through war.

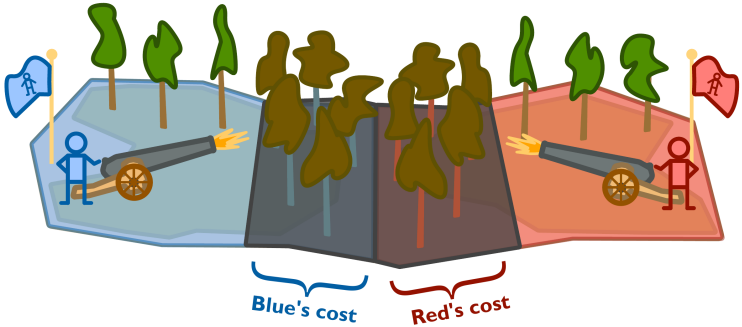

Figure 8: Let's make a deal!

- blue area is the proportion of land that side A expects to win through war
- red area is the proportion of land that B expects to win through war
- gray area represents the cost of war (e.g. land destroyed, people killed)

Pre-War Bargaining

Suppose A makes an **ultimatum** (take-it-or-leave-it offer) to B

1. If B accepts the offer, B receives red area, and A keeps remaining blue area

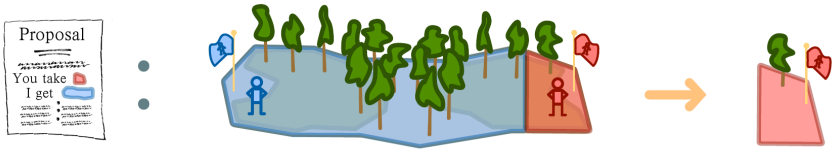

Figure 9: What B would get from A's offer

2. If B rejects the offer, a war will start, in which B expects to get this area in red (land and other booty won through war, minus costs)

Figure 10: What B expects to get from war

Will B accept A's offer, or go to war? It depends on which of these is bigger:

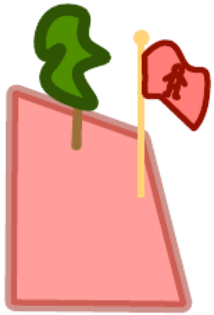

Figure 11: A's offer?

or

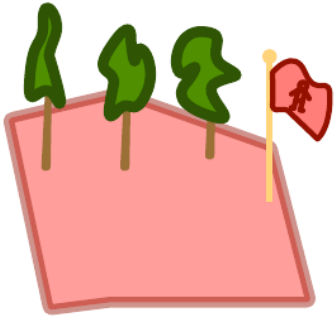

Figure 12: Spoils of war?

- if B expects to get better deal from war than from A's offer, B will **choose war**

Is there an offer that both A and B would prefer to war?

- yes, if the offer falls inside the **bargaining range**

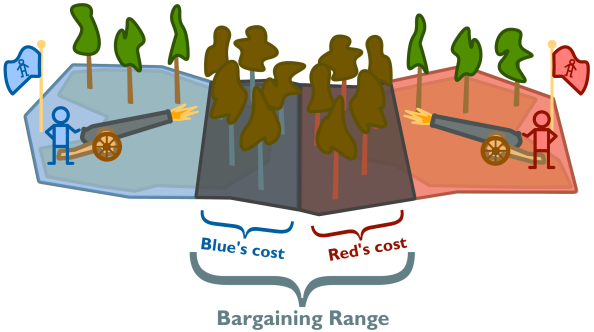

Figure 13: Bargaining range

Puzzle: If bargaining range exists, then two sides can always settle the dispute peacefully. Settlement will reflect balance of power. But wars still occur. Why?

Fearon (1995) offers three main explanations for why war may still occur:

1. **commitment problems**: states worry that *future shifts in relative power* may allow opponent to make new demands
2. **issue indivisibility**: some resources are *not subject to compromise* (e.g. sacred religious sites)
3. **incomplete information**: states may have *incentives to misrepresent* their true costs of war (e.g. secrecy around military capabilities)

Intra-War Bargaining

War begins when side A and side B cannot find a negotiated settlement that both prefer to war (e.g. due to incomplete information about relative military capabilities)

Over time, **fighting reveals new information** ("enemy is stronger than I thought")

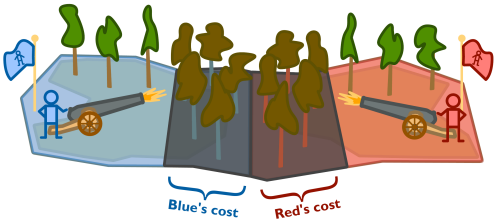

Figure 14: Expectations on day 1 of war

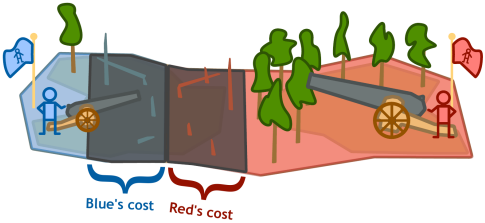

Figure 15: Expectations on day 100 of war

War ends when beliefs converge about likely outcome of war, sides make a deal ("I can't take any more of this. even a bad deal is better than more war. let's talk")

War is bargaining by other means

- physical combat changes the sides' understanding of their bargaining leverage
- this new understanding yields a new negotiated agreement on settlement terms

Figure 16: A's original offer

Figure 17: A's revised offer

How to gain bargaining leverage: **win battles!** (but how does one do that?)

Military Effectiveness

Predictors of victory and defeat in battle

Numerical preponderance	Technology	Force employment	Geography	Information
force strength	offense-defense balance	doctrine	distance	surprise
mobilization base	targeting selection	strategy	terrain	intelligence
industrial capacity	force structure	training	climate	OPSEC
natural resources	communication	officer quality	roads	censorship
replacement of losses	logistics	operational art	fortifications	propaganda

Numerical and Technological Preponderance

Numerical preponderance

1. Force strength
   a) which side has numerical superiority?
2. Mobilization base
   a) which side has more resources available to meet foreseeable wartime needs?
3. Industrial capacity
   a) which side can produce at scale, with surge capacity?
4. Natural resources
   a) which side has access to more raw materials?
5. Replacement of losses
   a) which side can more easily recover from attrition?

Figure 18: Biggest army wins

Technology

1. Offense-defense balance
   a) does available technology favor attacker or defender?
2. Target selection
   a) which side can engage enemy targets with greater accuracy and precision?
3. Force structure
   a) which side has optimal force mix (e.g. level of mechanization, tooth-to-tail ratio) for its mission?
4. Communication
   a) which side can more efficiently share information, coordinate actions?
5. Logistics
   a) which side can deploy troops and deliver supplies cheaper & faster?

Figure 19: Army with best tech wins

Operations Research Corner

Illustration of Numerical Preponderance: **Lanchester's Model of Direct Fire**

1. Assumptions
   a) each side is visible to the other
   b) each combatant on each side is able to fire on any opposing individual
   c) loss rate on one side is proportional to number of opponents firing
2. Formalization

$$dA/dt = -\alpha_B B_t, \quad dB/dt = -\alpha_A A_t$$

   where
   a) $\frac{dA}{dt}, \frac{dB}{dt}$ are *rates of attrition* in A's and B's forces over time (t)
   b) α_A, α_B are A's and B's *rates of fire*
   c) A_t, B_t are A's and B's *force strength* on the battlefield at time t
3. Solution
   a) by integrating with respect to time, we get the following conditions:

$$\alpha_B B^2 < \alpha_A A^2 \quad \text{(A wins)}, \quad \alpha_B B^2 > \alpha_A A^2 \quad \text{(B wins)}$$

   b) this is the **"Square Law"**: casualty ratio varies inversely to force ratio (force outnumbering opponent will have fewer casualties in equilibrium)

4. Example
   a) if A is twice as numerous as B $(A = 2B)$,
      but B is three times as effective as A $(\alpha_B = 3\alpha_A)$, A will still win:

$$3\alpha_A B^2 < \alpha_A (2B)^2 \quad \rightarrow \quad 3 < 4$$

   b) in a direct fire setting, the **numerically larger force will prevail**

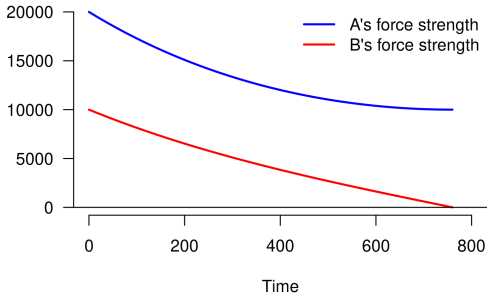

Figure 20: Attrition in the direct fire model

Illustration of Technological Dominance: **Lanchester's Model of Indirect Fire**

1. Assumptions
   a) each side is *invisible* to the other
   b) each combatant on each side fires into area other side occupies
   c) loss rate on one side is proportional to number of opponents firing *and* number of friendly troops occupying the area under fire
2. Formalization

$$dA/dt = -\alpha_B B_t A_t, \quad dB/dt = -\alpha_A A_t B_t$$

   where
   a) $\frac{dA}{dt}, \frac{dB}{dt}$ are *rates of attrition* in A's and B's forces over time (t)
   b) α_A, α_B are A's and B's *rates of fire*
   c) A_t, B_t are A's and B's *force strength* on the battlefield at time t
3. Solution
   a) by integrating with respect to time, we get the following conditions:

$$\alpha_B B < \alpha_A A \quad \text{(A wins)}, \quad \alpha_B B > \alpha_A A \quad \text{(B wins)}$$

   b) this is the **"Linear Law"**: casualty ratio varies inversely to relative rates of fire (force outgunning opponent has fewer casualties in equilibrium)

4. Example
   a) if A is twice as numerous as B ($A = 2B$),
      but B is three times as effective as A ($\alpha_B = 3\alpha_A$), B will now win:

$$3\alpha_A B > \alpha_A(2B) \quad \rightarrow \quad 3 > 2$$

   b) in an indirect fire setting, **technology matters more than numbers**

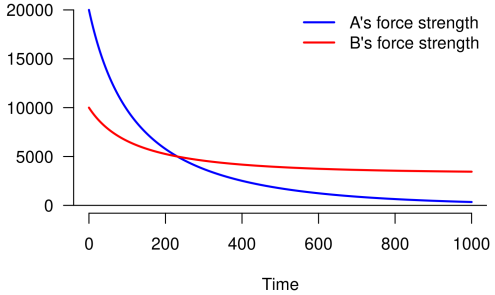

Figure 21: Attrition in the indirect fire model

Key assumptions Lanchester is making

1. Forces are within weapons range of each other
2. Effects of weapons rounds are independent
3. Fire is uniformly distributed across enemy targets (or area)
4. Rates of fire are constant over time
5. No reinforcements

What do you find problematic about these assumptions?

What's missing from these models?

Figure 22: Direct fire

Figure 23: Indirect fire

Force Employment

Force employment

1. Doctrine
   a) which side is more prepared for expected type of combat?
2. Strategy
   a) which side has smarter/clearer vision for how to win war?
3. Training
   a) are troops ready and able to implement the chosen strategy?
4. Officer & NCO quality
   a) are small team leaders capable of independent decisions?
   b) how well is discipline maintained?
   c) are senior leaders capable of managing large-scale maneuvers?
5. Operational art
   a) which side can best integrate ends, means?

Figure 24: Most skilled army wins

Example: **"Modern System"** (Biddle, 2004)

1. Key elements:
   a) cover and concealment
   b) dispersion
   c) small unit independent maneuver
   d) combined arms warfare
2. Goal: reduce exposure to firepower

But this is very hard to do!

1. Requirements:
   a) independent decision-making by 1,000s of junior officers
   b) tight coordination and synchronization between dispersed, moving units
   c) mastery of multiple, dissimilar weapons types
   d) trust (hard for superiors to monitor and control juniors' behavior)

Figure 25: The modern battlefield

Back to the Negotiating Table

If ending war is a choice, what drives this choice?

1. Convergence of beliefs about who would win a fight to the finish
   a) choice is shaped not only by brute force destructive potential ("can we destroy them?")
   b) but also by resolve and commitment to stakes ("is it worth it?")
   c) example: U.S. in Afghanistan
2. Wars do not end in stalemate
   a) stalemate creates uncertainty over who would prevail in long run
   b) this makes bargains harder to reach (at least in short term)
   c) negotiated settlement becomes possible when one side is unable and unwilling to maintain stalemate

Figure 26: Show the flag