

Maymester 2017 Class 1 and 2

Economist's approach to conflict

RAD

May 14, 2018

Introduction: 30-40 minutes

- 1 Introductions (why?-learning best when associated with a group)
- 2 Readings and class materials beyond book:
<https://my.vanderbilt.edu/robertdriskill/econ-2340-maymester-in-london/>
- 3 Strategy:
 - 1 Try as best we can to coordinate topics and readings with co-curricular activities.
 - 2 BUT: I want class to be interactive. If we wander down a different path, so be it.
- 4 Today: British Museum. We meet at 1:20 outside South Kensington Tube stop (tube stop will usually TBAIC)—don't be late, bring tube pass! We take Picadilly line east to Russell Square. If you get separated, we meet on the north side of the British Museum (google, map, whatever works for you).

What this course is about

Economics and economists

- 1 Econ is study of allocation of scarce resources—who gets what, and why.
 - 1 Usual study: allocation when property rights are secure, contracts enforced; a study of production and exchange (not always in markets, though).
 - 2 Application to war and conflict: Three big questions we tackle in this class: allocation of resources to fight a war; incentive problems (how to get people to fight); and "bargaining failure" (why can't we all just get along?).
- 2 Note: Anybody can study allocation of resources. What distinguishes the economists' way of doing this?

What this course is about

Economics and economists

"Curiously, no agreement exists on just what are the principles of economics, but no economist would dispute the six we discuss: first, the idea that in order to do one thing one must generally sacrifice the opportunity of doing another thing at the same time; second, the notion that incentives affect behavior; third, that decisions are made by comparing the extra benefits to be had against the extra costs incurred; fourth, that unequal information creates power favoring one party over another; fifth, the principle that, beyond some point, further applications of an input result in ever smaller yields of additional output; and sixth, the idea that people will substitute a relatively cheaper for a relatively more expensive item if the items are deemed comparable. (Apples and oranges can be compared, if all one wants is a piece of fruit.) These principles are (almost) self-evident, but their subtleties and implications are not"

Brauer, Jurgen; van Tuyl, Hubert (2008-11-15). Castles, >

What this course is about

Economics and economists

- 1 Opportunity cost
- 2 Incentives affect behavior
- 3 Decision rule: $MB=MC$
- 4 Informational problems: overcoming hidden attributes, hidden actions
- 5 Diminishing marginal returns
- 6 Substitution possibilities

What this course is about

Wait! There's more! Rational behavior, strategic behavior

- 1 Rational behavior: Think before you act with consideration of:
 - 1 constraints you face
 - 2 awareness of your preferences or objectives (know what you want, not necessarily why you want things).
 - 3 what actions will obtain these objectives.
- 2 A sub-set of rational behavior: Strategic. Specifically think about how your interactions with others affects the pursuit of your objectives.

What this course is about

Strategy: examples and amplification

(http://www.bbc.co.uk/history/worldwars/wwtwo/launch_ani_d_day.shtml)

- 1 If Allies threaten to land at either Calais or Normandy, how will the Germans respond? Will they hold a strategic reserve? Will they have thinner defenses at both spots? Calais has obvious advantages (shorter crossing, close to Germ. heart)
- 2 Other examples: Tennis (down the line or crosscourt); soccer penalty kicks.
- 3 Keep 'em guessing!

What this course is about

Big question I: Allocation of resources to prosecute a war

- 1 How many ships versus how many bombers, how many infantry divisions; castles versus armies;
- 2 Key ideas economists bring to the table: substitutability, diminishing returns, hidden actions and hidden information.

What is this course about?

Big question II: Incentive problems, economics of organization

"To most non-economists, economics has something to do with money, and the economics of war presumably has to do with how we pay for the bombs and bullets. Economists have different and broader ideas of what their field is; my own favorite definition is that economics is that approach to understanding human behavior which starts from the assumption that individuals have objectives and tend to choose the correct way to achieve them. From this standpoint, the potential subject matter is all of human behavior"

EconofWarDFriedman1

What this course is about

Friedman again on Big Question II

"Given such a broad definition of economics, one might almost say that all of warfare reduces to the technical problem of making guns that will shoot and the economic problem of getting someone to shoot them, preferably in the right direction. Board games, strategic simulations and popular articles tend to emphasize the technical problems-how far a tank will shoot, what kind of armor it will go through and how many tanks (or knights or hoplites) each side has; they generally take it for granted that the playing pieces will go where they are moved. In real battles they frequently do not. *The economic problem is why they do not and what can be done about it.*" (italics mine).

What this course is about

Friedman again

"Economics assumes that individuals have objectives. We do not know all of the objectives that any individual has, but we do know that for most of us, *staying alive is high on the list* (italics mine). The general commanding an army and the soldier in the front line have, in one sense, the same objectives. Both want their side to win, and both want both of them to survive the battle. The soldier, however, is likely to rank his own survival a good deal higher and the general's survival a good deal lower in importance than the general does. One consequence of that disagreement is that the general may rationally tell the soldier to do something and the soldier may rationally not do it. Neither is necessarily making a mistake; each may be correctly perceiving how to achieve his ends."

What this course is about

The second big question

- 1 The PA problem: generals versus "poilu," (translates as "hairy one," or in US, "grunt," "groundpounder"): "It was not unusual to see spirited resistance to orders from on high." (W. Grimes NYT review on 04/21/14 of "Poilu," a WWI notebook of Corporal Loius Barthas).
- 2 "Body-count Bennett," night ambushes, cops and doughnuts (elements of "hidden actions")

What this course is about

Big question 3: bargaining failure

- Standard econ assumes enforcement of property rights and contracts.
- In anarchy, "might makes right." Can economic analysis be applied?
 - Why not? Expected benefits versus expected costs of taking something versus producing something.
 - But war inefficient: why not pay tribute, save the costs of the actual fight?
 - The march to war is thus a "bargaining failure."
- Example: French rail strike

- 1 History of the world aka Acemoglu and Robinson *Why Nations Fail*
 - 1 15,000 BC: end of Ice Age, Hunters and Gatherers
 - 2 14,000 BC-9500: Younger Dryas Cooling, HG's
 - 3 9600 BC-today: "Long summer"
 - 1 9500: first domesticated plants
 - 2 Agriculture permits civilization: the joint achievement of prosperity and security.
 - 3 The state: "the monopoly of legitimate violence."
 - 4 In BC times, the rise of "participating democracies" is a long way off.

Paradox of civilization

"the key features of Lower Mesopotamia, the "cradle of civilization," were an extremely fertile alluvial soil, an abundance of edible animals, and irrigation technology. Identical factors were emphasized for the rise of Egypt, the first pristine civilization after Sumer. Both in Lower Mesopotamia and Egypt "irrigation agriculture could generate a surplus far greater than that known to populations on rain-watered soil" and "as productivity grew, so too did civilization" (Mann 1986: 80, 108)."

Paradox of civilization

"surplus production was only a necessary condition for civilization, not a sufficient one. In fact, prosperity could be self-defeating. Primitive food producers were surrounded by nomadic tribes for whom agricultural surpluses were a most tempting target for looting. The resulting clash is a primordial conflict shaping the civilizational process. According to McNeill (1979, p. 71), "Soon after cities first arose ... the relatively enormous wealth that resulted from [their economic activity] made such cities worthwhile objects of attack by armed outsiders." For anthropologists, intergroup violence had been prevalent since before civilization (Keeley 1996), but the emergence of large surpluses intensified the potential for conflict. According to Michael Mann, "the greater the surplus generated, the more desirable it was to preying outsiders" (1986: 48).

Paradox of civilization

Why Sumer and Egypt

- A proper balance was needed between surplus production and surplus protection ... The contextual conditions allowing for such a balance are rare, as evidenced by the fact that, out of thousands of primitive societies, only a handful could develop independent civilizations, starting with Sumer and Egypt.
- Pillage and Plunder

Introduction

Parliament, history: digression on "why fight."

- 1 No state? Somalia, other gang cultures, anarchy.
"So that in the nature of man, we find three principal causes of quarrel. First, competition; secondly, defence; thirdly, glory. The first maketh men invade for gain; the second, for safety; and the third, for reputation. The first use violence, to make them-selves masters of other men's persons, wives, children, and cattle; the second, to defend them; the third, for trifles..." (Thomas Hobbes (1886): *Leviathan*, Second Edition (London: Ballantyne Press). p. 64)
- 2 More on *Leviathan*?
[https://en.wikipedia.org/wiki/Leviathan_\(Hobbes_book\)](https://en.wikipedia.org/wiki/Leviathan_(Hobbes_book)). Written in midst of English Civil War.
- 3 Thucydides, Hobbes: three motives for war:
 - 1 Greed
 - 2 Fear
 - 3 Honor

Review of Hobbes (a thin veneer of sophistication)

More on the three reasons for fighting

Hobbes [3] Chapter 13, p. 57:

Competition (Greed): if any two men want a single thing which they can't both enjoy, they become enemies; and each of them on the way to his goal (which is principally his own survival, though sometimes merely his delight) tries to destroy or subdue the other.

Distrust (fear): Because of this distrust amongst men, the most reasonable way for any man to make himself safe is to strike first...People who would otherwise be glad to be at ease within modest bounds have to increase their power by further invasions, because without that, in a purely defensive posture, they wouldn't be able to survive for long.

Glory (honor): Every man wants his associates to value him as highly as he values himself; and any sign that he is disregarded or undervalued naturally leads a man to try, as far as he dares, to raise his value in the eyes of others....when there is no common power to keep them at peace, 'as far as he dares' is far enough to make them destroy each other.

Hobbes: economic consequences of "hold up" (Baliga's term)

Hobbes [3] Chapter 13, p. 57-58:

[T]here is no place for hard work, because there is no assurance that it will yield results; and consequently no cultivation of the earth, no navigation or use of materials that can be imported by sea, no construction of large buildings, no machines for moving things that require much force, no knowledge of the face of the earth, no account of time, no practical skills, no literature or scholarship, no society; and-worst of all-continual fear and danger of violent death, and the life of man solitary, poor, nasty, brutish, and short.

Empirical evidence:

For the savage people in many parts of America have no government at all except for the government of small families, whose harmony depends on natural lust. Those savages live right now in the brutish manner I have described.

Hobbes [3] Chapter 14, p. 60: The First Law of Nature
[A]s long as every man continues to have this natural right to everything-no man, however strong or clever he may be, can be sure of living out the time that nature ordinarily allows men to live. And consequently it is a command or general rule of reason that every man ought to seek peace, as far as he has any hope of obtaining it; and that when he can't obtain it he may seek and use all helps and advantages of war.

Hobbes [3) Ch. 17, p. 79

The only way to establish a common power that can defend them from the invasion of foreigners and the injuries of one another, and thereby make them secure enough to be able to nourish themselves and live contentedly through their own labours and the fruits of the earth, is to confer all their power and strength on one man, or one assembly of men, so as to turn all their wills by a majority vote into a single will... This is the method of creation of that great LEVIATHAN, or rather (to speak more reverently) of that mortal god to which we owe, under the immortal God, our peace and defence.

In summation:

- State of nature suggests anarchy is a Prisoners'Dilemma because of greed.
- First Law of Nature suggests peace is a best response to peace and war to war, a Coordination game. It suggests a channel through which fear may operate.
- Leviathan offers a theory of government.

Thomas Hobbes (1651): Leviathan, or the Matter, Forme, and Power of a Commonwealth, Ecclesiasticall and Civil,

http://www.earlymoderntexts.com/f_hobbes.html

Fear (peace to peace and war to war)

- "The idea that fear of an opponent's motives might drive an otherwise dovish player into aggression comes up in Thucydides ("The growth of Athenian power and the fear this caused in Sparta, made war inevitable.") and also Hobbes. But both sides might be afraid and this simply escalates the fear logic further.
- Schelling in his work on the reciprocal fear of surprise attack: "If I go downstairs to investigate a noise at night, with a gun in my hand, and find myself face to face with a burglar who has a gun in his hand, there is a danger of an outcome that neither of us desires. Even if he prefers to leave quietly, and I wish him to, there is a danger that he may think I want to shoot, and shoot first. Worse, there is danger that he may think that I think he wants to shoot. Or he may think that I think he thinks I want to shoot. And so on."

David Hume, *A Treatise of Human Nature, Volume II* (1739)

Two neighbors may agree to drain a meadow, which they possess in common; because 'tis easy for them to know each others mind; and each must perceive, that the immediate consequence of failing his part, is the abandoning of the whole project. But 'tis very difficult and indeed impossible, that a thousand persons shou'd agree in any such action; it being difficult for them to concert so complicated a design, and still more difficult for them to execute it; while each seeks a pretext to free himself of the trouble and expense, it wou'd lay the whole burden on others.

Jean-Jacques Rousseau, *Discourse on the Origin and Foundations of Inequality among Men* (1775)

This is how some men could imperceptibly acquire some idea of mutual commitments and the advantages to be had in fulfilling them. ... Were it a matter of catching a deer, everyone was quite aware that he must faithfully keep to his post in order to achieve this purpose; but if a hare happened to pass within reach of one of them, no doubt he would have pursued it without giving it a second thought, and that, having obtained his prey he cared very little about causing his companions to miss theirs.

Evolution of cooperation

Palanpur, India: 200 or so families, a "timeless backwater"; sow their winter crops several weeks after the date at which yields would be maximized; no one willing to plant first, as the seeds on a lone plot would be all eaten by the birds. Had a large group ever agreed to sow earlier, all together, all planting on the same day so as to minimize losses? "If we knew how to do that, we would not be poor."

Hume again:

I observe, that it will be for my interest to leave another in possession of his goods, provided he act in the same manner with regard to me....And this may properly be called a convention....The stability of possession ... arises gradually, and acquires force by slow progression, and by our repeated experiences of the inconveniences of transgressing it. ... In like manner are languages gradually established by human conventions without any promise. In like manner do gold and silver become the common measure of exchange.

- The state and the "iron law of oligopoly:" If a state is strong enough to monopolize violence and provide security, it is strong enough to keep the bulk of the surplus for itself; the development and use of *extractive institutions*.
- What is remarkable: With the Glorious Revolution in 1600's, Great Britain becomes the world's first *participatory democracy*
 - "Broad" political rights: growth of commercial interests (long-distance trade) alongside of landowners.
 - Parliament a "balance of power" wrt the Crown.
 - shutting the door in the face of the King's representative.

Other thoughts on Parliament?

- 1 Wellington, Nelson.
- 2 Universal male suffrage after WWI.

What this course about: WWI as poster child

- Brief history
 - A world of colonial powers: France, Russia, UK, emergent Germany, Italy to some extent
 - World of alliances: Germany and AH empire vs France, UK, Russia.
 - Arms races, especially UK vs Germany in navies
 - Franco-Prussian war: short, swift, the loser paid
 - Economically integrated (Norman Angell, "The Great Illusion.")
 - Eve of war: both sides anticipated a short war with reparations, both sides expected to win. If it did not end quickly, cooler heads would prevail and end it.
- What had happened to military technology as illustrated by Civil War?
 - Breech-loading, rifled barrel weapons
 - Improved artillery
 - machine guns perfected
 - Early civil war: a war of movement; later civil war, butchery as defense gained upper hand
 - Upshot: pendulum swung to defence.

- "Make the right wing strong" (Schlieffen's dying utterance)
 - Opportunity cost.
 - PA problem: where's the glory in defence? (what are incentives of left-wing generals? Civil War generals "leaked info to newspapers that enhanced their careers); March on Paris? (Von Kluck exposes his flank).
 - Belgian neutrality: misperceptions ("they won't ... fight," Britain will not enter war). Historians say: Germans "had" the information, i.e., objective observer would have predicted this, but didn't see it this way. (behavioral economics: why do economists, Dr.'s, disagree?)
 - Behavioral: see what you want to see (Romeo and Juliet).
- Militarism: misaligned incentives again, PA problem ("bloody wars and dread diseases")
- France: quick strike through Ardennes, no need to be defensive, belief the Germans wouldn't invade neutral Belgium.
- Offense-defence misperceptions

WWI: the cost

Country	KIA	% Pop.	Wounded	Casual. as % force.
UK	900,000	2	2,000,000	36%
France	1,700,000	4.25	4,266,000	73%
Italy	589,000	3	1,000,000	39%
Russia	2,300,000	1.75	5,000,000	76%
US	117,000	.13	204,000	7.1%
AH	2,000,000	3.75		
Germany	2,000,000	3.75	4,000,000	64.9%

WWI cost: back of env. calc.

- British population: 45,000,000
- Pop. of people who are "age of service:" 15,000,000
- Men of age of service: 7,500,000
- About every eighth such man died, every fourth wounded
- Probably disproportionately high outside of metropolises
- For France, about doubled: one of every fourth such man died

WWI costs: comparisons

Country	Military deaths	Pop.	%
France	200,000	41,000,000	.04%
Germany	5,000,000	70,000,000	7%
UK	383,000	48,000,000	.07%
US	416,000	131,000,000	.03%

- Viet Nam: 47,000 battle deaths, 153,303 WIA, about 25 million eligible men.
- Population? maybe 200,000,000

Why are we here?



Why are we here?

V1 Bombs

"The weapon was a flying torpedo, twenty-five feet long with stubby wings, a crude jet engine, and a one-ton warhead. It could cross the English coast twenty minutes after launch; when the fuel ran dry, the engine quit and the bomb fell. Hitler called them "cherry stones." "

Atkinson, Rick (2013-05-14). *The Guns at Last Light: The War in Western Europe, 1944-1945 (The Liberation Trilogy)* (p. 107). Henry Holt and Co.. Kindle Edition.

Why are we here?

V1 Bombs

"But subsequent volleys showed greater promise. By noon on June 16, of 244 launches, 73 cherry stones had reached "Target 42," also known as London. This very morning the nameless weapon had been anointed the Vergeltungswaffe— reprisal weapon— or V-1. "Terror is broken by terror," the Führer liked to say. "Everything else is nonsense.

Rundstedt suggested that the V-1 be used against those half million enemy soldiers now massed in the beachhead. Rommel agreed. Hitler summoned a military expert who explained that the flying bomb's inaccuracy made any target smaller than London difficult to hit: the V-1s were aimed at Tower Bridge on the Thames, but the margin of error might be fifteen kilometers or more. Relentless pummeling of Target 42, Hitler told the field marshals, would "make it easier for peace." Panic would paralyze Britain, with psychological and political chaos."

Atkinson, Rick (2013-05-14). *The Guns at Last Light: The War in Western Europe, 1944-1945 (The Liberation Trilogy)* (p. 107). Henry Holt and Co.. Kindle Edition.

Why are we here?

V1's on June 18, 1944

"In the Guards Chapel at Wellington Barracks on Birdcage Walk, ... a full-throated congregation belted out the "Te Deum" and prepared to take communion from the bishop of Maidstone. "To Thee all angels cry aloud," they sang, At 11: 10 A.M. an annoying growl from those same heavens grew louder. Ernest Hemingway heard it in his Dorchester Hotel suite, ... from the window he looked for the telltale "white-hot bunghole" of a jet engine. ... Clementine Churchill, the prime minister's wife, heard it in Hyde Park, The Guards Chapel congregation heard it and kept singing. Then they heard nothing— that most terrifying of all sounds— as the engine quit, the bunghole winked out, and the black cruciform fell. Through the chapel's reinforced concrete roof It plummeted before detonating in a white blast that blew out walls, blew down support pillars, and stripped the leaves from St. James's plane trees. A funnel of smoke curled fifteen hundred feet above the wrecked nave; rubble ten feet deep buried the pews even as six candles still guttered on the altar and the bishop stood unharmed. One hundred and twenty-one others were dead

Why are we here?

V1's

In a memo on Sunday evening, the supreme commander ordered that the targets code-named CROSSBOW, comprising V-1 launch areas, supply dumps, and related sites, “are to take first priority over everything except the urgent requirements of the battle.” Yet more than thirty thousand attack sorties already had flown in the past six months, dropping the tonnage equivalent of four Eiffel Towers on CROSSBOW in an effort to eviscerate a program Allied intelligence knew was in development. ... Eisenhower’s “first priority” edict dismayed his air force chieftains, who favored the uninterrupted smashing of German cities, oil facilities, and other strategic targets.

Why are we here?

V1's

"A British study calculated that "the average Londoner" could expect to be within a half mile of a V-1 detonation once a month, odds that did "not appear unduly alarming." Few Londoners saw it that way. V-1 explosions sucked workers from office windows, incinerated mothers in grocery stores, and butchered pensioners on park benches. A lieutenant who was recuperating in a hospital hit by a flying bomb wrote his wife that the blast "pushed through the walls and surrounded us, gripped us, entered us, and tossed us aside." He confessed to being "more afraid than I have ever been of anything in my life." "

Atkinson, Rick (2013-05-14). The Guns at Last Light: The War in Western Europe, 1944-1945 (The Liberation Trilogy) (p. 110). Henry Holt and Co.. Kindle Edition.

Why are we here?

V1's

"By August, 1.5 million Londoners would evacuate the city, more than during the Blitz. Of 10,492 V-1s ultimately fired at Britain, about 4,000 were destroyed by fighters, balloons, and anti-aircraft guns, while others veered off course or crashed prematurely. But about 2,400 hit greater London, killing 6,000 and badly injuring 18,000. (Not one struck Tower Bridge.) It was, an official British history concluded, "an ordeal perhaps as trying to Londoners as any they had endured throughout the war." "

Atkinson, Rick (2013-05-14). *The Guns at Last Light: The War in Western Europe, 1944-1945 (The Liberation Trilogy)* (pp. 110-111). Henry Holt and Co.. Kindle Edition.

Why are we here?

Faulty Towers

https://en.wikipedia.org/wiki/The_Germans

- Air war (see CBB)
- Iwo Jima; castle defenses; ; Invasion of UK; Normandy invasion
- Implication: CSF depends on force ratio (no uncertainty)
- When do we expect first-strike advantage?
- Propensity for peace when defense is king

Scenario

- Attacking a castle, an island, or Omaha Beach in Normandy.
- "American casualties, projected with an elaborate formula called Love's Tables, would likely reach 12 percent of the assault force on D-Day, or higher if gas warfare erupted. The 1st Infantry Division, the point of the spear on Omaha Beach, estimated that under "maximum" conditions, casualties would reach 25 percent, of whom almost a third would be killed, captured, or missing. The admiral commanding bombardment forces at Utah Beach told his captains that "we might expect to lose one-third to one-half of our ships." Projected U.S. combat drownings in June, exclusive of paratroopers, had been calculated at a grimly precise 16,726. To track the dead, wounded, and missing, the casualty section under SHAEF's adjutant general would grow to three hundred strong; so complex were the calculations that an early incarnation of the computer, using punch cards, would be put to the task."

Atkinson, Rick (2013-05-14). The Guns at Last Light (pp. 15-16). Henry Holt and Co., Kindle Edition

Scenario

Omaha Beach

"... now it was known, and would forever be known, as Omaha. Five miles long, composed of packed sand yielding to shingle sorted in size by a thousand storms, the beach offered but five exits up the hundred-foot escarpment, each following a narrow watercourse to four villages of thick-walled farmhouses a mile or so inland.

... The German defenses were fearsome. Eighty-five machine-gun nests, soon known to GIs as "murder holes," covered Omaha, more than all three British beaches combined. Unlike the obstacles at Utah, many of the 3,700 wood pilings and iron barriers embedded in the tidal flat at Omaha were festooned with mines ... Thirty-five pillboxes and eight massive bunkers ... defended the beach's five exits, while eighteen antitank sites, six Nebelwerfer rocket-launcher pits, and four artillery positions covered the balance of the beach. Guns enfiladed nearly every grain of sand on Omaha, concealed from the sea by concrete and earthen blast shields that aerial photos had failed to find."

Atkinson, Rick *The Guns at Last Light*, Henry Holt and Co. Kindle

Some military background

Organization

- Three combat arms
 - Infantry: queen of battle.
 - rifles: semi-automatic in WWII;
 - machine guns: 200-300 rounds per minute in combat.
 - grenades, anti-tank, mortars.
 - Most battle deaths.
 - Companies (200 at full strength); 4 platoons (3 rifle, 1 mortar); 3-4 squads per platoon.
 - Artillery: king of battle; organized in "batteries," shoot shells with max range maybe 15 KM; most kills.
 - Armor: tanks; critical in warfare across open terrain.
- REMF's: as much as 90% of armed forces. Logistics key for sustained operations.

War (battle) model: A attacks, B defends

- Force attrition through time:

$$M_A(t + \Delta) - M_A(t) = -\beta_d M_B(t);$$

$$M_B(t + \Delta) - M_B(t) = -\alpha_a M_A(t).$$

- Variables and parameters: $M_A, M_B; \alpha_d, \beta_a; M_A(0), M_B(0)$
- e.g., $\alpha_a = 0.1, \beta_d = 0.05, M_A(0) = 200, M_B(0) = 200$

A attacks, B defends

time	M_A	M_B
0	200	200
1	180	190
2	161	181
3	142.9	172.95
4	125.605	165.805
5	109.0245	159.52475
6	93.072025	154.073525
7	77.6646725	149.4199238
8	62.72268013	145.5366901
9	48.16901111	142.4005561
10	33.9289555	139.9921056
11	19.92974494	138.2956578
12	6.100179166	137.2991705
13	-7.62	136.99

- Percentage attrition:

$$\frac{M_A(t + \Delta) - M_A(t)}{M_A(t)} = -\frac{\beta_d M_B(t)}{M_A(t)};$$
$$\frac{M_B(t + \Delta) - M_B(t)}{M_B(t)} = -\frac{\alpha_a M_A(t)}{M_B(t)}.$$

A attacks, B defends

A attacks, B defends: MAD path

- Equal percentage losses

$$\frac{\beta_d M_B(t)}{M_A(t)} = \frac{\alpha_a M_A(t)}{M_B(t)};$$

$$\alpha_a M_A^2 = \beta_d M_B^2;$$

$$\frac{M_A}{M_B} = \sqrt{\frac{\beta_d}{\alpha_a}}.$$

$$M_A = \sqrt{\frac{\beta_d}{\alpha_a}} M_B;$$

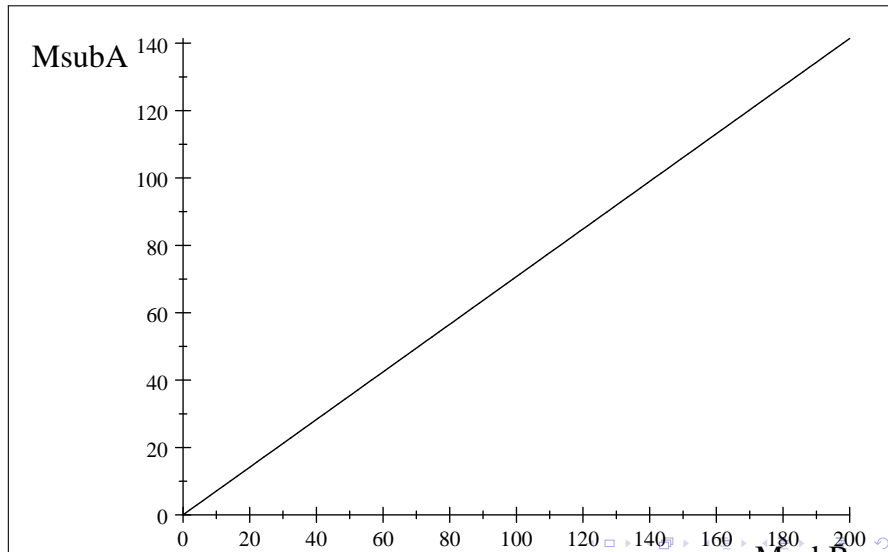
$$M_B = \sqrt{\frac{\alpha_a}{\beta_d}} M_A.$$

- A dichotomizing line in the $M_B - M_A$ plane: Above the line, A loses, B wins; below, vice versa

A attacks, B defends

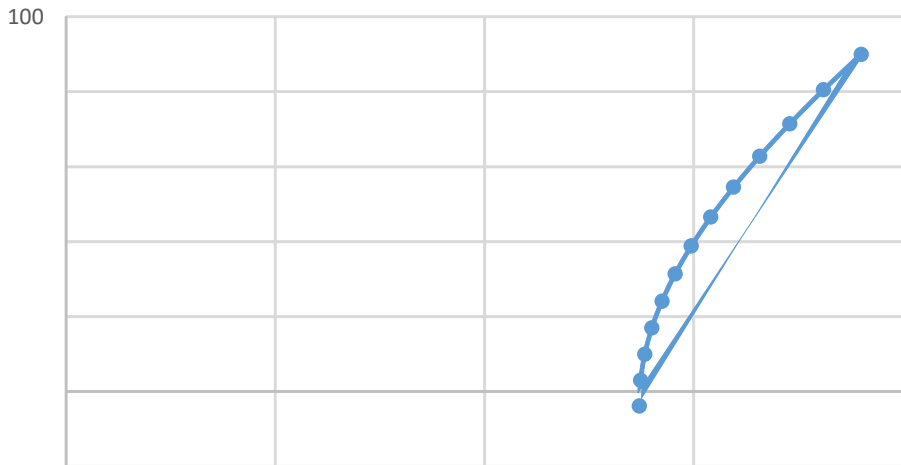
A attacks, B defends

$$y = \sqrt{\frac{.05}{.1}x}$$



Actual paths

$a(a)=.05, b$



A defends B attacks

- Attrition dynamics

$$\begin{aligned}M_A(t + \Delta) - M_A(t) &= -\beta_a M_B(t); \\M_B(t + \Delta) - M_B(t) &= -\alpha_d M_A(t);\end{aligned}$$

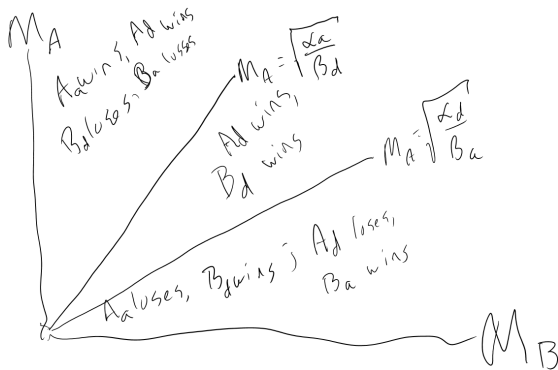
- In percentage terms:

$$\begin{aligned}\frac{M_A(t + \Delta) - M_A(t)}{M_A(t)} &= \frac{-\beta_a M_B(t)}{M_A(t)} \\ \frac{M_B(t + \Delta) - M_B(t)}{M_B(t)} &= \frac{-\alpha_d M_A(t)}{M_B(t)}\end{aligned}$$

- Equal percentage losses

$$\frac{\beta_a M_B(t)}{M_A(t)} = \frac{\alpha_d M_A(t)}{M_B(t)};$$
$$\alpha_d M_A^2 = \beta_a M_B^2;$$
$$\frac{M_A}{M_B} = \sqrt{\frac{\beta_a}{\alpha_d}}.$$

- A dichotomous line in $M_B - M_A$ plane



Getting soldiers to fight

Back to Friedman

- Two soldiers, Charley and Ronnie
- Two actions: Brave or Shirk
- Individual goals: maximize chances of staying alive
- If R chooses to be **B**rave:
 - If C chooses B, then $P_R = .8$, $P_C = .8$
 - If C chooses S, then $P_R = .6$, $P_C = .9$
- If R chooses to **S**hirk:
 - If C chooses B, then $P_R = .9$, $P_C = .6$
 - If C chooses S, then $P_R = .7$, $P_C = .7$

Getting soldiers to fight

Prisoner's dilemma

R/C	B	S
B	(.8, .8)	(.6, <u>.9</u>)
S	(<u>.9</u> , .6)	(<u>.7</u> , <u>.7</u>)

British Museum: Pillage and Plunder

Shelby Moats: "I could just go and rob someone here in London-they don't have guns." Or something to that effect. Compare with Hobbes: "Because of this distrust amongst men, the most reasonable way for any man to make himself safe is to strike first, that is, by force or cunning subdue other men - as many of them as he can, until he sees no other power great enough to endanger him. This is no more than what he needs for his own survival, and is generally allowed." Jackson-Morelli remark: Effectively there is nothing stopping someone from grabbing resources except fear of retaliation.