

# PS 0500: Nuclear Weapons

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<https://williamspaniel.com/classes/ps-0500-2017/>

# Outline

- The Nuclear Club
- Mutually Assured Destruction
- Obsolescence Of Major War
- Nuclear Pessimism
- Why Not Proliferate?
- Mixed Strategies
- The Iraq War

# Outline

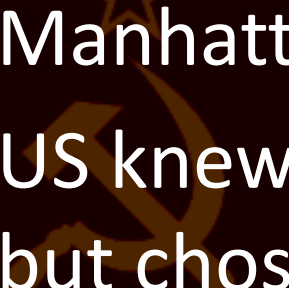
- The Nuclear Club
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- Why Not Proliferate?
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- The Iraq War

# United States (1945)

- Manhattan Project
- Hiroshima and Nagasaki bombings
- Would have been a lot worse if the Nazi scientists had won the race
  - ...but fortunately the Nazis were Naziing



# Soviet Union (1949)

- 
- Manhattan Project spies
  - US knew the Soviets were developing a bomb but chose not to launch preventive war
    - Immediately after WWII
    - No intelligence
  - Cold War starts in earnest

# United Kingdom (1952)

- Tube Alloys
- Agreement with the United States

# France (1960)


- France and the United States do not have as intimate a relationship as the U.S. and the U.K.
- France sought strategic independence
  - Therefore, nukes



# China (1964)

- Sino-Soviet split

# India (1974)

- India does not like Pakistan very much
  - Tested the “Smiling Buddha,” a “peaceful nuclear explosion,” in 1974
  - Remained mostly dormant until 1998. (Hold that thought...)
- 

# Israel (1979)

- Israel does not have nuclear weapons



# South Africa (1979)

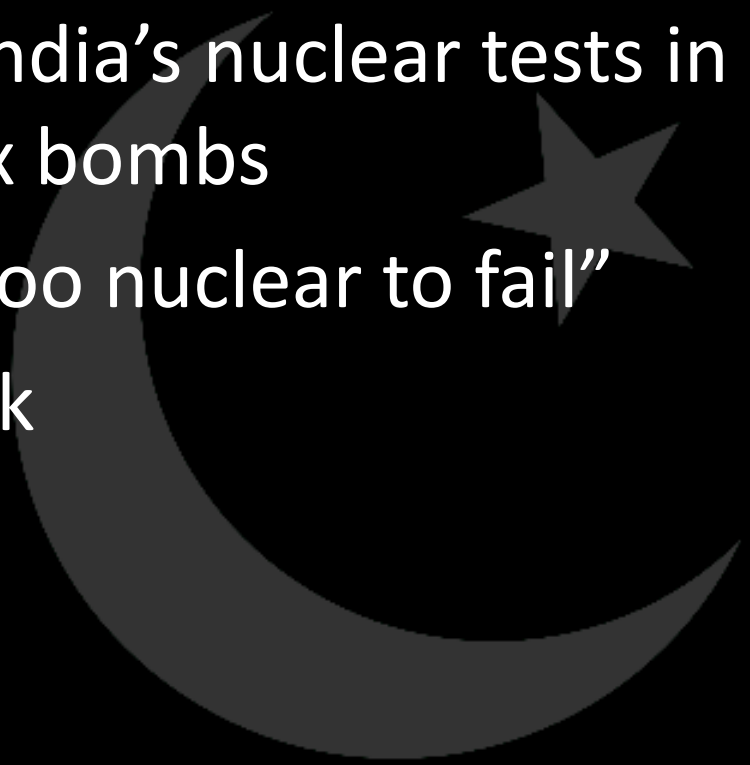
- The Vela Incident
  - A US satellite (Vela Hotel) detected a flash in the Atlantic Ocean between South Africa and Antarctica
- Built due to concerns of civil war spillover from Angola
- Dismantled at the end of Apartheid

# Soviet Successor States

- Ukraine, Kazakhstan, and Belarus had nuclear weapons on their soil during the Soviet Union's breakup
- Moscow still had command control
- Countries accepted cash to dismantle the weapons and forgo native nuclear development

# Pakistan (1998)

- Five weeks after India's nuclear tests in 1998, Pakistan tested six bombs
- Pakistan is now “too nuclear to fail”
- A.Q. Khan network



# The 1998 Ig Nobel Prize Winners

*The 1998 Ig Nobel Prizes were awarded at the 8th First Annual Ig Nobel Prize Ceremony, at Harvard's Sanders Theatre. The ceremony was webcast live.*

**SAFETY ENGINEERING:** Troy Hurtubise, of North Bay, Ontario, for developing, and personally testing a suit of armor that is impervious to grizzly bears. [REFERENCE: "Project Grizzly", produced by the "National Film Board of Canada. ALSO: *Bear Man: The Troy Hurtubise Saga*, by Troy Hurtubise, Raven House Publishing, Westbrook, ME, USA, 2011.]

**BIOLOGY:** Peter Fong of Gettysburg College, Gettysburg, Pennsylvania, for contributing to the happiness of clams by giving them Prozac.

[REFERENCE: "Induction and Potentiation of Parturition in Fingernail Clams (*Sphaerium striatinum*) by Selective Serotonin Re- Uptake Inhibitors (SSRIs)," Peter F. Fong, Peter T. Huminski, and Lynette M. D'urso, "Journal of Experimental Zoology, vol. 280, 1998, pp. 260-64.]

**PEACE:** Prime Minister Shri Atal Bihari Vajpayee of India and Prime Minister Nawaz Sharif of Pakistan, for their aggressively peaceful explosions of atomic bombs.

**CHEMISTRY:** Jacques Benveniste of France, for his homeopathic discovery that not only does water have memory, but that the information can be transmitted over telephone lines and the Internet. [NOTE: Benveniste also won the 1991 Ig Nobel Chemistry Prize.]

[REFERENCE: "Transatlantic Transfer of Digitized Antigen Signal by Telephone Link," J. Benveniste, P. Jurgens, W. Hsueh and J. Aissa, "Journal of Allergy and Clinical Immunology - Program and abstracts of papers to be presented during scientific sessions AAAAI/AAI.CIS Joint Meeting February 21-26, 1997"]

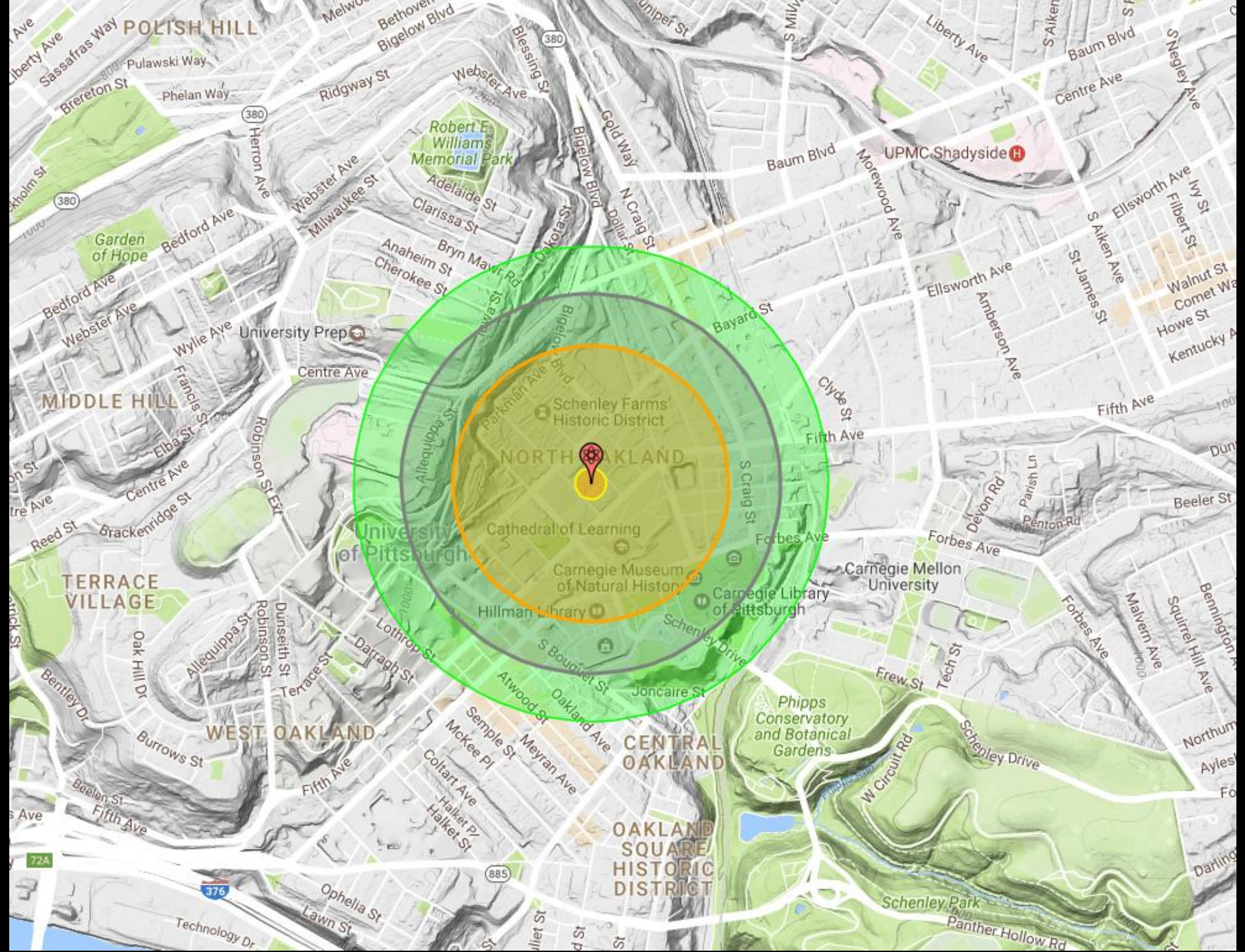
**SCIENCE EDUCATION:** Dolores Krieger, Professor Emerita, New York University, for demonstrating the merits of therapeutic touch, a method by which nurses manipulate the energy fields of ailing patients by carefully avoiding physical contact with those patients.

# North Korea (2006)

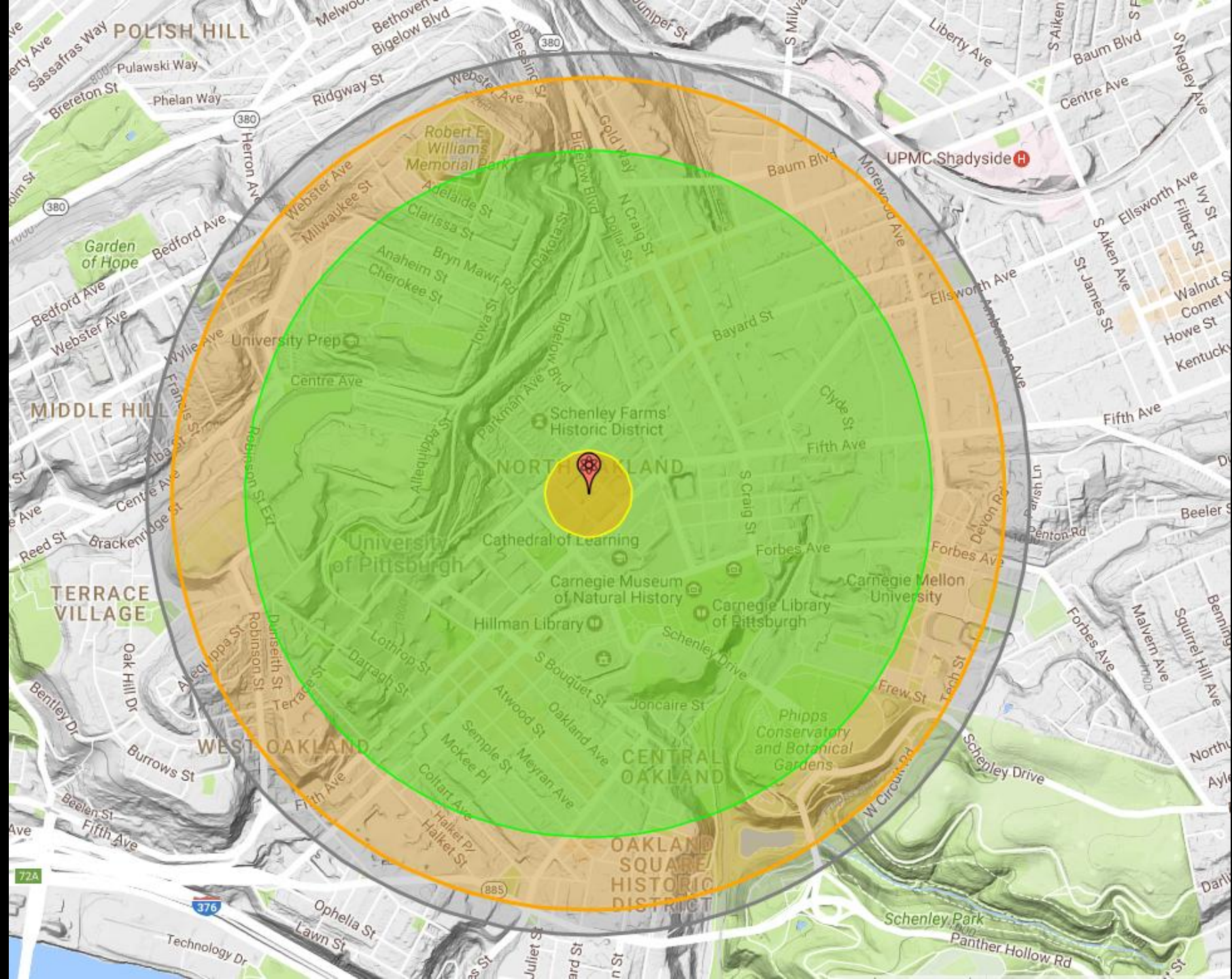
- Conducted a (relatively crummy) explosion in 2006, 2009, and 2013



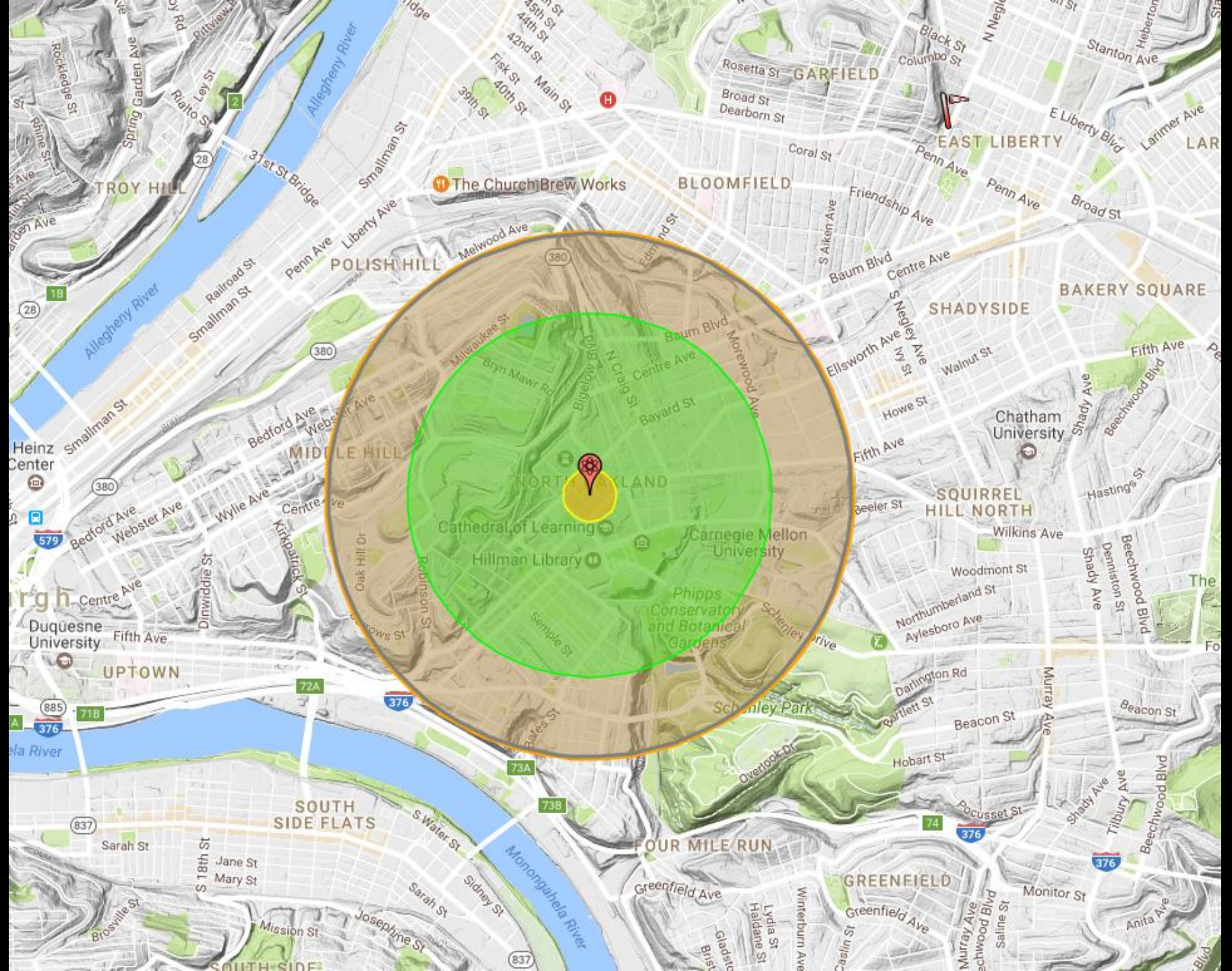




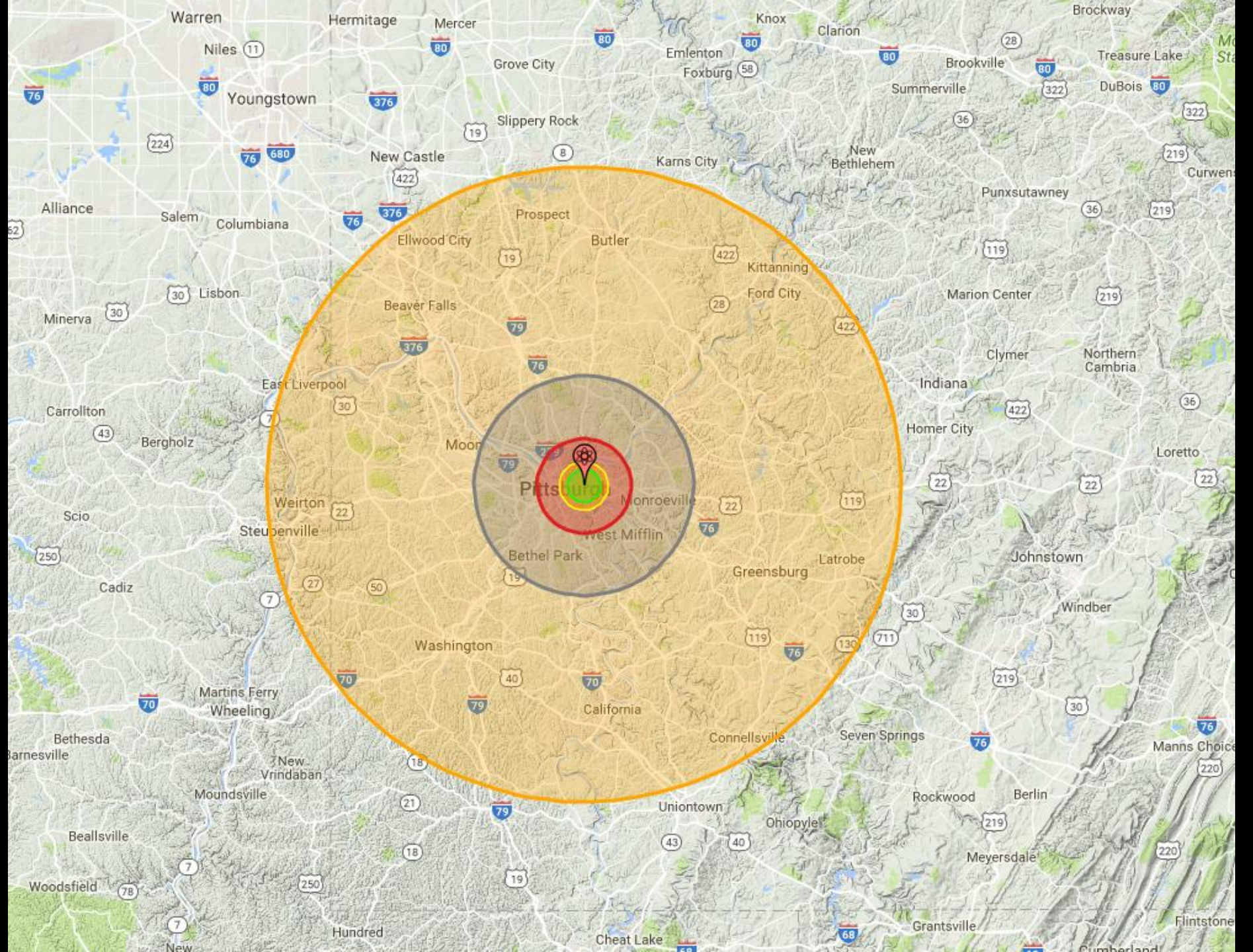












# North Korea (2006)

- Conducted a (relatively crummy) explosion in 2006, 2009, and 2013
- But a crummy bomb on Seoul...
- At one point agreed to trade us their bombs for a billion pounds of food (seriously)

# Iran (2018)

- ?

# Questions

## Macro

- How do nuclear weapons affect the world system?
- Do nuclear weapons promote peace?
- Would the Cold War been a hot war without nuclear weapons?

## Micro

- Why do states choose to proliferate?
- What can we do to stop it?
- How do we best handle North Korea and Iran today?

# Outline

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- Mutually Assured Destruction
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# Mutually Assured Destruction

States live in a world of *mutually assured destruction* if:

1. Both states are self-preserving
2. Both states have large stockpiles of nuclear weapons
3. Each state has a secure second strike; no state achieve a “splendid” first strike

# The Strategic Triad

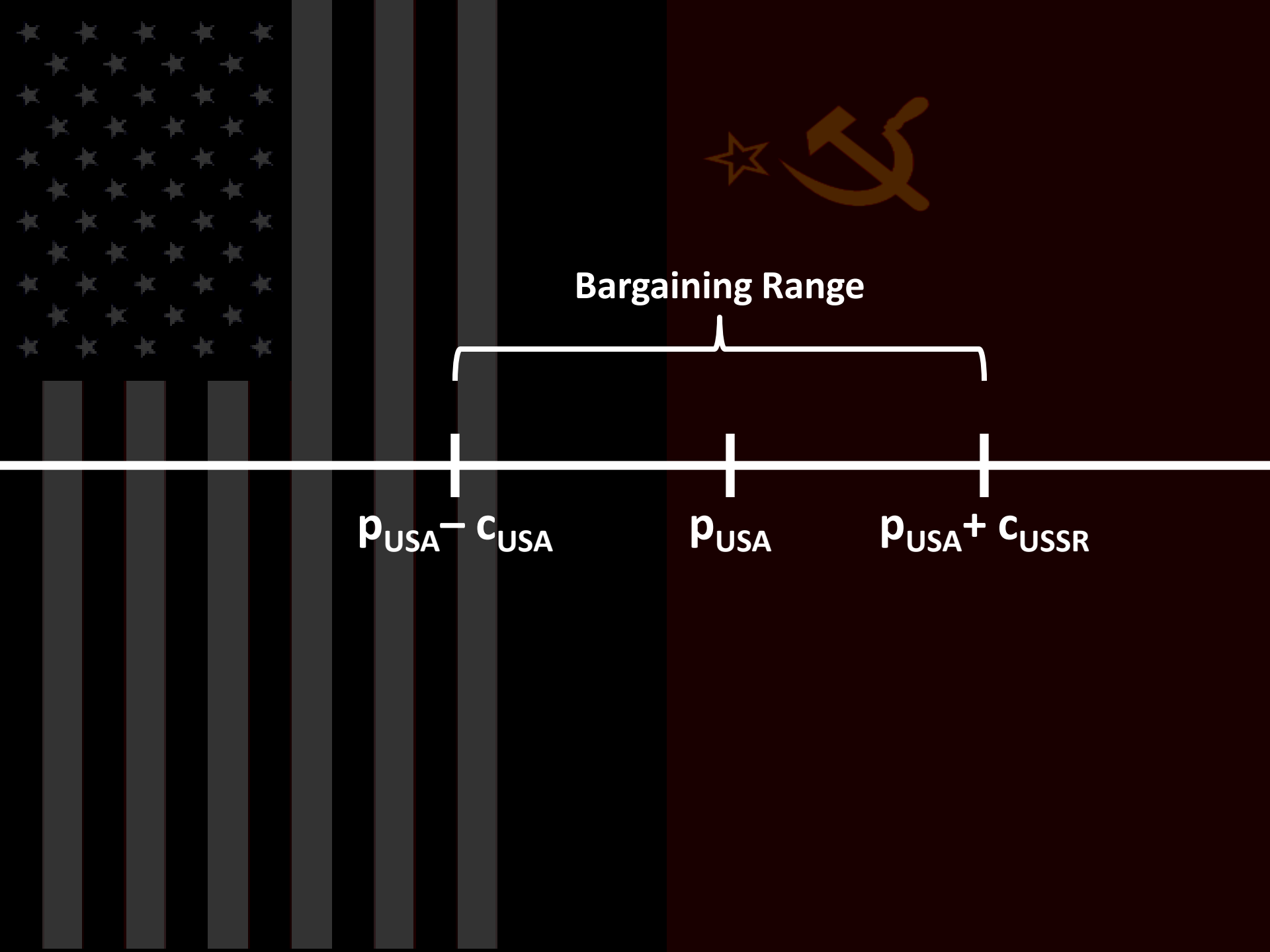
- The United States had three methods of nuclear retaliation
  - Strategic bombers
  - Intercontinental ballistic missiles
  - Submarine-launched ballistic missiles

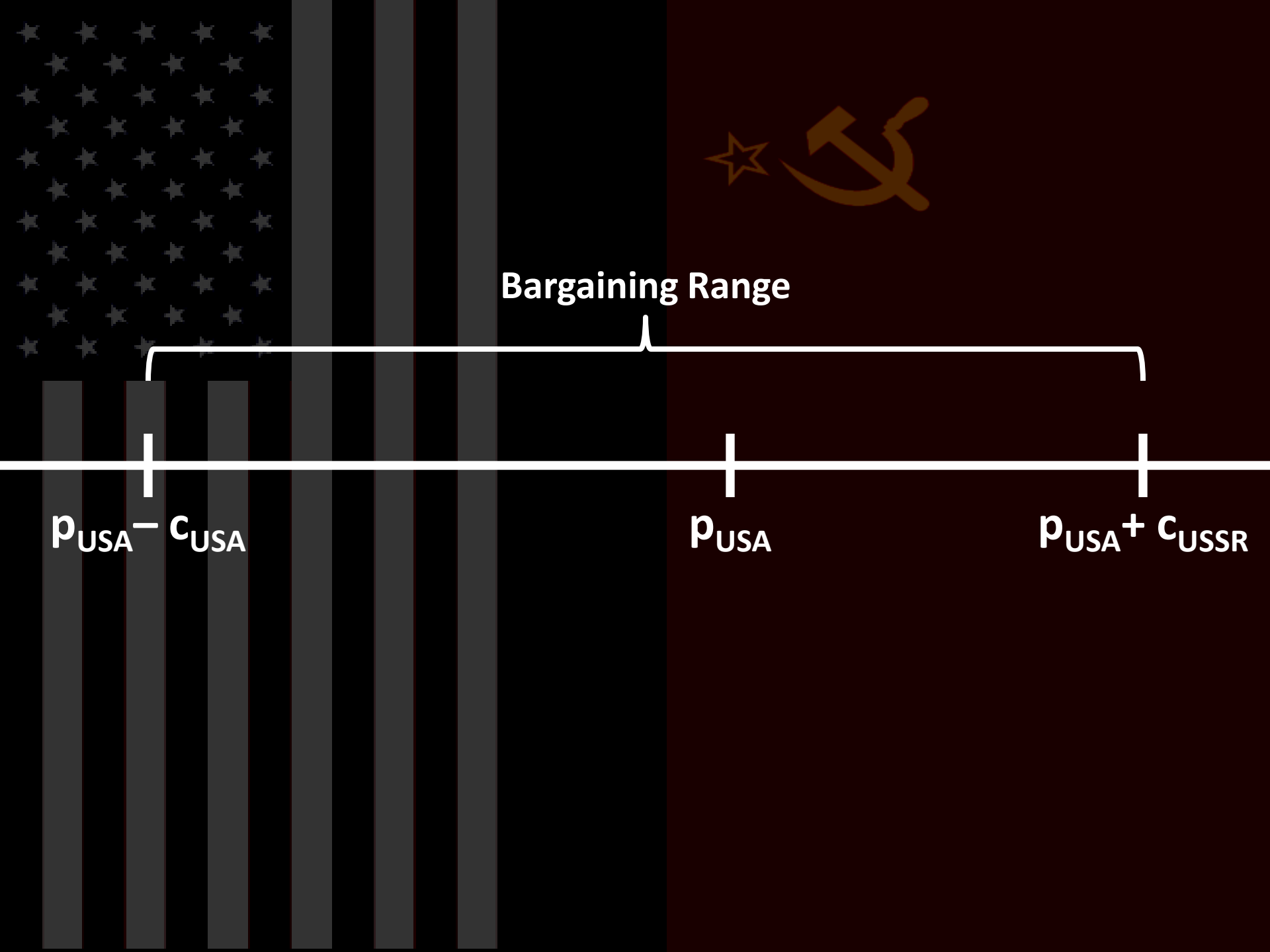
# Everyone, Calm Down

- Under these conditions, no side would want to start a large-scale war
  - If I start a war, I face enormous nuclear retaliation
    - Worse than a disadvantageous peace
  - If my opponent starts a war, he faces enormous nuclear retaliation
    - Worse than a disadvantageous peace

# Bargaining Model of War

- Larger costs: easier to reach bargained settlement





# Policy Implication

- Promoting nonproliferation may be a waste of time
  - If we really just want to stabilize the world and minimize the number of wars, spreading nuclear weapons might be the way to do it

# Outline

- The Nuclear Club
- Mutually Assured Destruction
- **Obsolescence Of Major War**
- Nuclear Pessimism



# Alternate Hypothesis

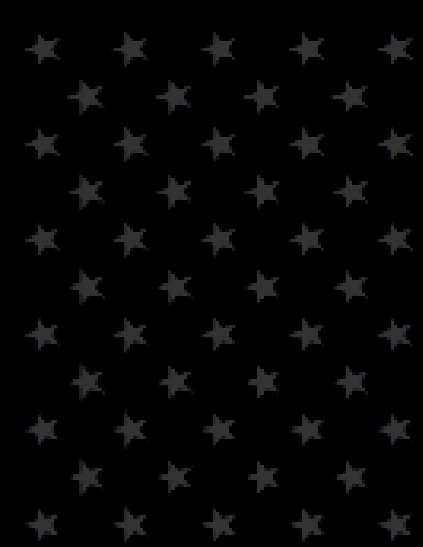
- War between **major powers** is obsolete
  - Two major powers cannot fight wars with one another because the costs will outweigh whatever possible benefit there is

# Alternate Hypothesis

- Nuclear weapons do not change this
  - Mueller: “A jump from a fiftieth-floor window is probably quite a bit more horrible to think about than a jump from a fifth-floor one, but anyone who finds life even minimally satisfying is extremely unlikely to do either.”

# Most Deadly Wars

1. World War II: 16.6 million dead
2. World War I: 8.5 million dead
3. Iran-Iraq: 1.3 million dead
4. Vietnam: 1 million dead



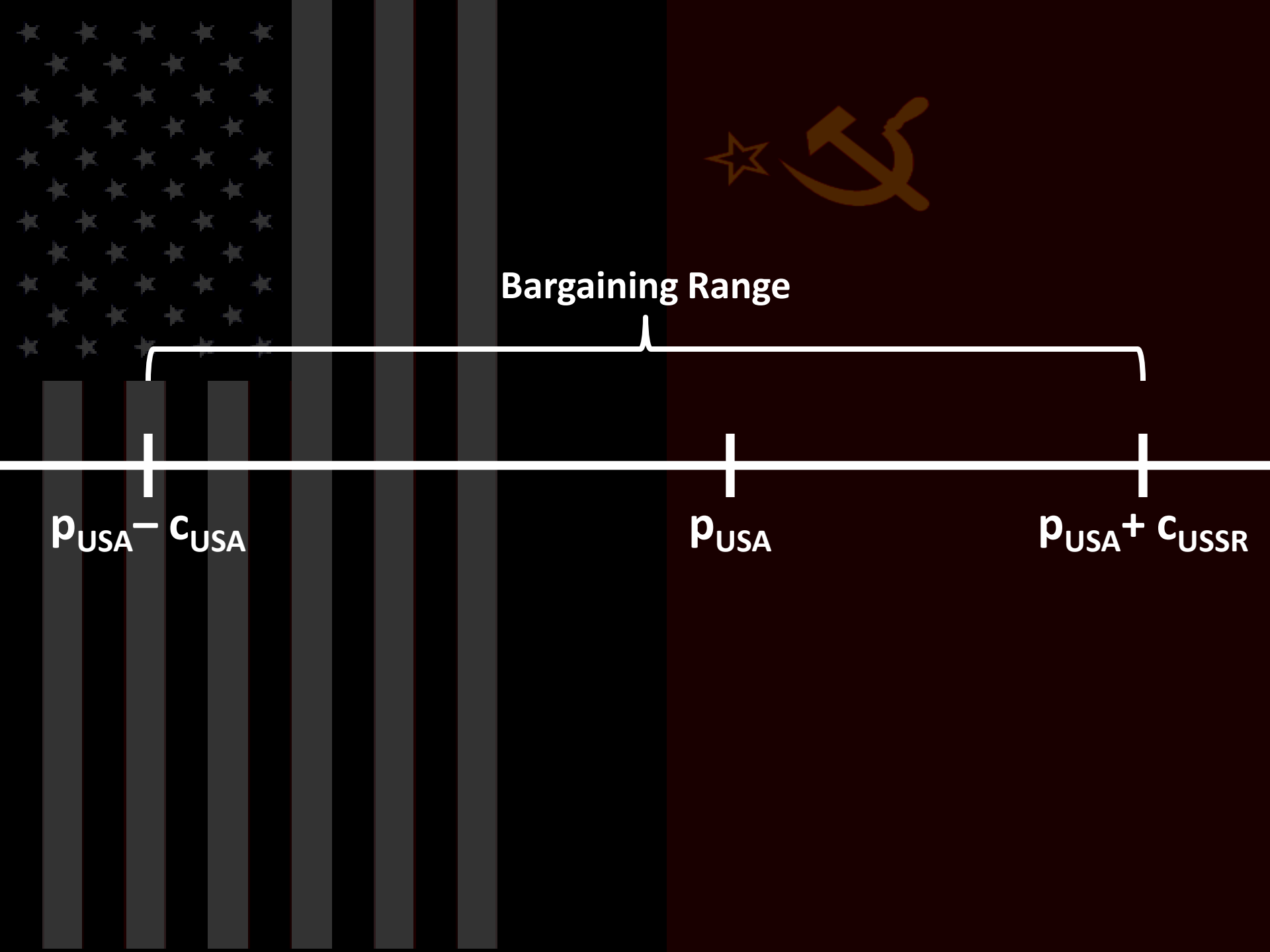
Bargaining Range  
Before Modern Era

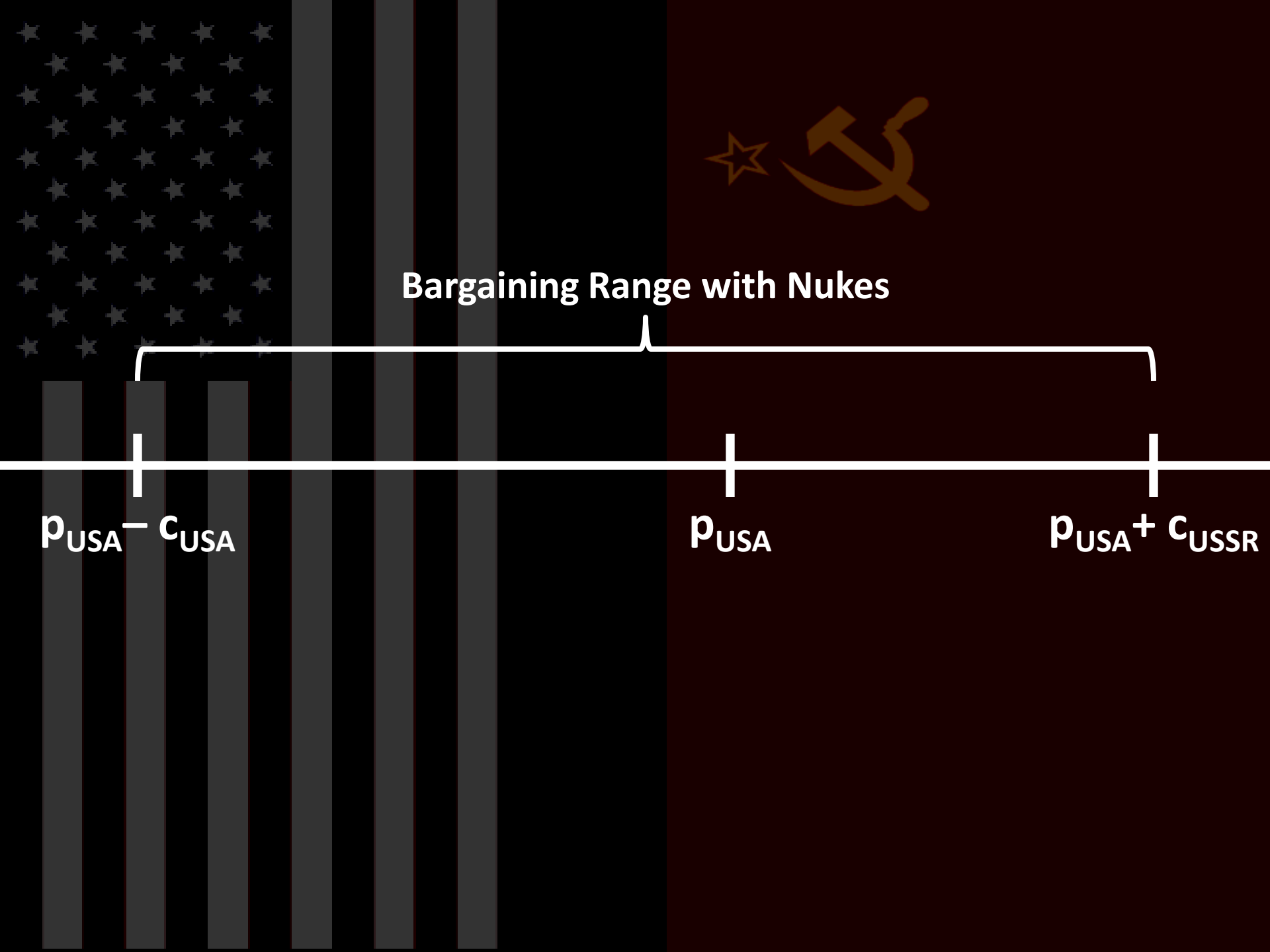


$p_{\text{USA}} - c_{\text{USA}}$

$p_{\text{USA}}$

$p_{\text{USA}} + c_{\text{USSR}}$





# Policy Prescription

- Suppose mutually assured destruction is not necessary to maintain peace
- Should we have nukes?
  - Accidents?
  - Costs?

# Outline

- The Nuclear Club
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- Why Not Proliferate?
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If nuclear weapons aren't very  
useful, should we have them?

# Nuclear Downsides

1. Costs of nuclear weapons
2. Accidental nuclear warfare
3. Rogue nuclear weapons

# Costs of a Nuclear Program

- Nukes are not cheap
  - Costs of development
  - Costs of delivery
  - Costs of maintenance
- Total cost of US program (1945-1998): \$7 trillion (2012 dollars)
  - Still spend around \$16 billion per year

# Risky Business

- Unlike conventional weapons, it is easy to accidentally destroy the world with nuclear weapons
  - Dr. Strangelove and fluoride
  - Stanislav Petrov and the 1983 Soviet false alarm

KEVIN  
COSTNER

SERGEY  
SHNYRYOV

NATALIYA  
VDOVINA

STANISLAV  
PETROV

EVERY MOMENT COUNTS



A PETER ANTHONY AND STATEMENT FILM

# THE MAN WHO SAVED THE WORLD

STATEMENT PRESENTS A FILM BY PETER ANTHONY, STANISLAV PETROV, "THE MAN WHO SAVED THE WORLD", KEVIN COSTNER, SERGEY SHNYRYOV, NATALIYA VDOVINA,  
GALINA MALININA, OLEG KASSIN, IGOR FILIPYEV, GUYTS JAKOWLEVS, COSTUME DESIGNER ROBERT DE NIRO, MATT DAVON, WALTER CROMBIE, AND ASHTON KUTCHER  
EXECUTIVE PRODUCERS KRISTIAN EDINIS, PRODUCED BY PETER SCHULTZ, EDITED BY MORTEN HELBERG AND MORTEN HESSE, A.C.E., PRODUCTION DESIGNER ANDERS JØRSTEDT AND NIM HATTSSEN, A.S.C.,  
DIRECTED BY PETER ANTHONY, PRODUCED BY JACOB STABERG, WRITTEN BY PETER ANTHONY



WWW.THEMANWHOSAVEDTHEWORLDMOVIE.COM

# Missing Weapons?

- During the height of the Cold War, 68,000 nuclear weapons were active in the world
- Now down to 4,100
  - Less concern about having massive retaliation capability
  - More concern about losing a weapon

# Nuclear Realities

- No one in Washington is seriously interested in dismantling all American warheads
- The talk about doing so is just that—talk

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# Why Not Proliferate?

1. Threat of preventive war
2. Costs of proliferation
3. Bribes

# Preventive War

- Previously: *exogenous* power shifts cause preventive war if the shift is too large relative to the costs of conflict
- If shift is *endogenous* and visible, proliferator internalizes the credible preventive war threat and does not build
- No concessions necessary

# Preventive War

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- If shift is *endogenous* and visible, proliferator internalizes the credible preventive war threat and does not build
- No concessions necessary

Too Hot

How big is the power shift?

# Costs

- Nuclear weapons are not free
- Proliferation is an investment in the future
- If additional coercive power is not worth cost, proliferator does not build
- No concessions necessary

Too Cold

Too Hot

How big is the power shift?

# Bribes

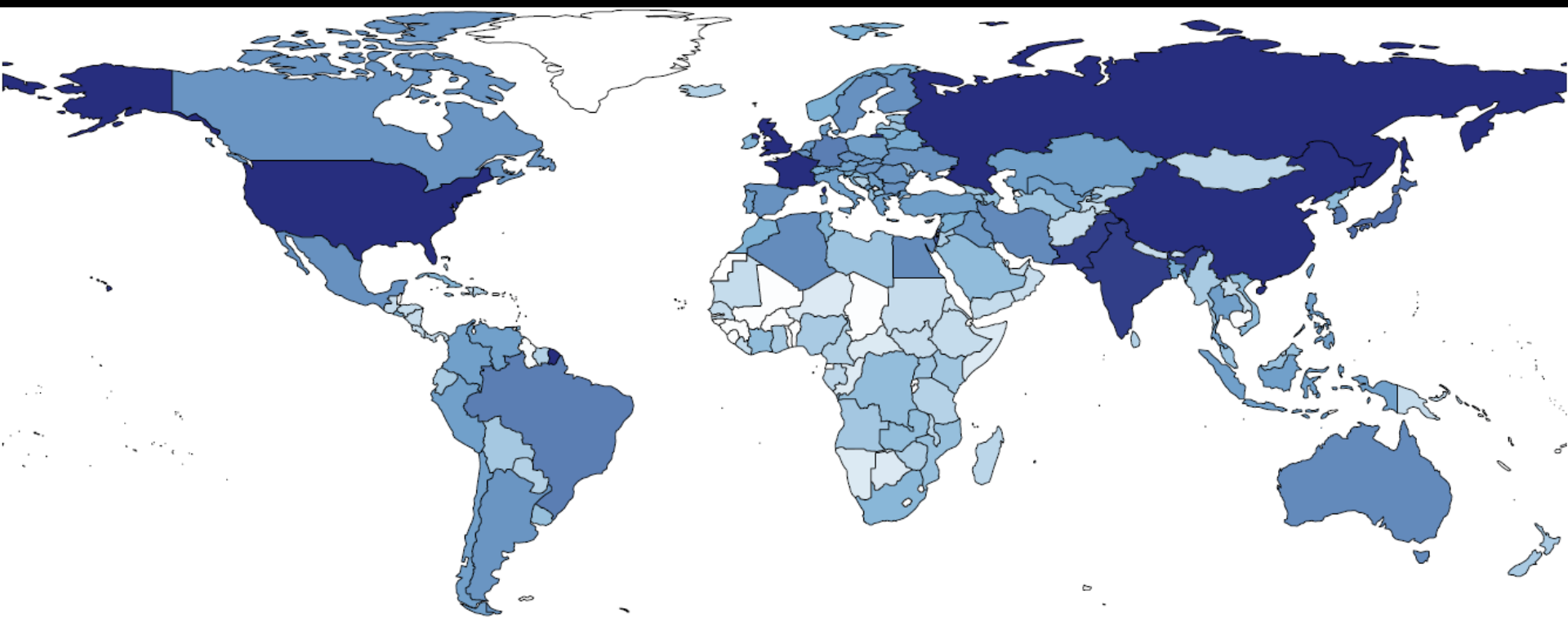
- Previously: more power => more concessions
- Why not just offer concessions as if proliferator already had nuclear weapons?
  - Proliferator has no incentive to build
  - Opponent doesn't have to deal with another nuclear country

Too Cold

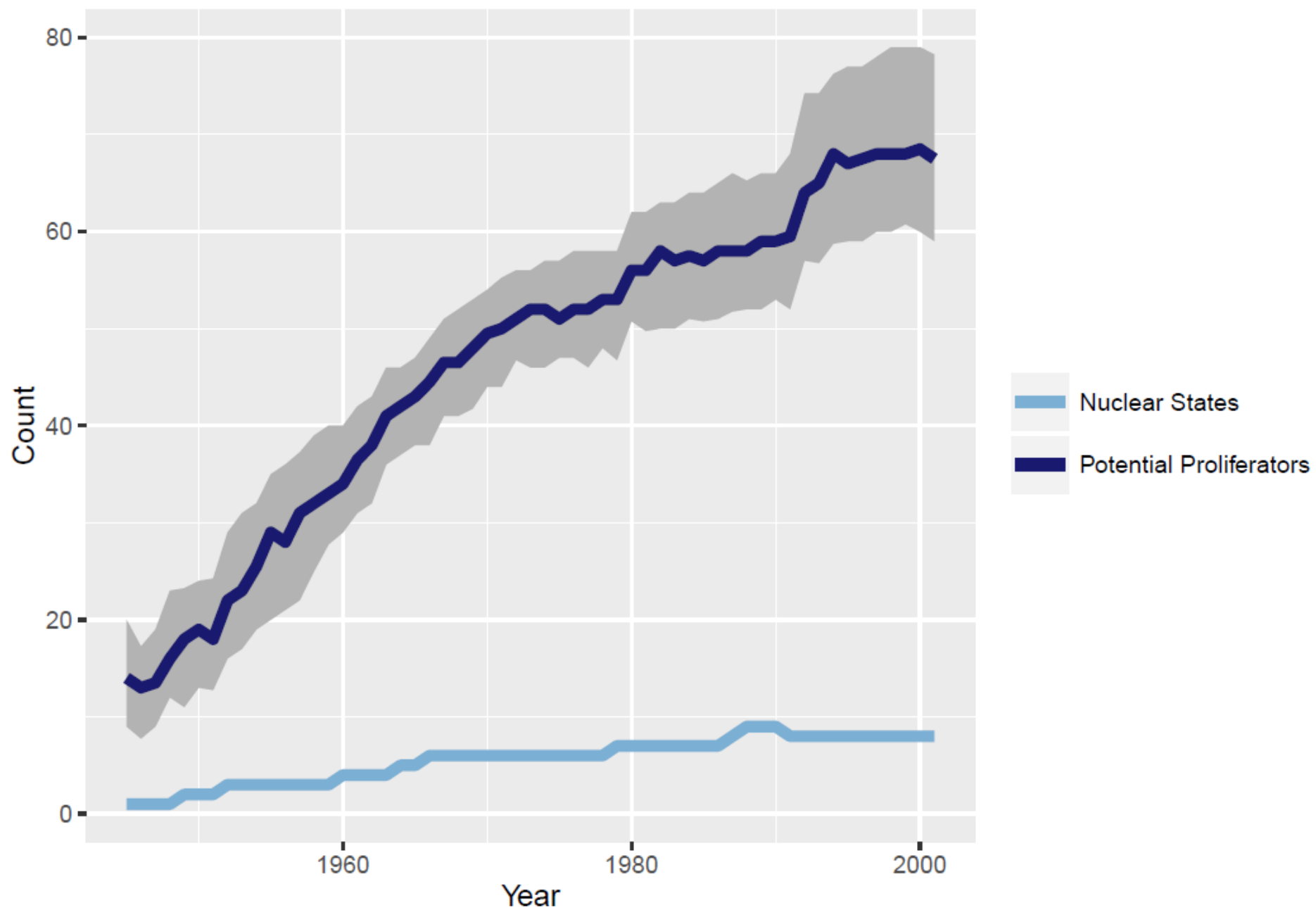
Just Right?

Too Hot

How big is the power shift?



# Capability and Proliferation Over Time



# Preventive War

- Previously: *exogenous* power shifts cause preventive war if the shift is too large relative to the costs of conflict
- If shift is *endogenous* and **visible**, proliferator internalizes the credible preventive war threat and does not build
- No concessions necessary

Too Hot

How big is the power shift?



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Covert Proliferation

Rising State

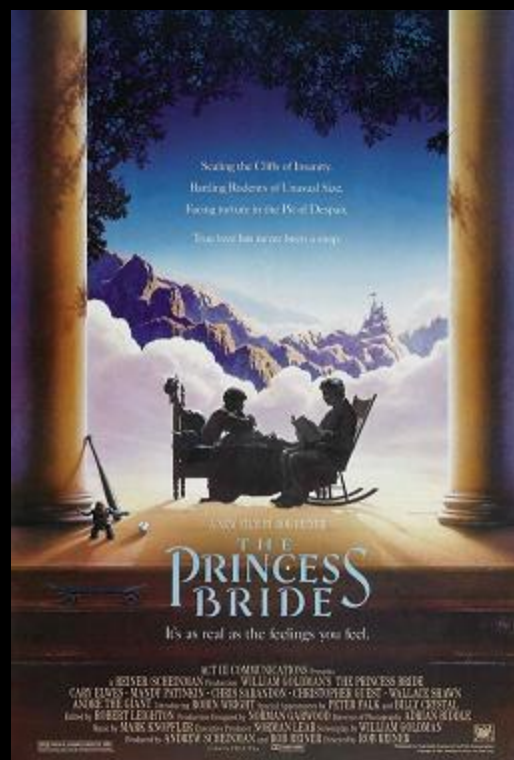
Declining State

Prevent

Peace

Build

Don't Build

Scaling the City of Iniquity.  
Hurling Hordes of Unwieldy Size.  
Facing torture in the Worst of Places.  
True love has never been a ruse.

AND OLIVER JACOBSON

# THE PRINCESS BRIDE

It's as real as the feelings you feel.

WILLIAM GOLDMAN'S SCREENPLAY BY ROBERT SWEENEY  
ROBERT SWEENEY PRODUCED BY WILLIAM GOLDMAN THE PRINCESS BRIDE  
CAST: ELLEN MARSH - VIVIAN - CHRISTOPHER GUEST - WALLACE SHAWN  
ANDRE THE GIANT Directed by BOB WEINSTEIN Special Appearance by PETER FALK and HILLY CRISTAL  
Edited by EUGENE LEVITZ Music composed by NORMAN OBRIDGE Directed by the composer ALAN SILVER  
Based on MARK SHAPIRO Screenplay by WILLIAM GOLDMAN  
Produced by ROBERT SWEENEY and BOB WEINSTEIN Screenplay by WILLIAM GOLDMAN  
Directed by ROBERT SWEENEY





Movie is so old Bears were actually good back then





Movie is so old Bears were actually good back then













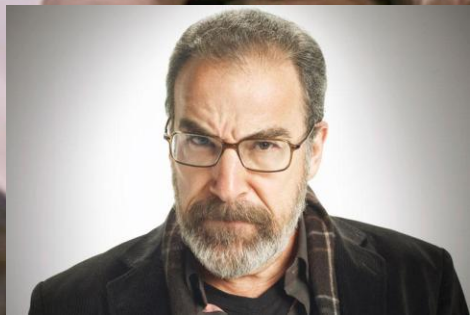




















[clip]

# Simple Soccer Penalty Kicks

- The striker aims left or aims right
- The goalie dives left or dives right
- Assume the striker and goalie are superhuman. How should they play?

## Penalty Kicks

## Goalie

## Striker

		Dive Left	Dive Right
Kick	Left	0, 0	1, -1
	Right	1, -1	0, 0

## Penalty Kicks

## Goalie

## Striker


		Dive Left	Dive Right
Kick	Left	0, 0	1, -1
	Right	1, -1	0, 0

## Penalty Kicks

## Goalie

## Striker

		Dive Left	Dive Right
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## Penalty Kicks

## Goalie

## Striker

		Dive Left	Dive Right
Kick	Left	0, 0	1, -1
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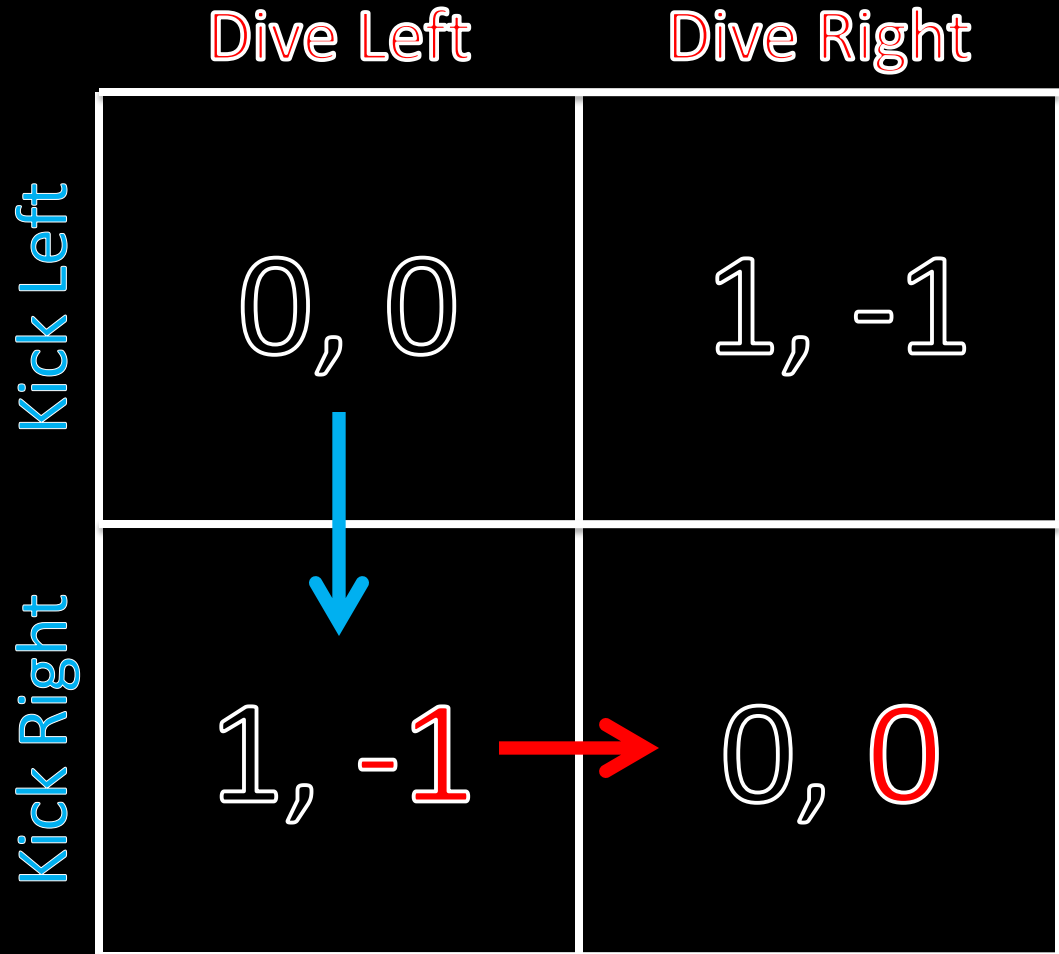


## Penalty Kicks

# Goalie

# Striker

		Dive Left	Dive Right
Kick	Left	0, 0	1, -1
	Right	1, -1	0, 0



A blue arrow points from the payoff (0, 0) in the (Kick Right, Dive Left) cell to the payoff (1, -1) in the (Kick Right, Dive Right) cell. A red arrow points from the payoff (1, -1) in the (Kick Right, Dive Right) cell to the payoff (0, 0) in the (Kick Left, Dive Right) cell.

## Penalty Kicks

# Goalie

# Striker

Kick Left  
Kick Right

Dive Left

Dive Right

0, 0

1, -1

1, -1

0, 0





## Penalty Kicks

# Goalie

# Striker

		Dive Left	Dive Right
Kick	Left	0, 0	1, -1
	Right	1, -1	0, 0

The diagram illustrates a game of Penalty Kicks between a Striker and a Goalie. The Striker chooses to Kick Left or Kick Right, and the Goalie chooses to Dive Left or Dive Right. The payoffs are shown in the matrix cells, with arrows indicating the best response for each player.

Payoff Matrix:

	Kick Left	Kick Right
Dive Left	0, 0	1, -1
Dive Right	1, -1	0, 0

Arrows indicate the best response for each player:

- Striker's best response to Dive Left is Kick Right (1, -1).
- Striker's best response to Dive Right is Kick Left (0, 0).
- Goalie's best response to Kick Left is Dive Right (-1).
- Goalie's best response to Kick Right is Dive Left (-1).

## Penalty Kicks

# Goalie

# Striker

		Dive Left	Dive Right
Kick	Left	0, 0	1, -1
	Right	1, -1	0, 0

Diagram illustrating the strategic interaction between a Striker and a Goalie during a Penalty Kick. The Striker chooses between Kick Left and Kick Right. The Goalie chooses between Dive Left and Dive Right. The payoffs (Striker, Goalie) are shown in the cells.

Arrows indicate the best response for each player:

- From (0, 0) to (1, -1) for the Striker (downward arrow).
- From (1, -1) to (0, 0) for the Striker (rightward arrow).
- From (1, -1) to (0, 0) for the Goalie (upward arrow).

## Penalty Kicks

# Goalie

# Striker

		Dive Left	Dive Right
Kick Left	Kick Right	0, 0	1, -1
		1, -1	0, 0

## Penalty Kicks

# Goalie

# Striker

		Dive Left	Dive Right
Kick	Left	0, 0	1, -1
	Right	1, -1	0, 0

The diagram illustrates a game of Penalty Kicks between a Striker and a Goalie. The Striker chooses to Kick Left or Kick Right, and the Goalie chooses to Dive Left or Dive Right. The payoffs are given as (Striker, Goalie).

Payoff Matrix:

	Dive Left	Dive Right
Kick Left	0, 0	1, -1
Kick Right	1, -1	0, 0

Arrows indicate best responses:

- From (0, 0) to (1, -1) (Striker's best response to Dive Left)
- From (1, -1) to (0, 0) (Goalie's best response to Kick Left)
- From (1, -1) to (0, 0) (Striker's best response to Dive Right)
- From (0, 0) to (1, -1) (Goalie's best response to Kick Right)

## Penalty Kicks

# Goalie

# Striker

		Dive Left	Dive Right
Kick Left	Kick Left	0, 0	.5, -.5
	Kick Right	1, -1	0, 0

Diagram illustrating the strategic form of the Penalty Kicks game. The Striker chooses between Kick Left and Kick Right. The Goalie chooses between Dive Left and Dive Right. The payoffs are shown in the cells, with arrows indicating the best response for each player.

Payoffs (Striker, Goalie):

- (Kick Left, Dive Left): 0, 0
- (Kick Left, Dive Right): .5, -.5
- (Kick Right, Dive Left): 1, -1
- (Kick Right, Dive Right): 0, 0

# Guessing Games!

- Penalty kicks are a guessing game
  - Makes players act randomly (but intelligently)
- Is preventive war also?

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- Why Not Proliferate?
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# Trivia Time!

- What was the original official military name for the Iraq War?



# Trivia Time!

- What was the original official military name for the Iraq War?

Operation

Iraqi

Liberation

# Trivia Time!

- What was the original official military name for the Iraq War?

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Covert Proliferation

Rising State

Declining State

Prevent

Peace

Build

Don't Build


Covert Proliferation

Rising State

Build

Don't Build

Declining State

Prevent

Peace

Prevent	Build	Don't Build
Peace		Status Quo

Covert Proliferation

Rising State

Build

Don't Build

Declining State

Prevent

Peace

War  
Payoffs

Status  
Quo

Covert Proliferation

Rising State

Declining State

Prevent

Peace

Build

Don't Build

War Payoffs  
& Wasted  
Costs

War  
Payoffs

Status  
Quo

Covert Proliferation

Rising State

Declining State

Prevent

Peace

Build

Don't Build

War Payoffs  
& Wasted  
Costs

War  
Payoffs

Successful  
Power  
Shift

Status  
Quo

Some Payoffs...

Rising State

Build

Don't Build

Declining State

Prevent

.6, .1

.6, .2

Peace

.3, .6

.8, .2

	Build	Don't Build
Prevent	.6, .1	.6, .2
Peace	.3, .6	.8, .2



Covert Proliferation

Rising State

Declining State

Prevent

Peace

Build

Don't Build

War Payoffs  
& Wasted  
Costs

War  
Payoffs

Successful  
Power  
Shift


Status  
Quo

Covert Proliferation

Rising State

Declining State


		Build	Don't Build
Prevent Peace	Prevent	War Payoffs & Wasted Costs	War Payoffs
	Peace	Successful Power Shift	Status Quo



Covert Proliferation

Rising State

Declining State

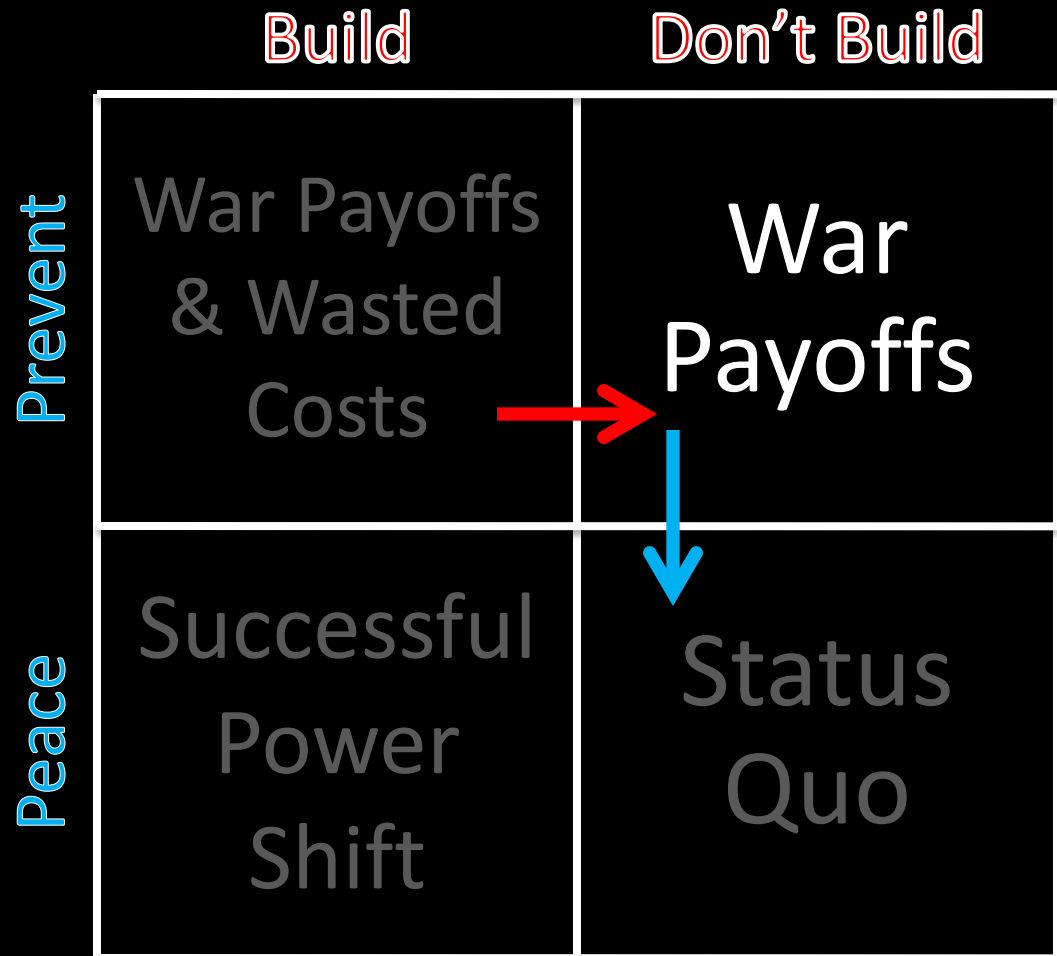
		Build	Don't Build
Prevent	War Payoffs & Wasted Costs	 War Payoffs	
Peace	Successful Power Shift	Status Quo	

Covert Proliferation

Rising State

Declining State

		Build	Don't Build
Prevent	Peace	War Payoffs & Wasted Costs	War Payoffs
	Peace	Successful Power Shift	Status Quo

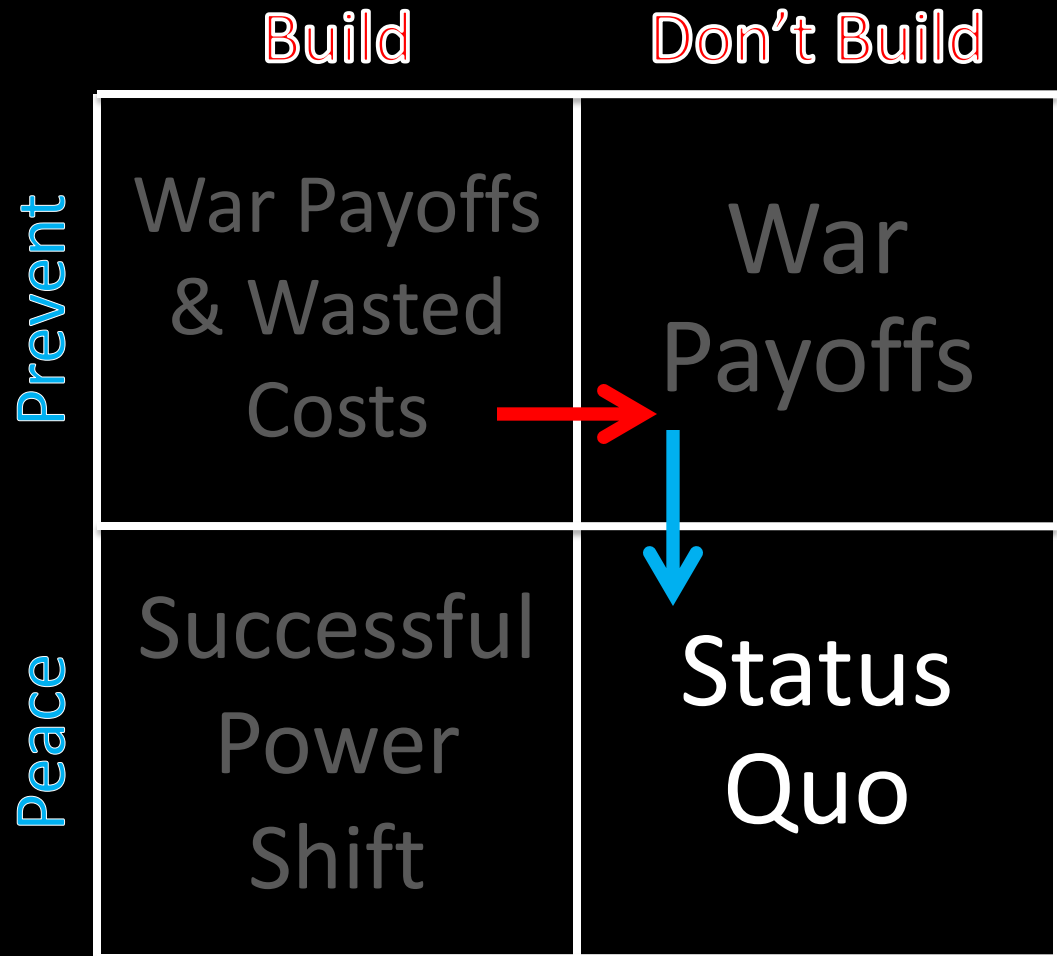


Covert Proliferation

Rising State

Declining State

		Build	Don't Build
Prevent	Peace	War Payoffs & Wasted Costs	War Payoffs
	Peace	Successful Power Shift	Status Quo

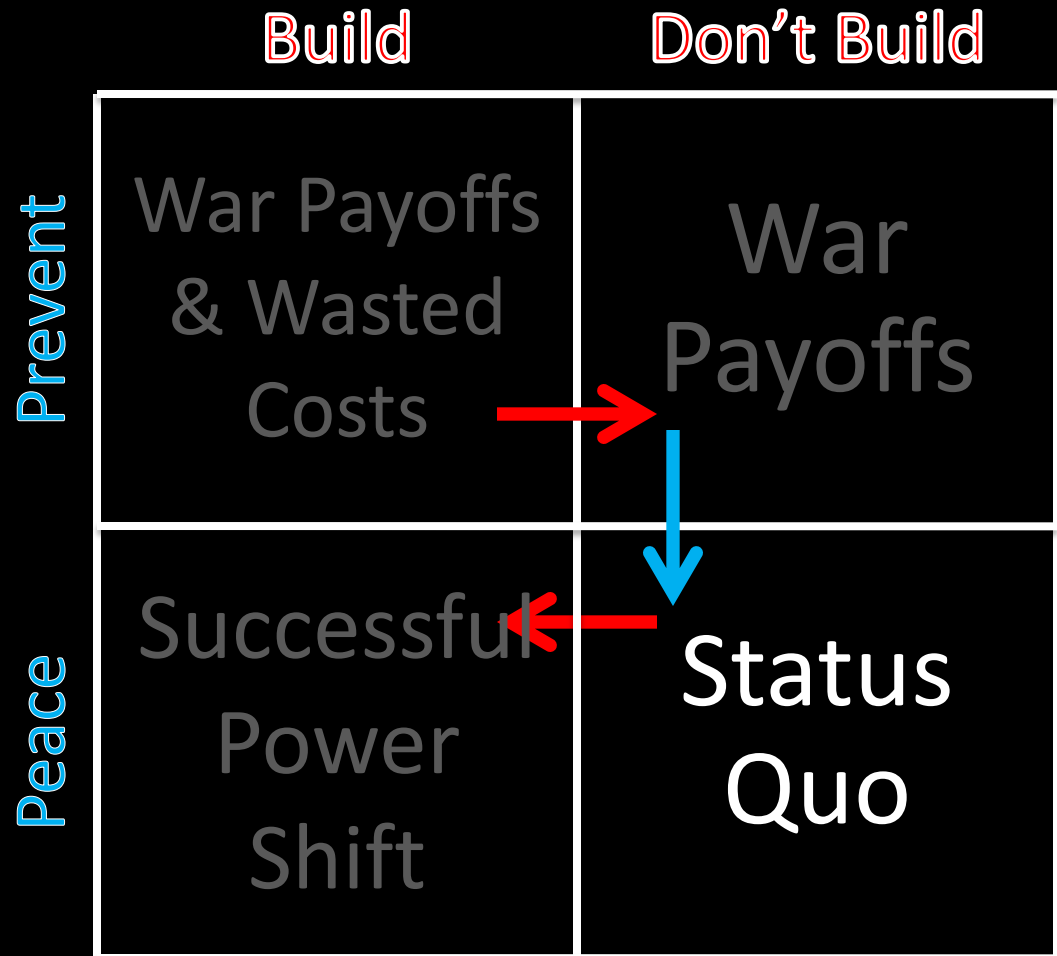


Covert Proliferation

Rising State

Declining State

		Build	Don't Build
Prevent	Peace	War Payoffs & Wasted Costs	War Payoffs
	War	Successful Power Shift	Status Quo



Covert Proliferation

Rising State

Declining State

		Build	Don't Build
Prevent	Peace	War Payoffs & Wasted Costs	War Payoffs
	War	Successful Power Shift	Status Quo

The diagram illustrates a strategic interaction between a Rising State and a Declining State. The Rising State chooses between 'Build' and 'Don't Build'. The Declining State chooses between 'Prevent' and 'Peace'. The resulting payoffs are as follows:

- If the Rising State 'Builds' and the Declining State 'Prevents', the outcome is 'War Payoffs & Wasted Costs'.
- If the Rising State 'Builds' and the Declining State 'Peaces', the outcome is 'Successful Power Shift'.
- If the Rising State 'Doesn't Build' and the Declining State 'Prevents', the outcome is 'War Payoffs'.
- If the Rising State 'Doesn't Build' and the Declining State 'Peaces', the outcome is 'Status Quo'.

Arrows indicate a sequence of events: a red arrow points from 'War Payoffs & Wasted Costs' to 'War Payoffs', a blue arrow points from 'War Payoffs' to 'Status Quo', and a red arrow points from 'Status Quo' to 'Successful Power Shift'.

Covert Proliferation

Rising State

Declining State

	Build	Don't Build
Prevent	War Payoffs & Wasted Costs	War Payoffs
Peace	Successful Power Shift	Status Quo



Covert Proliferation

Rising State

Declining State

		Build	Don't Build
Declining State	Prevent	War Payoffs & Wasted Costs	War Payoffs
	Peace	Successful Power Shift	Status Quo

Covert Proliferation

Rising State

Don't Build

Declining State

Prevent

	War Payoffs

Covert Proliferation

Rising State

Don't Build

Declining State

Prevent

	Mistaken Preventive War

# What Are You Buying?

- Do you accept that the U.S. should have invaded Iraq if Iraq had a WMD program?
- Do you accept that the U.S. could not adequately monitor Iraqi activity?

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- Do you accept that the U.S. could not adequately monitor Iraqi activity?
- If yes, you accept that mistaken preventive war is rational
  - It just looks silly after the fact!

# What Are You Buying?

- Do you accept that the U.S. should have invaded Iraq if Iraq had a WMD program?
- Do you accept that the U.S. could not adequately monitor Iraqi activity?
- If yes, you accept that mistaken preventive war is rational
  - It just looks silly after the fact!