PONI Capstone Conference
Offutt Air Force Base
June 15, 2023

Learn more about the *Project on Nuclear Issues* at the Next Generation Nuclear Network

nuclearnetwork.csis.org

Keynote Address: Rear Admiral Anthony Carullo, Director, Plans and Policy (J5), U.S. Strategic Command

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Panel 1: Understanding Adversaries' Thinking

Moderator: Dr. John Emery

Panelists: Annika Kastetter, Elliot Ji, Hannah Harris

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From

SLBMs

to

Shooting

Stars

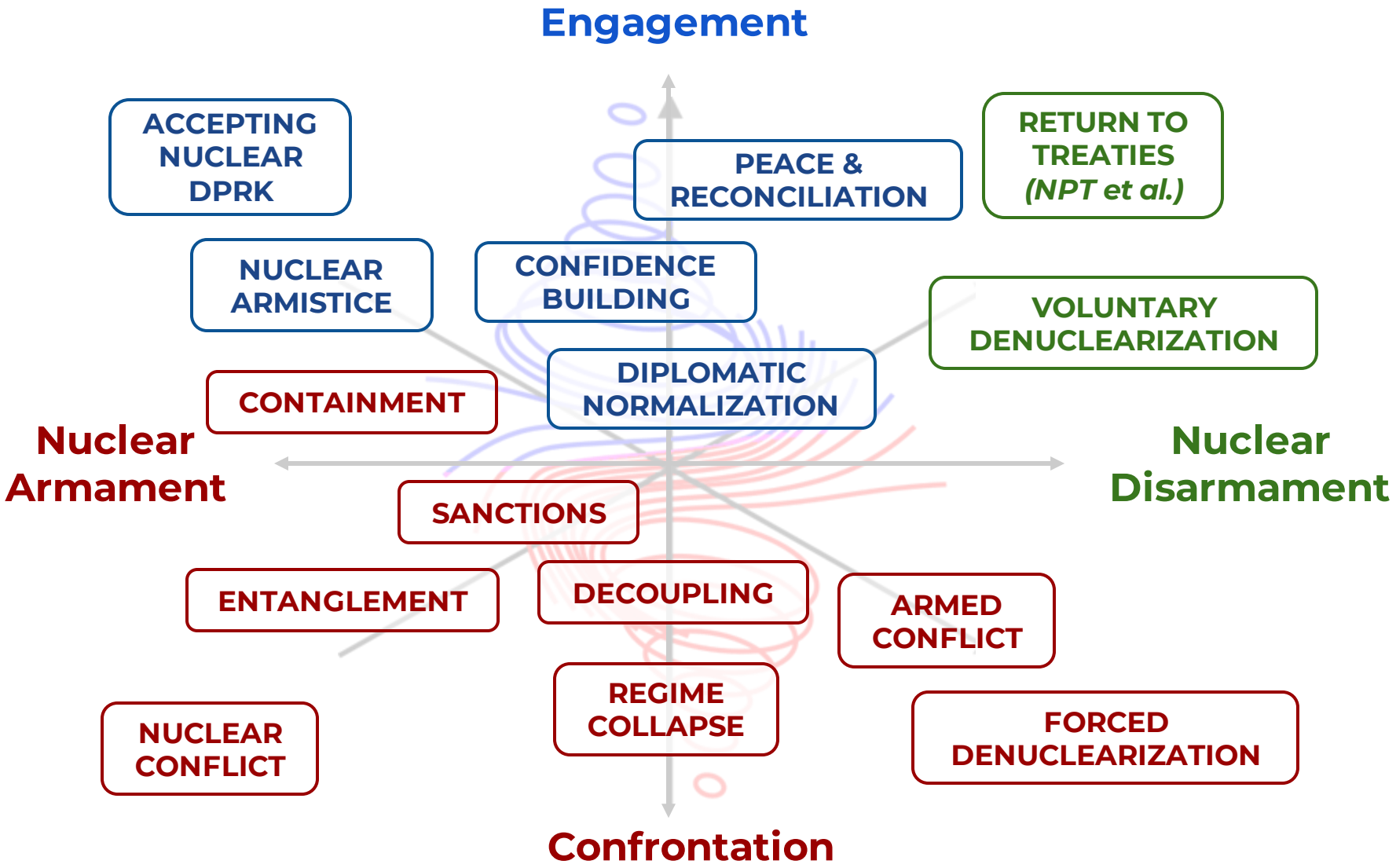
NUCLEAR RISK REDUCTION *VIA* SCIENTIFIC COOPERATION *WITH* NORTH KOREA

Hannah E. Harris

CSIS PONI Capstone Conference 2023
U.S. Strategic Command, Offutt Air Force Base

US-DPRK relations: Where do we go from here?

What role does **science** play?



B *ottom*
L *ine*
U *p*
F *ront*

Denuclearization diplomacy has *not* achieved CVID of DPRK missile & nuclear enterprises

Shift to a *"human rights up front"* approach with DPRK has strengths and weaknesses

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L *ine*
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RECOMMENDATION:

US-DPRK scientific cooperation *as* **nuclear risk reducer**

B*ottom* **L***ine* **U***p* **F***ront*

Denuclearization diplomacy has *not* achieved CVID of DPRK missile & nuclear enterprises

Shift to a *"human rights up front"* approach with DPRK has strengths and weaknesses

RECOMMENDATION:

US-DPRK scientific cooperation *as* nuclear risk reducer

" US-DPRK Cooperative Threat *Transformation* "

Astro *for* Non-Pro. *via* Sci/Diplo. *with* North Korea

Road Map

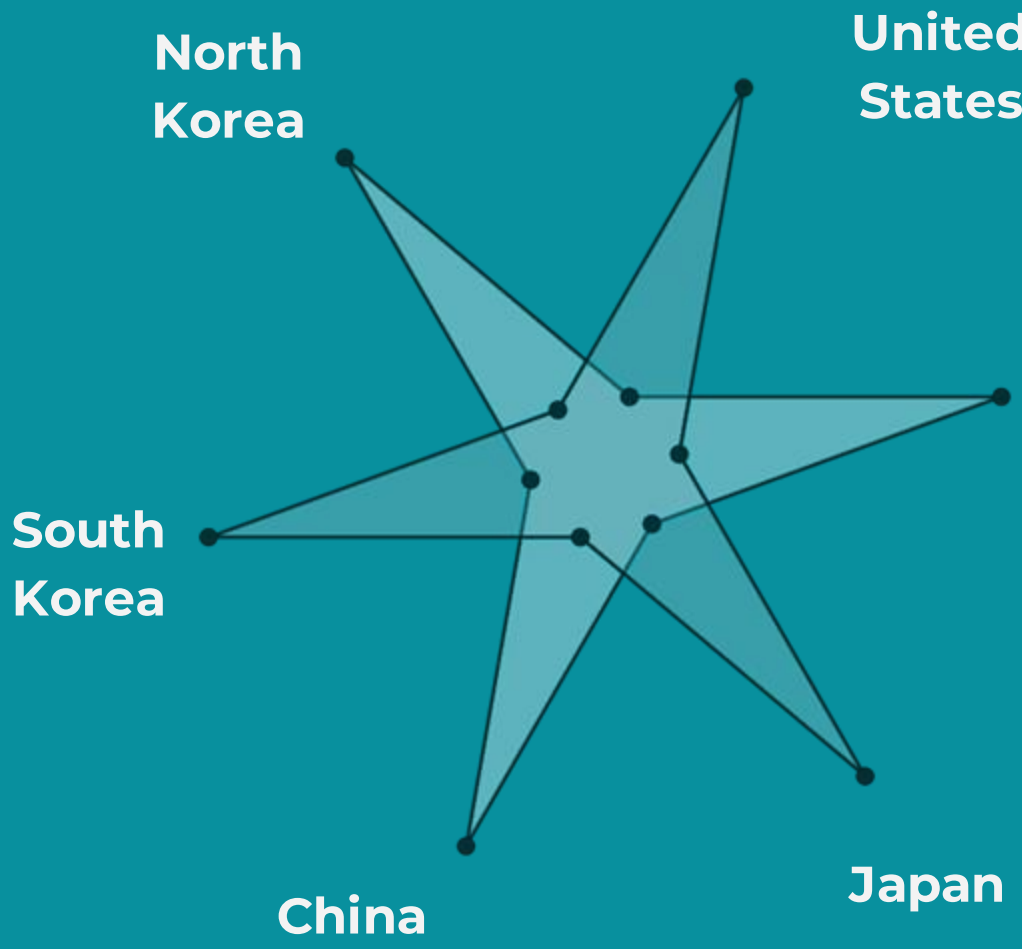
Part 1: <u>Why</u> the US should cooperate with North Korea on science, and astrophysics more specifically:

1. Historic precedence & current state of int'l science cooperation
2. Complementarity of nuclear and astro physics
3. Unique role of astronomy in Korean history and statehood

Part 2: <u>What</u> should this cooperation look like?

1. "Science-for-science" as a strategic deal
2. A concept for "US-DPRK Cooperative Threat *Transformation*"

Scientific Cooperation *for* Nuclear Diplomacy



Korean Peninsula Energy Development Organization (1995-2006)

Nunn-Lugar Cooperative Threat Reduction (1991)

“Peaceful” use? “Dual” use? It’s all just *use* in science!

*A*strophysics *(as pre- & co-requisite) for* *N*uclear *C*apacity & *S*ecurity

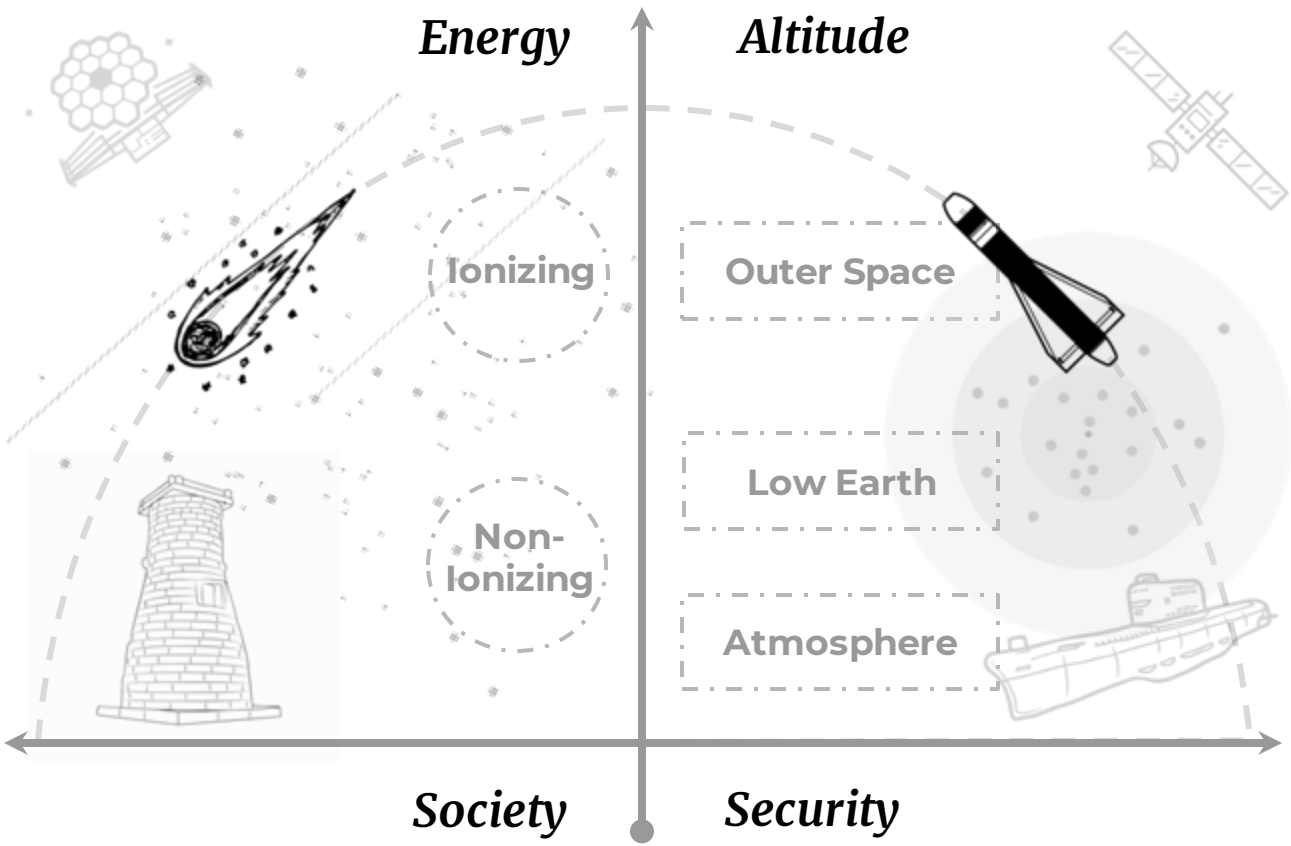
HIGH RESOLUTION
FULL SPECTRUM
PRECISION
"SEEING"

DIPLOMACY

EDUCATION

ONTOLOGICAL SECURITY

"BIG" QUESTIONS



NEUTRONICS

NC3 & GPS

BIG DATA

INTEL

BALLISTICS

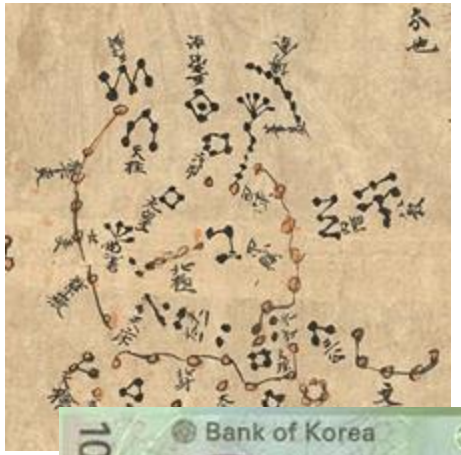
TIMEKEEPING

INFRASTRUCTURE

Astrophysics *has* unique utility *for* diplomacy *with* North Korea

~1300 b. c.

Ancient astronomical data: early classified intelligence



~800 b. c.

Astronomy capacity essential to statehood, negotiation, deterrence

1950s-1980s

North Korean cosmology legitimizes Kim Regime

1960s - TODAY

Six Decades* of IAU-DPRK Cooperation

1957

Opening of Pyongyang Astronomical Observatory

Road Map

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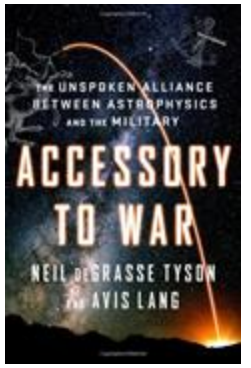
A Strategy of "Science-for-Science"

1. Unlike **WMD nonproliferation** and **human rights**, arguments of **scientific value** are *less* polarizing & subjective
2. <u>"Science-for-science" deal:</u> weakens appeal of asymmetric, sanctions-fueled "arms-for-food" offers; science is a *"no-BS"* and *"no spin zone"*
3. <u>Costs of opting-out are non-trivial:</u>
    a. Isolation is antithetical to scientific progress
    b. **Anti-science rhetoric** and **prosecution of scientists** damages credibility domestically and internationally (See: China & COVID-19)



US-DPRK Cooperative Threat Transformation

Panel 2: Alliance Coordination and Assurance

Moderator: Dr. Jennifer Bradley

Panelists: Karl Riedel, Josh Chang, Jasmin Alsaied

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A Hitchhiker's Guide to Japanese Nuclear Latency

Karl Riedel

"Japan should discuss a possible sharing of nuclear weapons similar to that of NATO members in the wake of the Russian invasion of Ukraine."

February 27th, 2022

China rattled by calls for Japan to host US nuclear weapons

Will Ukraine invasion push Japan to go nuclear?

By Rupert Wingfield-Hayes
BBC News, Tokyo

The legacy of Shinzo Abe: a Japan divided about nuclear weapons

By Sayuri Romei | August 24, 2022

How Japan Could Go Nuclear

It Has the Smarts and the Resources, but Does Tokyo Have the Will?

By Mark Fitzpatrick October 3, 2019

Outline

Main Arguments:

- Hawkish pro-nuclear comments are a symptom of a well-established pattern in the US-Japan security relationship that are intended to court security assurances from Washington
- Japan *could* theoretically proliferate VERY well, but is *highly unlikely* to be able to for cultural-political reasons
- The biggest driving factor behind this entire problem stem from how the US conducts its security relationships with its East Asian partners

Outline

1. Japan's Proliferation Capabilities in Context
2. Proliferation Incentives
3. The Strategy of Ambiguity
4. Policy Recommendations

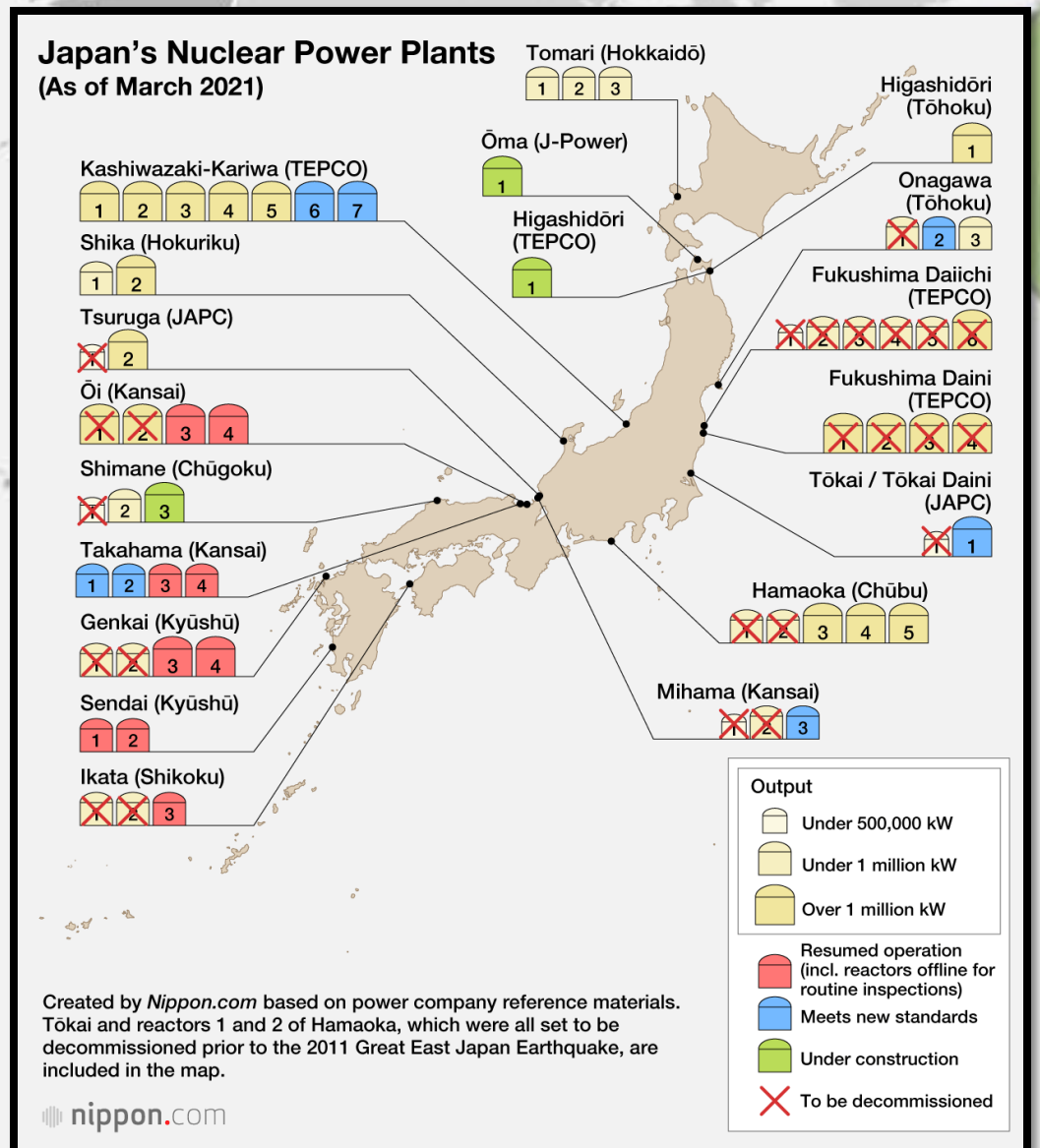
Part 1

Japan's Nuclear Capability

"As the level of our nuclear technologies increases for peaceful purposes, it will increase for military purposes, too . . . By improving our nuclear latency potential"

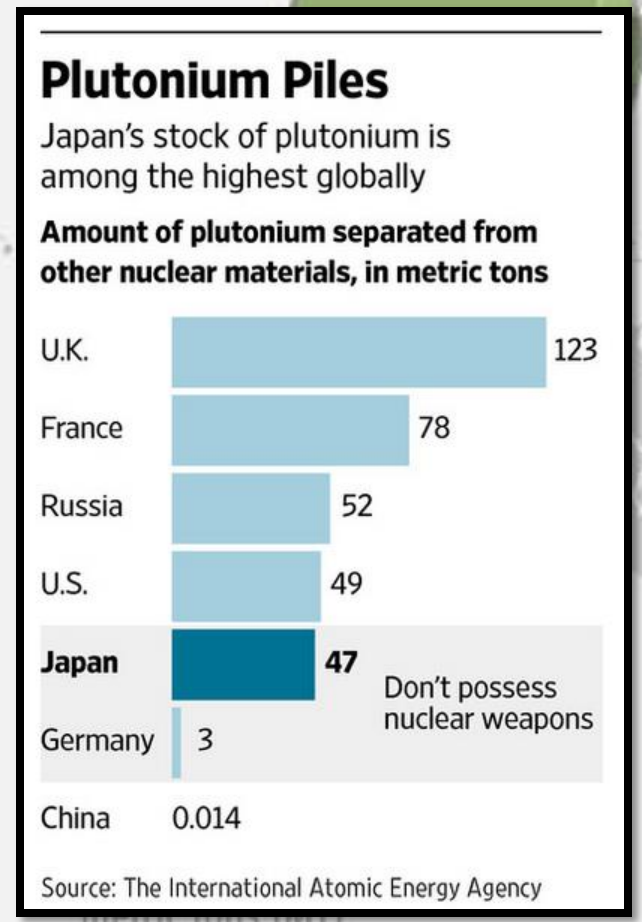
Prime Minister Nobusuke Kishi
Excerpt from Memoirs Published in 1983

Japan as a “Para-Nuclear State”



- As of early 2022, Japan has 33 *operable* reactors, located at 17 different plants across the country.
- Only 10 reactors are currently operating, with the majority in some form of restart application or upgrade process.
- Japan also boasts a highly-advanced commercial, industrial, and nuclear industry.

Japan as a “Para-Nuclear State”



- **Japan Has a lot of Plutonium.**
- **Currently, only 11,000kg (~20%) exists in their domestic inventory. The rest is located overseas in the UK and France.**
- **Japan *theoretically* has enough plutonium stockpiled to create thousands of nuclear weapons.**

Japanese Breakout Time: However Long You Want it to be

"Japan could make a nuclear device in five weeks"
Yevgeny Primakov
Former Director of the Foreign Intelligence Service

Japan Has Nuclear 'Bomb in the Basement,' and China Isn't Happy

By Robert Windrem

No nation has suffered more in the nuclear age than Japan, where atomic bombs flattened two cities in World War II and three reactors melted down at Fukushima just three years ago.

But government officials and proliferation experts say Japan is happy to let neighbors like China and North Korea believe it is part of the nuclear club, because it has a "bomb in the basement" -- the material and the means to produce nuclear weapons within six months, according to some estimates. And with tensions rising in the region, China's belief in the "bomb in the basement" is strong enough that it has demanded Japan get rid of its massive stockpile of plutonium and drop plans to open a new breeder reactor this fall.

80

FAS Federation of American Scientists

ower program based on reprocessed plutonium has aroused widespread suspicion that Japan i
lerable nuclear potential, becoming a "paranuclear state." Japan would not have material or te
Japan could possibly produce functional nuclear weapons in as little as a year's time. On the
rs as, as a virtual nuclear weapons state. The Japanese people's abhorrence of nuclear weapo
an acquiring nuclear weapons unlikely.

Pu stock
metric tons (MT)

Kaku Danto Shisaku ni 3nen Ijo Sankei Shimbun, December 25, 2006.

Reportedly, after North Korea launched ballistic missiles in July 2006, a senior Japanese official led an internal assessment of Japan's capability to produce a small nuclear warhead.[101] This internal assessment concluded in September 2006 that it would take at least 3 to 5 years for Japan to produce a prototype of small nuclear warhead, with the investment of 200 to 300 billion yen (approximately U.S. $1.7-2.5 billion, assuming an exchange rate of U.S. $1= YEN120) and a few to several hundreds of experts and engineers.[102] This surprising revelation was reported in December 2006, two months after the North Korea's nuclear test in October. In fact, however, this examination had been already concluded in September prior to North

Part 2

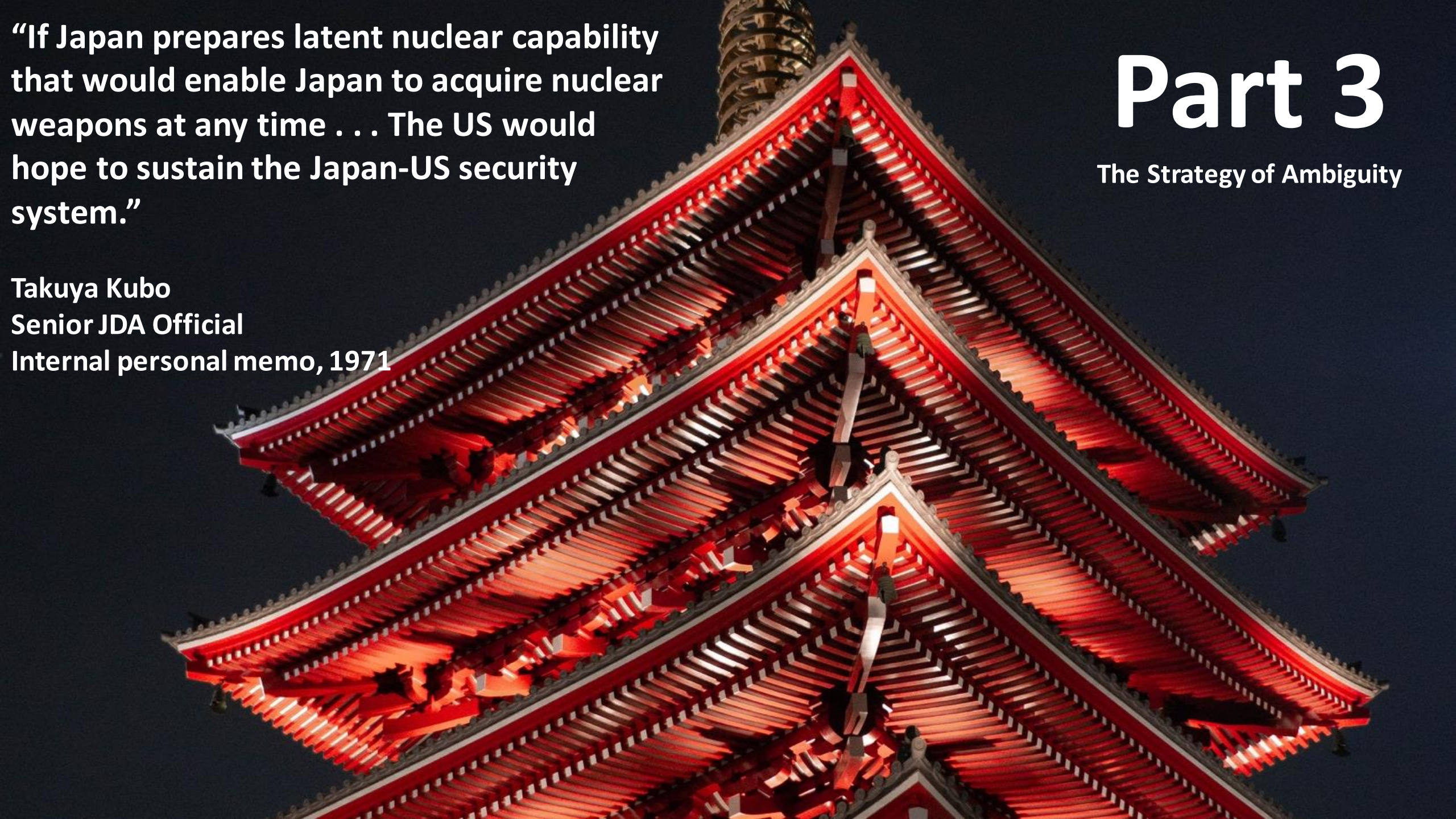
Proliferation Incentives

"If Chicoms ha[ve] nuclear weapons, the Japanese also should have them…"

Eisaku Satō
Japanese Prime Minister
In Private meeting with L.B.J.
January 1964

- China, DPRK, Russia
- Taiwan Strait Crisis
- Ukraine War
- Uncertainty of US nuclear umbrella

- Hiroshima, Nagasaki, Lucky Dragon, Fukushima Daiichi (2011)
- 75%+ strongly in favor of signing the TPNW
- 50%~ oppose reforming Article IX



Part 3

The Strategy of Ambiguity

“If Japan prepares latent nuclear capability that would enable Japan to acquire nuclear weapons at any time . . . The US would hope to sustain the Japan-US security system.”

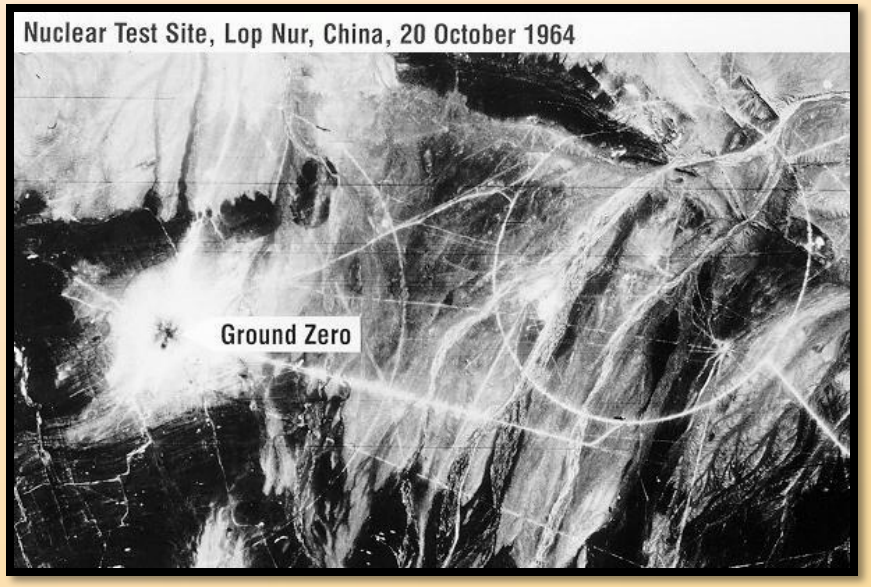
Takuya Kubo
Senior JDA Official
Internal personal memo, 1971

The Insecurity-Ambiguity-Assurance Pattern

Abe Shinzo
Prime Minister
2006-2007
2012-2020

- October 9th, 2006: DPRK tests first nuclear device
- Foreign Minister Taro Aso publicly calls for debate on what conditions require revisiting nuclear development issue
- 10 days later, Condoleezza Rice reaffirms US commitment to extended deterrence in visit to Tokyo

Eisaku Satō
Prime Minister
1964-1972




The Japan Times
'All the News Without Fear or Favor'
SATURDAY, OCTOBER 17, 1964
LATE CITY EDITION
20 Yen

Red China Explodes A-Bomb

U.K. Labor Wins by Bare Majority

Statement Couples Test With Call for Summit On Banning All N-Arms

Wilson Moves Into Coveted Downing St.

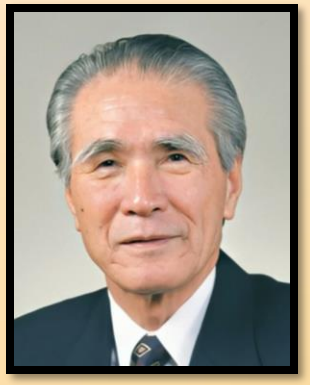
World Mark for Kathy
U.S. Wins 2 More Swim Gold Medals

Suzuki Voices 'Protest' Against Test

- October 16th, 1964: **China tests their first nuclear device**
- November 9th, 1964: Sato assumes office
- January 1965: Informs LBJ in private communication of desire to develop NWs
- Johnson Administration becomes anxious about proliferation risk, focuses on convincing Sato administration to sign the NPT
- 1969-72: Despite having both **reasons** and **desire** to proliferate, Sato is forced to have US nuclear weapons removed from Okinawa during the reversion process due to overwhelming political pressure.

Kiichi Miyazawa
1991-1993

Morohiro Hosokawa
1993-1994



Tomiichi Murayama
1994-1996

Ryutaro Hashimoto
1996-1998

Economy? STRUGGLING

China? RISING

North Korea? PLUTONIUM PRODUCTION

Relationship with US? LEFT ON "READ"

NPT Indefinite Extension? COMING UP

- Nuclear ambiguity tactic not employed
- Japan becomes obsessed with the idea that the U.S. must maintain 100,000 troops in Asia

Policy Recommendations

Rethinking our East Asian Relationships

The Issues

- The nuclear umbrella is ambiguous, uncertain, and unproven.
- This continued focus on the nuclear umbrella gives hawkish administrations an effective but counter-productive tool to court security assurances.
- This scenario suffocates Japan's pro-disarmament population and simultaneously wastes the U.S. and Japan's diplomatic & strategic capital.

Possible Solutions

1. Upgrade our extended deterrence framework via the NATO model. Integrate our East Asian allies into a more substantive, practiced nuclear umbrella structure of security relationship.

2. *Deemphasize* the nuclear umbrella. Instead, focus on a more concrete and sustained collective-defense relationship.

Extended Deterrence Satisfaction Guaranteed? ROK and Japanese Views of GBSD and U.S. Nuclear Modernization




Josh Chang

June 15, 2023

CSBA
Center for Strategic and Budgetary Assessments

BLUF

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U.S. extended nuclear deterrence will require further discussions on joint operationalized planning between Washington and its allies, which will strengthen U.S. credibility and clarify the capabilities and resources needed to sustain a joint deterrent posture.

Research Questions

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1. What do U.S. allies think about U.S. nuclear modernization?

2. To what extent to do allied views of U.S. modernization affect their perceptions of the overall extended deterrence relationship?

Roadmap

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- Background on U.S. Nuclear Modernization
- Purpose of Study
- Framing U.S. Extended Nuclear Deterrence
- Takeaways & Implications

Background

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- United States seeking to overhaul and upgrade aging nuclear triad.
- Debate about the costs, necessity, and relevance of certain modernization programs.

U.S. Nuclear Modernization Program
• LGM-35A Sentinel (GBSD) • Long Range Standoff Weapon (LRSO) • B-21 Raider • Columbia-class Ballistic Missile Submarine (SSBN) • NC3 Infrastructure, Platforms, and Networks • B-61 Mod 12 • F-35A Nuclear Certification

Purpose of Study

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- Domestic views of programs such as Sentinel are well documented, but very little focus on allied views of U.S. nuclear modernization.
- Why does this matter?
  - More than 30 countries covered by U.S. nuclear umbrella.
  - Besides U.S. declaratory policy and strategy, do aging nuclear capabilities and delayed modernization make allies nervous about the credibility of the U.S. arsenal?
  - Surveying allied views of modernization as a way to shed light on their views of extended deterrence.

Why Focus on South Korea and Japan

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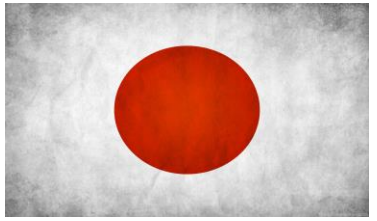
- Rough nuclear neighborhood: diversifying and expanding nuclear arsenals of PRC and DPRK.
- Recent Statements/Claims/Developments:
  - President Yoon: ROK indigenous nuclear capability.
  - Late PM Abe: NATO-style nuclear-sharing.
  - Washington Declaration: Greater ROK voice in nuclear planning, U.S. SSBN port visits, & formation of Nuclear Consultative Group (NCG) in exchange for ROK adherence to NPT.
- Extended deterrence mechanisms, institutions, and structure in East Asia not as fleshed out as those in EUCOM/NATO.



Framing U.S. Extended Nuclear Deterrence

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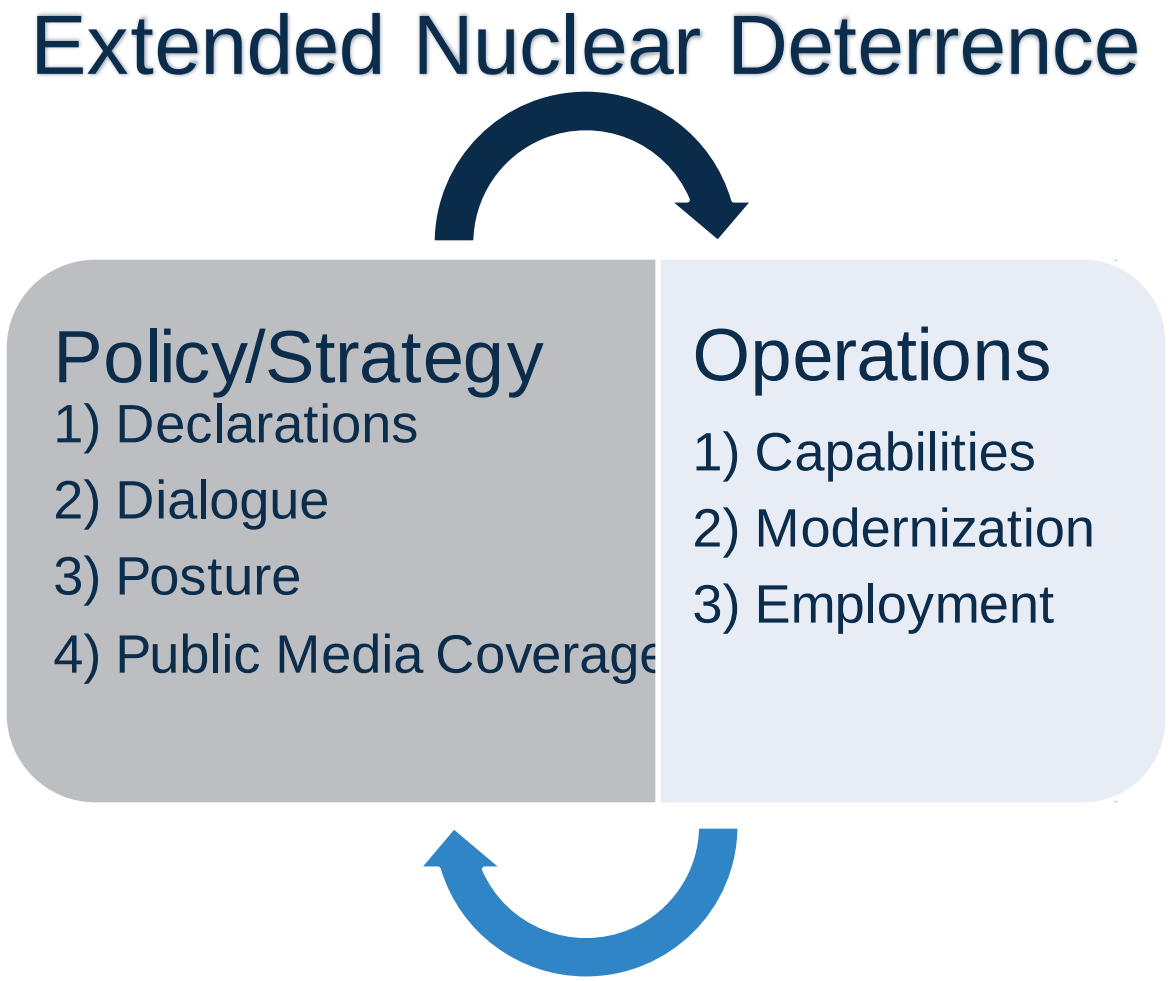

Themes and Takeaways: Mulling Modernization

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Modernization is unequivocally important. Washington should not have delayed it.

Modernization is not the be-all, end-all of extended deterrence. Also matters how the United States employs newly-acquired capabilities.

All parts of the triad and non-strategic nuclear capabilities are critically important. Modernization is about full rejuvenation of the entire triad **AND** supporting NC3.

based assets in nuclear signaling and deterrence

2. Strategic vs. Theater-Level

3. Conventional vs. Nuclear Extended

Themes and Takeaways: Clarity through Comms

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Allies sought clarification on the following issues:

How would U.S. nuclear capabilities be employed in a crisis or conflict?

What are the programs being modernized? How long will modernization take? How will U.S. nuclear force structure evolve in the long-term?

What are the divisions of labor between the United States and its allies in an extended deterrence arrangement?

How should the United States and its allies manage expectations and better communicate with one another on extended deterrence issues?

Policy Implications and Further Questions

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Moving beyond declarations and policy: what does an operational division of labor look like between the United States and its allies for extended nuclear deterrence?

How does Washington reconcile sovereign decision-making over nuclear planning and classification issues regarding employment guidance with the need to keep allies in the loop?

Reassurance mechanisms for alliances under the U.S. nuclear umbrella and the Washington Declaration as a guiding template for strengthening U.S. extended deterrence.

Framing U.S. Extended Nuclear Deterrence

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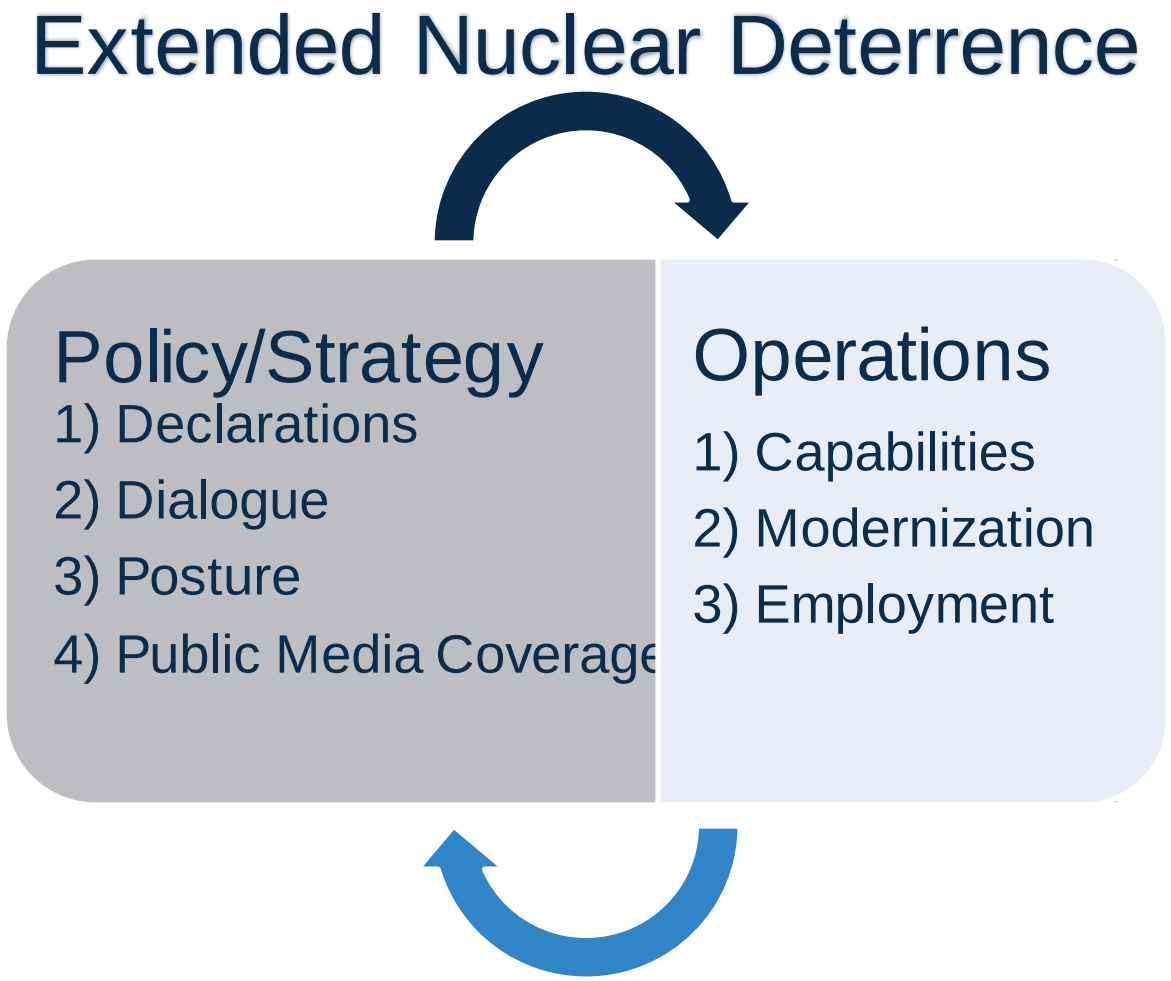

BLUF

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U.S. extended nuclear deterrence will require further discussions on joint operationalized planning between Washington and its allies, which will strengthen U.S. credibility and clarify the capabilities and resources needed to sustain a joint deterrent posture.

Questions?

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AUKUS Security Pact: A New Precedent for NNWS

LT Jasmin Alsaied

Surface Warfare Officer, United States Navy

Publication thanks to Center for Strategic and International Studies, Project on Nuclear Issues, Nuclear Scholars Initiative

Primer

- AUKUS Pact: Australia, United Kingdom, United States
  - Information Sharing rights, platforms
  - Intensified US force laydown, posture within the Indo-Pacific
  - Construction and delivery of nuclear-propelled submarines (with conventional weapon capabilities)
  - Other quantum, cyber, AI, hypersonic capabilities to be released/determined
- Trilateral partnership announced in SEP 2021
- Announcement after the cancellation of the French-Australian submarine deal (worth 56 million euros)

BLUF

AUKUS can support the safe and effective delivery of nuclear-powered submarines and set precedent for future Article 14 arrangements

Australia- a NNWS- is a model case due to their stringent adherence to safeguards and nuclear nonproliferation advocacy

Roadmap

- Potential for Precedent
- Technical Challenges
- AUKUS Options
- Article 14
- Future Actions and Moving Forward

Challenges to Australia’s Request

Technical Challenges

- Fuel enrichment capabilities, fuel delivery shipment
- Details of construction, transport, storage of nuclear/sensitive material
- Spent fuel management
- Burden of responsibility to protect sensitive information but provide clarity to IAEA

AUKUS Options

- US-UK construction and delivery
    - core intact and sealed prior to delivery to
  - Allows for engagement with the IAEA
  - Upholds NPT norms by allowing minimal chance to loss to export
  - Spent fuel, material, classified information would return to the custody of the US and UK for proper storage, destruction and application of safeguards

Invocation of Article 14

- Invoked under peaceful military nuclear uses, such as propulsion
- Requires states to not use nuclear material to build nuclear weapons or explosive devices and that material is not in conflict with any other undertaking of the state

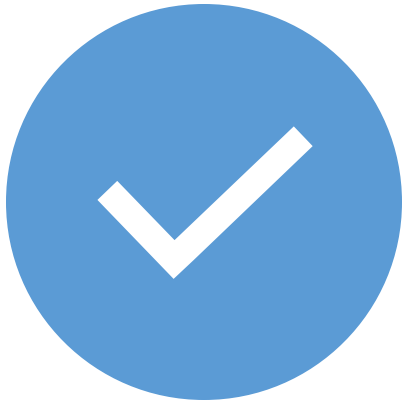
Requires coordination, discussion, and ultimate approval by IAEA

Provides plan to ensure no material is "lost to export"

Protects classified nature, sensitive technology of AUKUS partners

- Australian Prime Minister wrote to the IAEA on **14 March** expressing intent to invoke the paragraph 14 exemption

IAEA Advisory Services



ADDITIONAL PROTOCOL

ANCILLARY DOCUMENTS

COMPREHENSIVE SAFEGUARDS AGREEMENTS

Future Actions

- Phased Approach w/ Unanswered Questions
  - Fuel enrichment
  - Congressional approval
- Geopolitics remains important
  - NPT RevCon: AUKUS became large agenda item
  - China's reactions to AUKUS
- **Internal and External Messaging**
  - IAEA
  - AUKUS partners

Moving Forward

- **AUKUS pact will strengthen and uphold NPT norms**
  - If done using the Article 14 exemption, other states could also pursue nuclear-propelled submarine programs and strengthen nonproliferation norms
- AUKUS partners are dedicated to positively engaging with the Board of Governors and the IAEA
  - Continue to use internal and external messaging to build confidence
- AUKUS is an exercise in widening Australia's **nuclear tolerance**
  - **No safeguards ≠ no verification**

Keynote Address: Frank Rose, Principal Deputy Administrator, National Nuclear Security Administration

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Panel 3: Strategic Stability

Moderator: Dr. David Allison

Panelists: Zach Burdette, Stephanie Stapleton, Grace Farson, Carlos Rodriguez-Cruz y Celis

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The End of Arms Control? Examining the Ebb and Flow of US Participation in Nuclear Arms Control Agreements

Stephanie Stapleton

PhD Candidate
Kennesaw State University

Research Analyst
Strategy, Policy, Plans, and Programs Division
Center for Naval Analyses

KENNESAW STATE UNIVERSITY

A difficult time for arms control made worse by domestic partisan polarization in the US

- State of the Field
- Research Questions
- Methodology & Data
- Findings
- Policy Implications

Arms control is failing

- Russia's suspension of New START
- Lack of willing partners
- Emerging & disruptive technologies
- War
- Difficult US domestic environment

Balancing arms control approaches & deterrence

- Andrew Kydd (2000) utilizes Jervis's Deterrence Model by integrating three important behaviors:
  - Arms racing
  - Interstate Bargaining
  - War

- A need for new thinking on deterrence

See Andrew Kydd. "Arms Races and Arms Control: Modeling the Hawk Perspective." 2000

A shift away from treaty-based approaches

- Shift began under George W. Bush
- Accelerated by the Obama & Trump Administration
- Evident in the Biden Administration's "Frameworks" approach

“You need a Republican President and a Republican Congress”

- Consensus that modern Republicans are against arms control while Democrats generally support it.

- Differing approaches to the same problem from the parties[1]
  - disagreements over the tradeoffs needed
    - arms control, modernization programs, missile defense

1. Thematic analysis based on 7 expert-level personal interviews.

Research Question and Hypotheses

Does US participation in nuclear agreements show broad patterns over time?

H1: There are broad patterns to US nuclear agreement participation over time.

H1a: The occurrence of preferred agreement type has changed over time.

H1b: The probability of agreement failure is highest in the first 10 years after an agreement's negotiation.

H2: Political polarization has a significant effect on agreement creation and termination.

H3: Presidential party has no effect on nuclear agreement creation or termination.

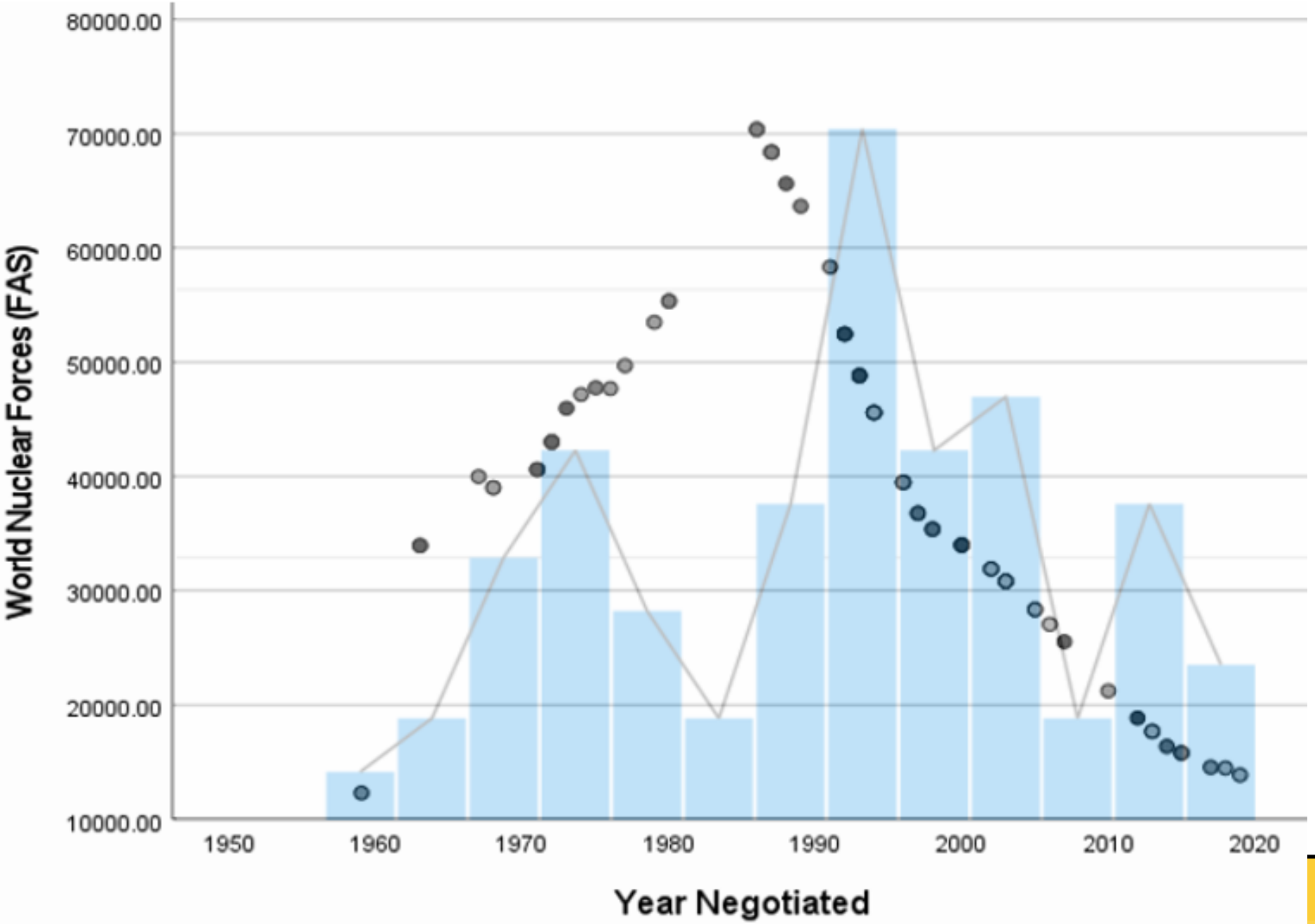
Methodology and Data

A quantitative exploratory study of nuclear arms control agreements that ban, restrict, reduce, or limit nuclear weapons between 1959 and 2021.

Data from:

- Historical records
- Partisan polarization database (Oh, 2023)

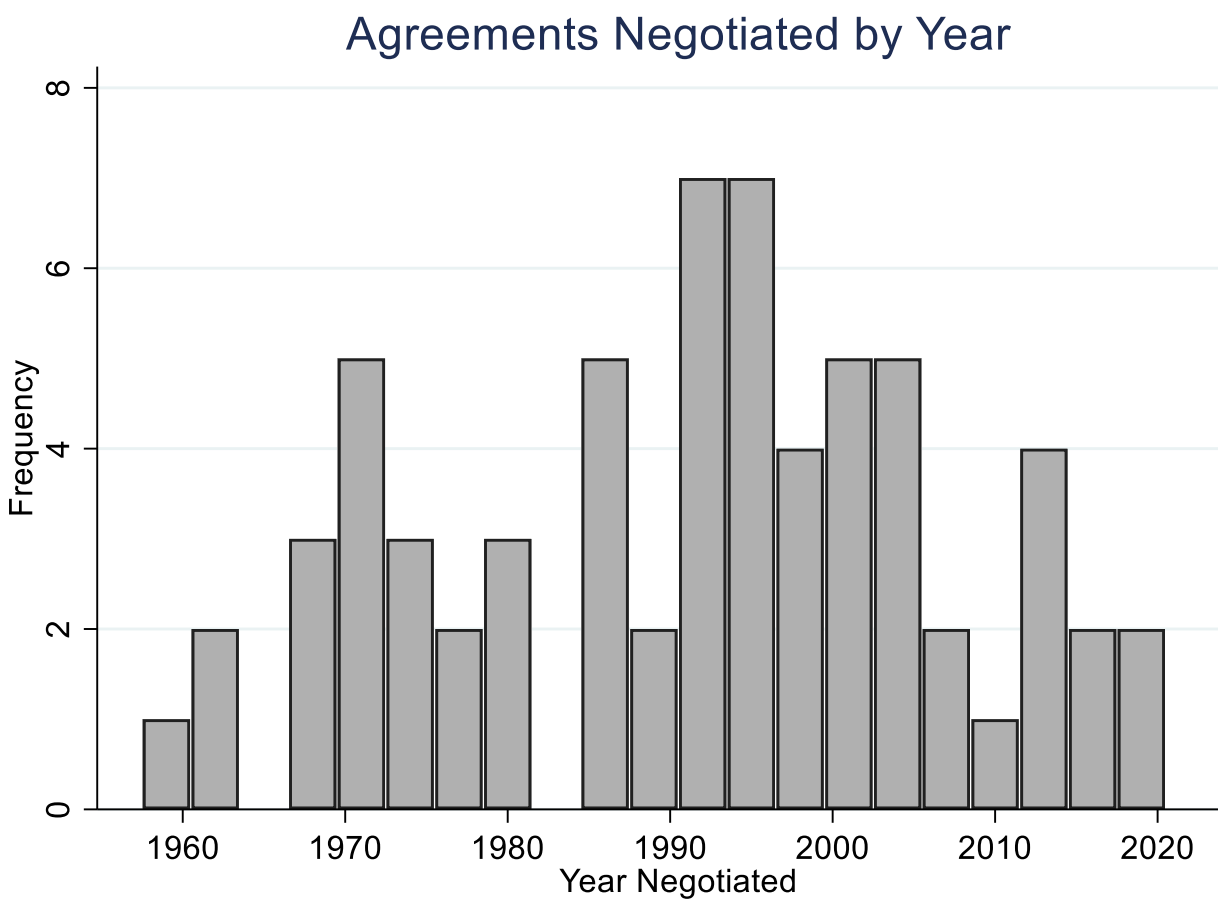
Level of World Nuclear Forces to the frequency of new agreements



Circles = # of Nuclear Weapons

Bars = # of agreements negotiated *(different scale)*

See Kristensen, H., and Korda, M. (2022). "Status of World Nuclear Forces." Federation of American Scientists.



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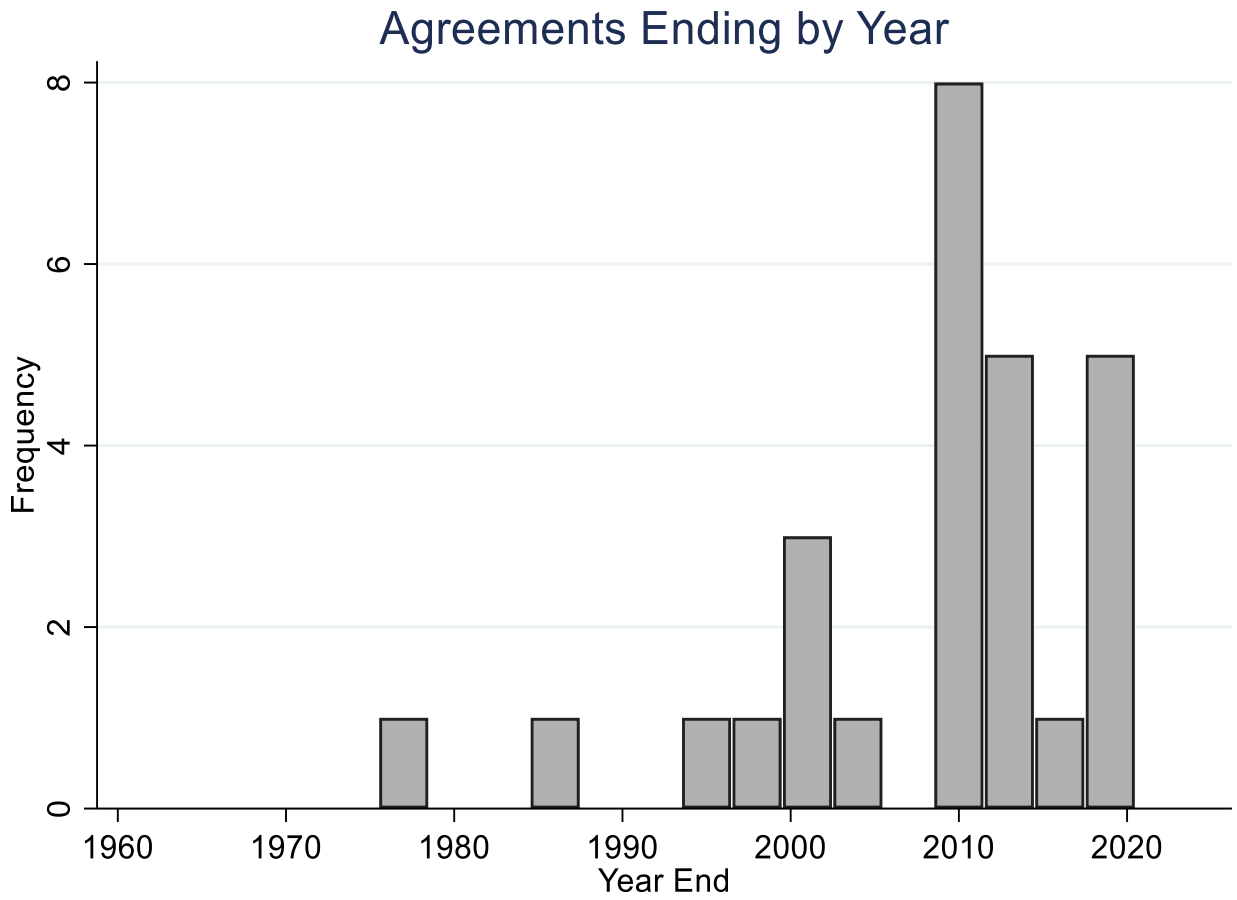
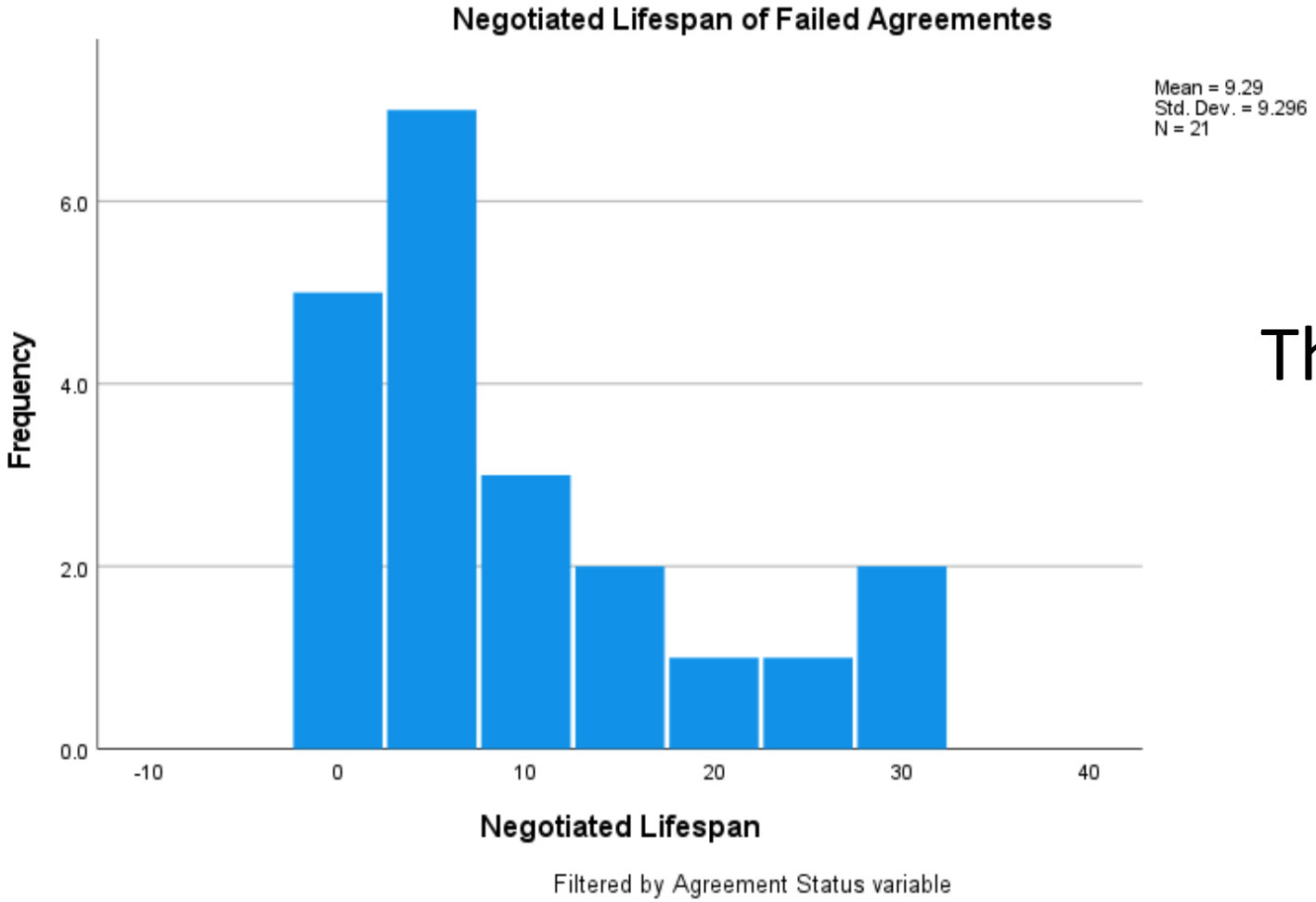


N=26

Time Matters

Agreements fail more often in the first ten years after negotiation.



The estimated survival time of failed agreements:

Mean: 9.29 years

Median: **6.0 years**

CI 95% [5.985, 14.197], CI 95% [2.169, 9.831], respectively

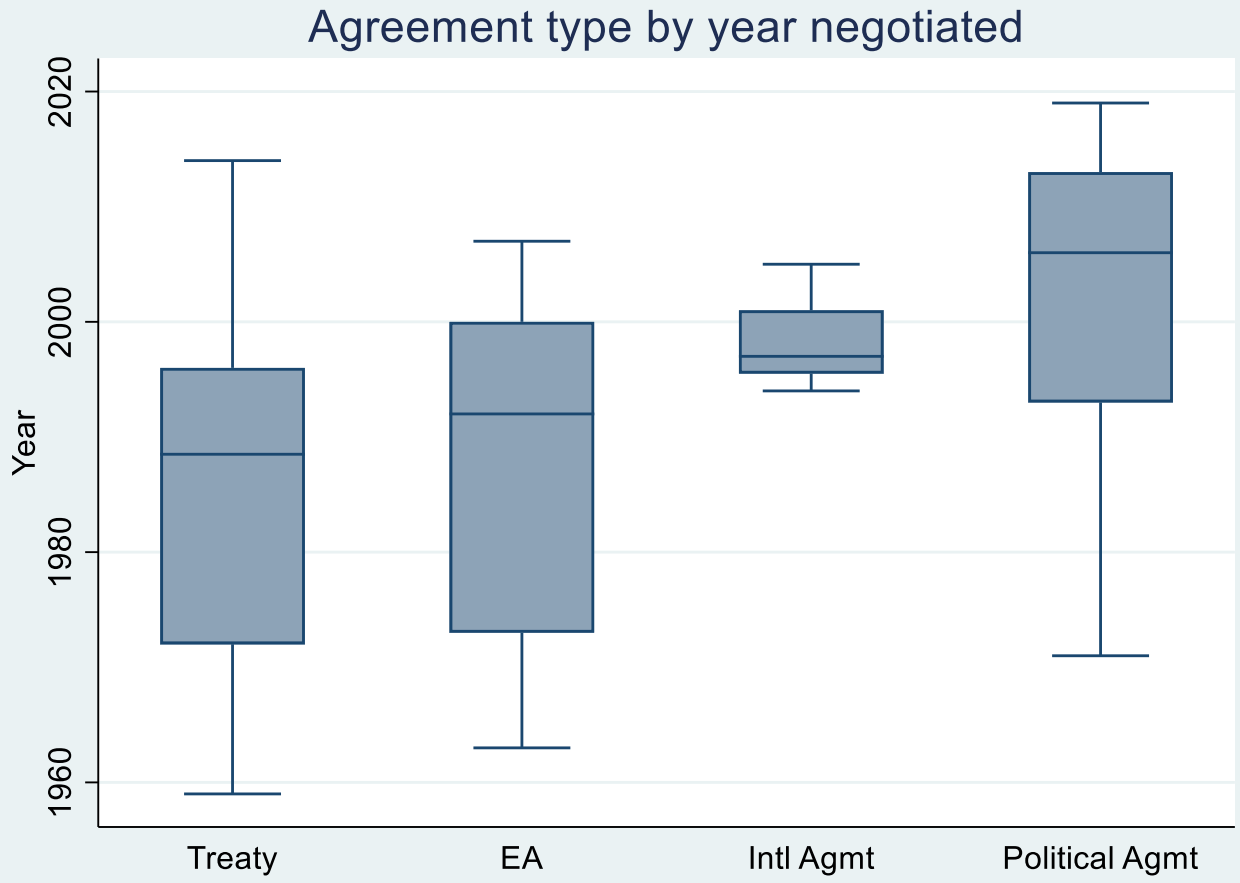
Agreements are increasingly informal

By year negotiated:

- significant but small positive relationship (p=.000)

As polarization increases:

- statistically significant negative relationship (p=.008)



Republican governments prefer less formal agreement types

Unified Democratic Government at Negotiation

Polarization	Minimum	Mean	Maximum
Treaty	**44% (.147)**	**58% (.123)**	**84% (.119)**
Political Agreement	20% (.103)	12% (.057)	4% (.040)

Unified Republican Government at Negotiation

Polarization	Minimum	Mean	Maximum
Treaty	12% (.066)	20% (.104)	52% (.250)
Political Agreement	**57% (.131)**	**43% (.144)**	**19% (.177)**

Impacts of Domestic Political Polarization

- Polarization has the most significant effect across the board
  - Presidents have more flexibility in agreement type when polarization moderates/lowers

- Increased polarization means
  - Agreements are less likely to reach implementation
  - Agreements are increasingly informal
    - Rarely does one party have enough unified control to ratify

Presidential party has no significant effect on agreement creation, termination, or type.

		Presidential Party at Negotiation		
		Republican	Democrat	Total
Agreement Status	Success	23	22	45
	Failure	10	11	21
Total		33	33	66

Presidential Party has no significant relationship at Negotiation (β = .087 and p= .489), at Termination (β = -.107, p= .582), and there is no significant relationship between Presidential Party and Agreement Type (β= -.104, p= .408).

Domestic Policy Implications

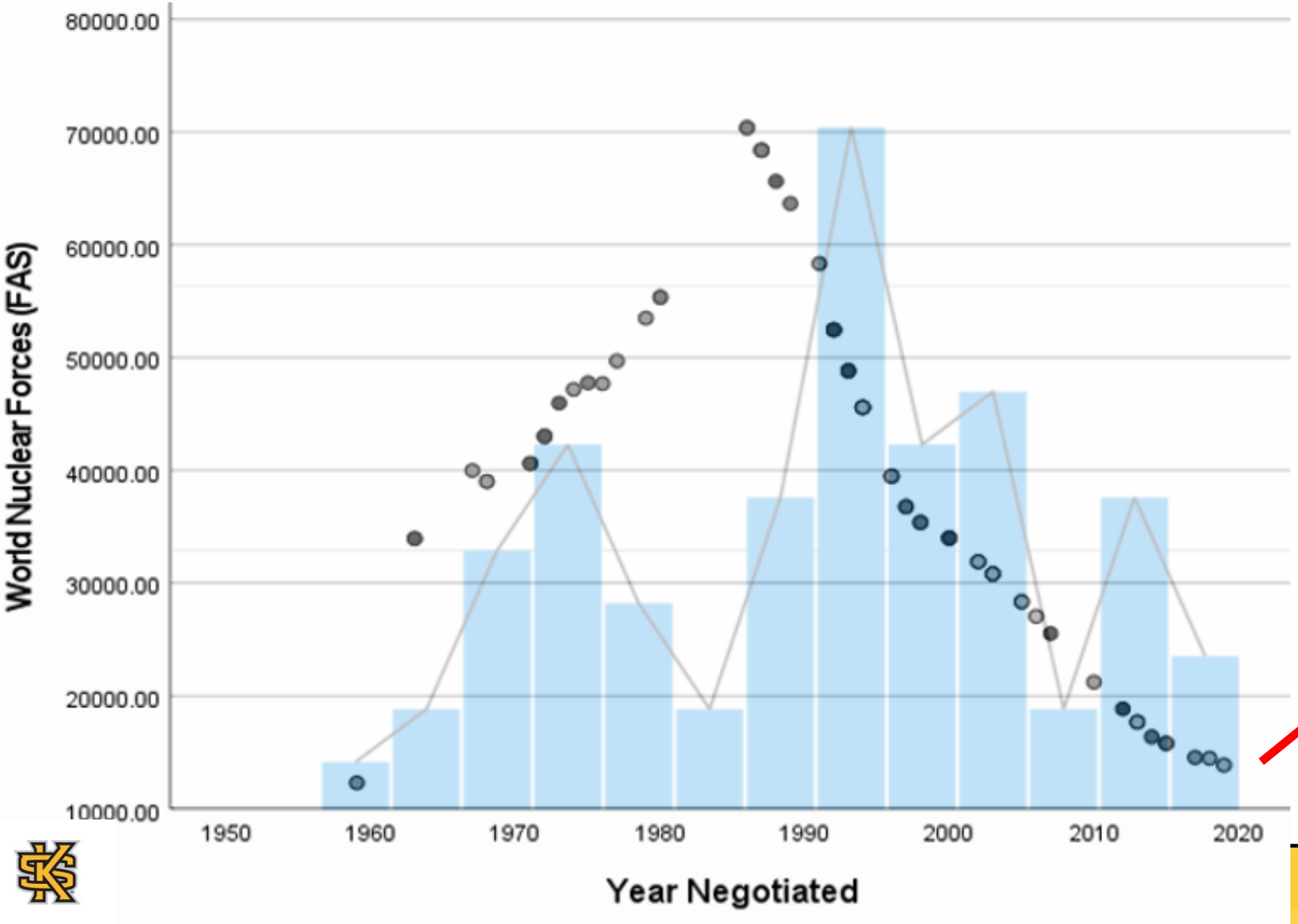
- **Polarization Matters**
  - domestic efforts to combat polarization will be crucial
    - growing congressional expertise and bipartisan programs
    - increased interagency coordination
- **Time to implementation matters**
  - Increased efforts towards ratification & implementation are needed in the first 10 years after negotiation.
- **Expect more informal agreements and frameworks**
  - Less preferable to allies and partners
- **Presidents from both parties attempt nuclear agreements**
  - Domestic politics and external factors are important constraints

Foreign Policy Implications

- Deterrence strengthening should be anticipated
  - A need to manage pressures from:
    - arms racing and conflict escalation

- Continued push to reduce nuclear risk needed:
  - Diplomatic engagement
  - Emerging & Disruptive Technologies
  - Missile Defense evolution & perceptions

Estimated Number of Nuclear Weapons & Negotiated Agreements by Year



Circles = # of Nuclear Weapons

Bars = # of agreements negotiated

I anticipate a continued increase in the number of nuclear weapons

Using Game Theory to Model Tripolar Escalation Dynamics

Grace Farson

ABOUT NSRI

- One of only 15 DOD-designated University Affiliated Research Centers
- Delivers responsive and innovative research, technology, tools and workforce development for strategic deterrence and countering weapons of mass destruction missions

ABOUT THE TEAM

- Comprised of 4 University of Nebraska interns
- All studying various disciplines:
  - Mathematics
  - Political Science
  - Economics
- We created 3 Tripolar models for analysis

POLICY IMPLICATIONS – BLUF

- Research Question: What impact does two near-peer competitors have on extended deterrence and assurance?
- Results prove a need for updated deterrence strategies
- Possible solutions:
  - Nuclear arms treaties between Russia, China, and the U.S.
  - Foster international level agreements of enforcing treaties
  - Work with international organizations to determine proportional, multi-lateral responses to new attack vectors
  - Increase cooperative manufacturing and industrial investment to tie hands

Agenda

- Background
- Definitions
  - Game Specifics
- Model
  - Game Tree
  - Results
- Takeaways / Summary
- Future Avenues

Background


NATIONAL STRATEGIC
RESEARCH INSTITUTE
at the University of Nebraska

Background

- China will soon join the U.S. and Russia as a nuclear peer or a nuclear near peer
- Game theoretic models analyze strategic situations, providing an avenue for exploration
- Zagare and Kilgour (2000) present the asymmetric escalation game to study the dynamics of bipolar deterrence

Definitions

Definitions – Choices

- Concede (C)
- Defy (D) / Match (M)
- Escalate (E)

Definitions – Outcomes

- Concede
- Win
- Limited Conflict
- All-Out Conflict

Game Specifics – Rules

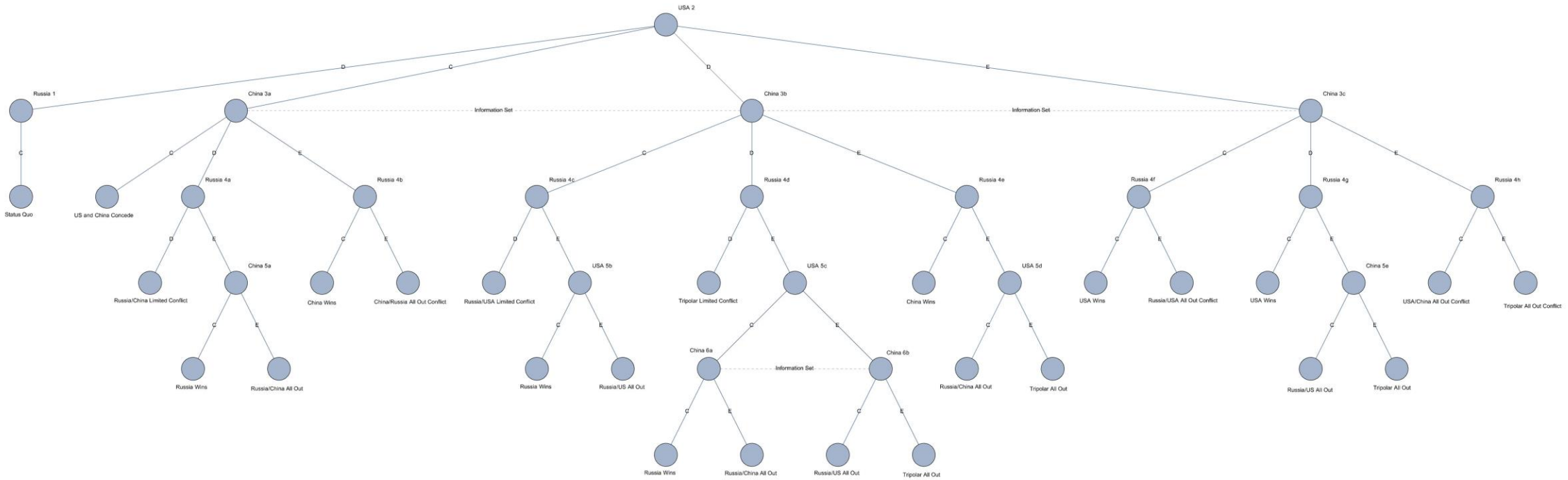
- Players act to optimize their own interests and do not coordinate actions with another player(s)
- Max of 3 choices : concede, match, or escalate
- Players know where they are in the game unless they are in an information set
- Player types:
  - "Hard" means preferring conflict to an opponent winning
  - "Soft" means preferring the opponent winning to conflict

Game Specifics – Assumptions

- Players execute a response-in-kind or escalatory attack based on their type
- Each player has probabilistic knowledge of opponents' type and knows its own type
- A response-in-kind is commensurate with Antagonist 1's initial decision
- Players are rational
- Players have incomplete information about each other's preferences

Tripolar Escalation – De-Escalation Game Model

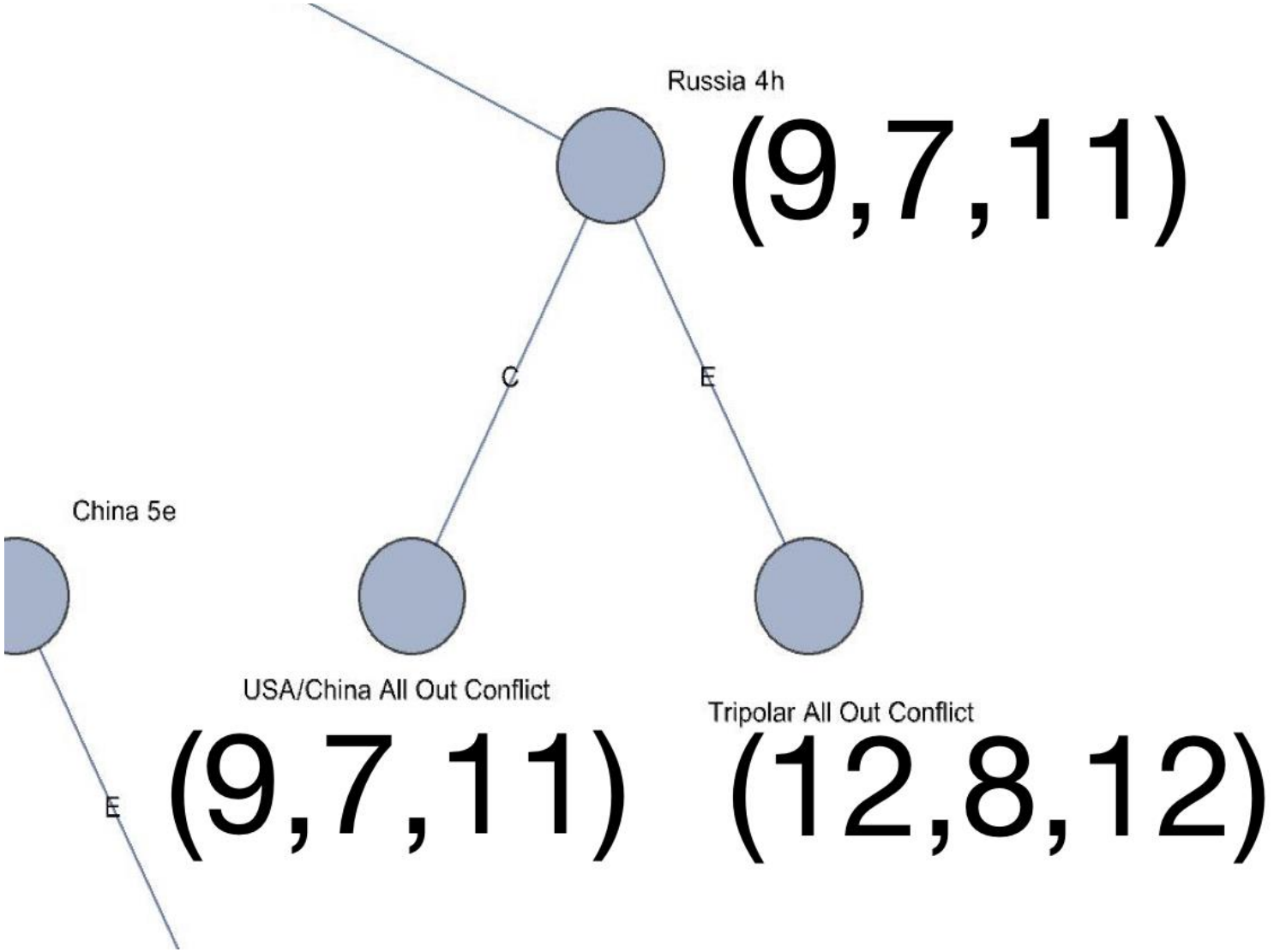
Model 1


USA 2
D
C
D
E
Russia 1
China 3a
Information Set
China 3b
Information Set
China 3c
C
C
D
E
C
D
E
C
D
E
Status Quo
US and China Concede
Russia 4a
Russia 4b
Russia 4c
Russia 4d
Russia 4e
Russia 4f
Russia 4g
Russia 4h
D
E
C
E
C
E
C
E
C
E
C
E
Russia/China Limited Conflict
China 5a
China Wins
China/Russia All Out Conflict
Russia/USA Limited Conflict
USA 5b
Tripolar Limited Conflict
USA 5c
China Wins
USA 5d
USA Wins
Russia/USA All Out Conflict
USA Wins
China 5e
USA/China All Out Conflict
Tripolar All Out Conflict
C
E
C
E
C
E
C
E
C
E
Russia Wins
Russia/China All Out
Russia Wins
Russia/US All Out
China 6a
Information Set
China 6b
Russia/China All Out
Tripolar All Out
Russia/US All Out
Tripolar All Out
C
E
C
E
C
E
C
E
Russia Wins
Russia/China All Out
Russia/US All Out
Tripolar All Out

PREFERENCE EXAMPLE SET

- Russia- Hard
  - US/China concede > Russia wins > China concedes > US concedes > status quo > complete de-mobilization > US/China all-out > Russia concedes > Russia/US all out > Russia/China all-out > Tripolar all-out > China wins > US wins
- United States- Hard
  - Status Quo > US wins > Complete de-mobilization > US concedes > Russia/China all-out > China concedes > Russia concedes > US/China concede > US/China all-out > Russia/US all-out > Tripolar all-out > China wins > Russia wins
- China- Soft
  - Status Quo > China wins > Russia concedes > Complete de-mobilization > US/China concede > Russia wins > US wins > China concedes > Russia/US all-out > US concedes > US/China all-out > Russia/China all-out > Tripolar all-out

Backwards Induction – Example



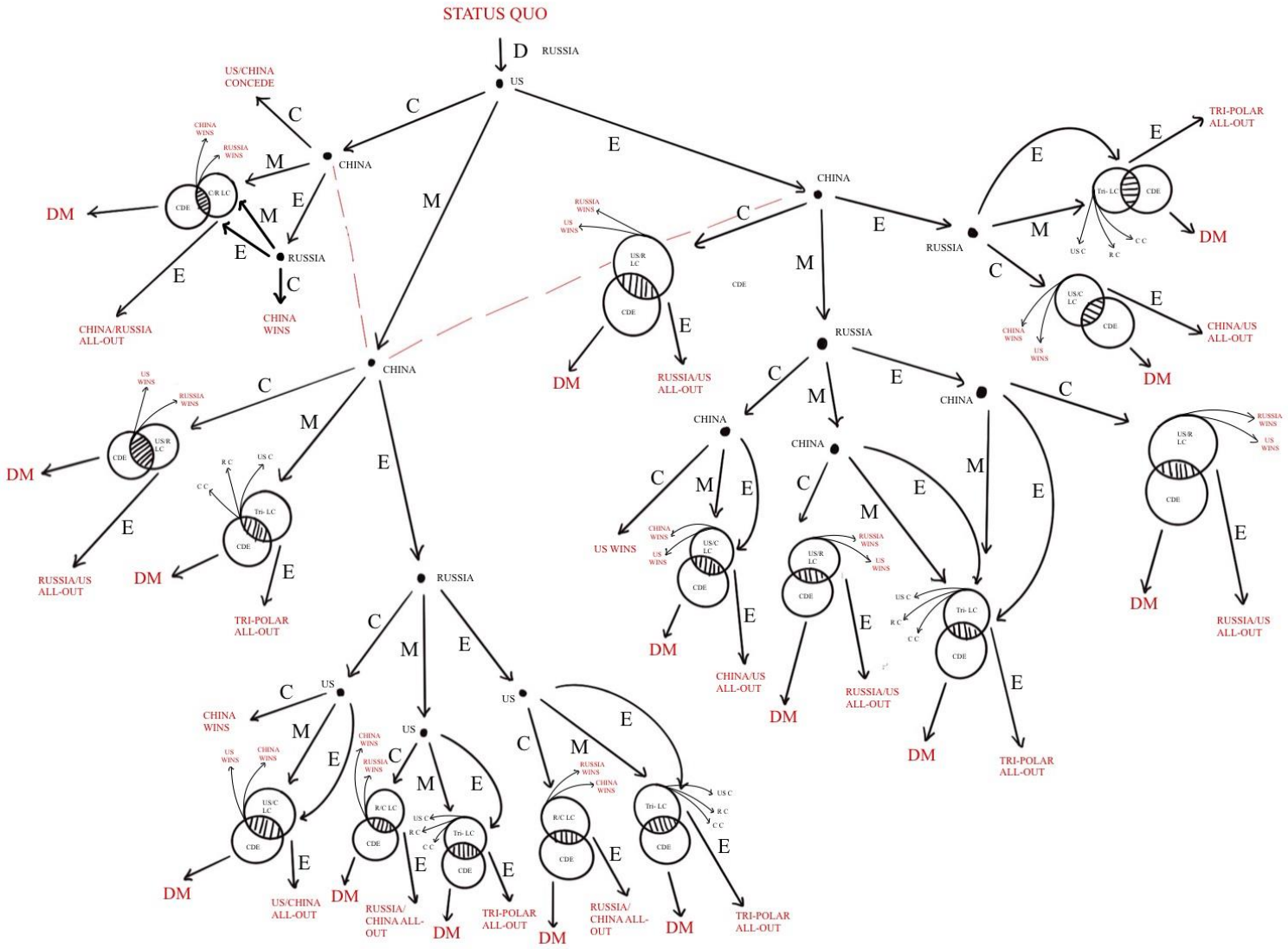
Results – Model 1

	Player Types (Russia, China, US)	Resulting Outcome
Preference Set 1	(Hard, Hard, Hard)	Tripolar Limited Conflict
Preference Set 1	(Hard, Hard, Soft)	R/US Limited Conflict
Preference Set 1	(Soft, Hard, Hard)	Status Quo
Preference Set 1	(Soft, Soft, Hard)	Status Quo
Preference Set 1	(Soft, Hard, Soft)	Status Quo
Preference Set 1	(Soft, Soft, Soft)	Status Quo

Pros/Cons

- Pros
  - Simplicity
  - Ability to Use Any Preference Sets
  - Easy Analysis of Escalation Patterns
- Cons
  - Devolved to All-out Conflict in Two Moves
  - Didn't Consider Levels of Limited Conflict
  - No Option for De-escalation or De-mobilization

Model 2


STATUS QUO
D RUSSIA
US
US/CHINA CONCEDE
C
M
E
CHINA
RUSSIA
DM
CHINA WINS
CHINA/RUSSIA ALL-OUT
RUSSIA/US ALL-OUT
TRI-POLAR ALL-OUT
US WINS
CHINA/US ALL-OUT
RUSSIA/CHINA ALL-OUT
US/CHINA ALL-OUT

Takeaways & Summary

Takeaways

- Three-player escalation games appear to increase the potential for all-out conflict and the rate of escalation when there is no option for de-escalation or de-mobilization
- Using some form of backwards induction, we found:
  - When all players are soft, the probability of all-out conflict is slim
  - When all players are hard, tripolar all-out conflict is the least probable outcome no matter what route is taken although other forms of all-out conflict are still possible
  - A player who moves first out of a state of conflict has an advantage as well as a higher probability of ending the game with one of their preferred outcomes

Summary

- Game theoretic models of multipolar deterrence interactions provide tools to diagram strategic interactions with and without complete information
- The model examined multipolar scenarios in which each party acts individually with no coordination between players
- Results prove a need for new deterrence strategies
- Zagare and Kilgour provide an important basis for extending previous research and models

Future Avenues

- Build new models to implement levels of limited conflict, de-escalation measures, and extended time frames for more realistic tripolar scenarios
- Utilize programming languages and agent-based modeling techniques to analyze more complex models
- Build a model to implement coordination between players
- Implement changing player types and new preference orderings for a more holistic analysis

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Sandia National Laboratories

Arms Control Cooperation with China

Carlos Rodriguez Cruz y Celis

East Asia Lead, CMC

PONI Capstone Conference 2023

Omaha, Nebraska

BLUF

Given China's historical mistrust of Western treaties and lack of extensive practical experience with arms control monitoring and verification measures, the United States should **leverage virtual reality models that demonstrate arms control verification measures to build trust with Chinese counterparts.**

Presentation Overview

- China's History of Treaty-Based Relationships with the West
- Differences in US-Russia and US-China Arms Control Approaches
- Non-Treaty-Based Arms Control with China

Research Question: What areas are most salient today for engaging China in arms control cooperation?

Century of Humiliation - 百年国耻

Major Foreign Invasions

- First Opium War (1839-1842)
- Second Opium War (1856-1860)
- Sino-Japanese War (1894-1895)
- Invasion of the allied forces of eight countries (1900)
- Japanese invasion of Manchuria (1931)
- Anti-Japanese War (1937-1945)

Treaty-Based Signatories

US-China

US-China-Russia

France-China

P5 Treaty

Differences in Bilateral Arms Control Considerations

US-Russia

- Lab-to-lab exchanges
- Historical basis for verification

US-China

- No joint research collaborations
- No experience with arms control CBMs

CCP and Transparency

Domestic

Political Tool to Achieve Policy Objectives

International Security

Political Tool to Portray Strength

Virtual Reality (VR)

VR has already been integrated into military training programs

Build VR models to conduct virtual technology demonstrations of arms control verification technologies

Expand technical familiarity to broader policy community in China with a stake in the future of arms control dialogues

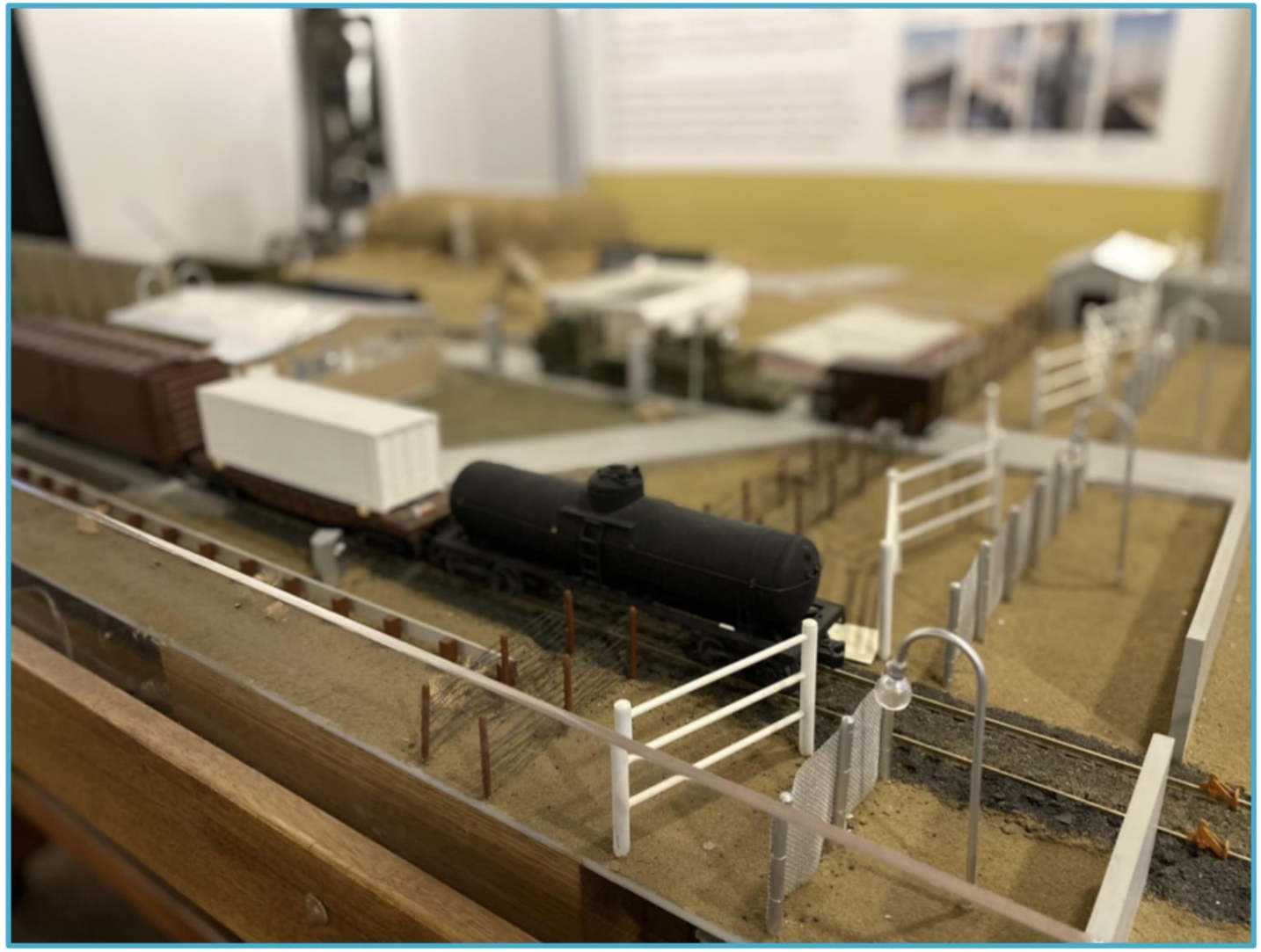
First Proposed Model: Facility-Wide Verification

Intermediate Nuclear Forces (INF) Treaty

Votkinsk Machine Building Plant placed under continuous monitoring

During negotiations, diorama model was presented to US policymakers to illustrate verification measures

Findings



Problem

- 3D scan of physical diorama too static
  - Difficult to create interactive elements

Solution

- Use 3D modeling software to construct the digital environment
  - Train cars, portal monitoring station, containers

Alternative Proposal: Individual Technologies

Create “digital twins” of existing arms control monitoring and verification technologies

“Digital twins” are 3D models that share the same physical properties of a real-world object

Ideal candidate for modeling would be a Chain of Custody sensor

Concluding Points

- US should take into account China's historical treaty-based interactions with the West when addressing new arms control agreements
- Treaty-based arms control in the near-term is unlikely to yield positive results
- US should take the initiative to engage Chinese counterparts in virtual reality technology demonstrations and consultations around monitoring and verification to lay the groundwork for successful dialogue in the future