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AN INCIPIENT ARMS RACE: HYPERSONIC WEAPON DEVELOPMENT IN THE UNITED STATES, CHINA, AND RUSSIA

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by

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December 2022

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The United States, China, and Russia are each competing to develop hypersonic weapons. Can this hypersonic weapon competition be classified as an arms race? Current literature regarding hypersonic weapons treats them as a manifestation of arms racing, but does not offer a comprehensive assessment of arms race dynamics in current hypersonic weapon development. This thesis uses traditional arms race theory and current strategic stability literature to analyze the hypersonic weapon competition and to highlight challenges the competition imposes.

This thesis proposes a new arms racing category to classify the hypersonic weapon competition: an incipient arms race. It defines an incipient arms race, examines the importance of recognizing its incipiency, and raises potential problems for policymakers to consider. This thesis recommends that policymakers fully consider the impact that a full arms race would have on global strategic security prior to committing the required resources to offensive and defensive hypersonic weapon systems.

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AN INCIPIENT ARMS RACE: HYPERSONIC WEAPON DEVELOPMENT IN THE UNITED STATES, CHINA, AND RUSSIA

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Submitted in partial fulfillment of the
requirements for the degree of

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LIST OF ACRONYMS AND ABBREVIATIONS

ABM	anti-ballistic missile
BMD	ballistic missile defense
CCP	Chinese Communist Party
CVN	nuclear aircraft carrier
DE	directed energy
EABO	Expeditionary Advanced Based Operations
HGV	hypersonic glide vehicle
ICBM	intercontinental ballistic missile
IOC	initial operational capability
NMD	national missile defense
PLA	People's Liberation Army
PRC	People's Republic of China
QDR	Quadrennial Defense Review
SALT	Strategic Arms Limitation Talks
THAAD	Terminal High Altitude Area Defense

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I. INTRODUCTION

Hypersonic weapon research and development is currently underway in the United States, China, and Russia. Some level of competition is present among the three states in pursuit of hypersonic weapon technology. Is this competition strong enough to be considered an arms race? What factors are driving this competition? Are these factors typically seen in an arms race?

A. IMPORTANCE

Hypersonic weapons fly at the speed of at least Mach five (five times the speed of sound) and can fly at low altitudes that make interception difficult. There are two categories of hypersonic weapons: hypersonic glide vehicles (HGV) and hypersonic cruise missiles. HGVs "are launched from a rocket before gliding to a target," while hypersonic cruise missiles "are powered by high-speed, air-breathing engines, or 'scramjets,' after acquiring their target."[1] According to the Congressional Research Service, "hypersonic weapons could challenge detection and defense due to their speed, maneuverability, and low altitude of flight."[2] Another troubling aspect of hypersonic weapons is their versatile payload: they are capable of carrying nuclear warheads.

The United States, China, and Russia are developing hypersonic weapons. China has tested and has potentially deployed multiple missiles that can carry HGVs: the DF-17, DF-41, and the DF-ZF HGV.[3] The DF-41 is capable of carrying a nuclear warhead.[4] Russia is developing its own hypersonic weapons: the Avangard, an HGV that Russians claim has been deployed since 2019, and the Tsirkon, a ship-launched hypersonic cruise missile that U.S. intelligence believes will be operational in 2023.[5] The Avangard HGV is

[1] Kelley M. Sayler, *Hypersonic Weapons: Background and Issues for Congress*, CRS Report No. R45811, (Washington, DC: Congressional Research Service, 2022), 2.

[2] Sayler, Hypersonic Weapons: Background and Issues for Congress, 2.

[3] Sayler, Hypersonic Weapons: Background and Issues for Congress, 15.

[4] Sayler, Hypersonic Weapons: Background and Issues for Congress, 15.

[5] Sayler, Hypersonic Weapons: Background and Issues for Congress, 12–13.

capable of carrying a nuclear payload in addition to conventional warheads. The United States does not field any hypersonic weapons, but it is developing multiple HGVs and hypersonic cruise missiles. The U.S. military hopes to begin fielding hypersonic weapons as early as FY2023. It is committed to placing only conventional warheads on these new delivery systems.[6]

Hypersonic weapons add another lethal weapon to the United States, Chinese, and Russian arsenals. It is important to understand what is driving the competition among these countries. This thesis will estimate if this competition embodies typical arms race dynamics. Identifying arms race characteristics in the current hypersonic competition will enable the analysis to project how this competition may evolve in the future. This situational awareness would assist leaders in evaluating the hypersonic competition to better avoid wasting resources on destabilizing arms racing. Because hypersonic weapons potentially pose a new challenge to global strategic security, it is critical to estimate their potential to producing destabilizing arms-racing dynamics in the global security landscape.

B. LITERATURE REVIEW

Two areas of prior research are relevant to this thesis: assessments of hypersonic weapons development that consider arms race expressions, and research on hypersonic weapons that treats them as a manifestation of arms racing. As discussed in this review, works in these areas fail to offer a comprehensive assessment of arms race dynamics in current hypersonic weapons development found in this thesis.

1. Hypersonic Weapons Assessments

Little literature exists that systematically analyzes hypersonic weapons development and places it within the broader arms race spectrum. Eleni Ekmektsioglou's article is an exception.[7] Her piece identifies the reason behind the evolution of hypersonic weapons and their impact on the U.S.-China relationship within an escalatory context.

[6] Sayler, Hypersonic Weapons: Background and Issues for Congress, 4, 6.

[7] Eleni Ekmektsioglou, "Hypersonic Weapons and Escalation Control in East Asia," *Strategic Studies Quarterly*, Summer 2015.

Additionally, Ekmektsioglou's work focuses on the history of hypersonic weapons development in the United States and China, and she highlights the follow-on effects of development throughout the process.

In her account of Chinese hypersonic weapon development history, the phenomenon she describes most closely resembles the action-reaction cycle of arms racing.[8] This piece is limited in that it describes the action-reaction cycle strictly from an historical perspective. Ekmektsioglou does not attempt to classify hypersonic weapons developments as an arms race. She also believes that it is too soon to call hypersonic weapons development an arms race.[9] She does not attempt to place hypersonic weapons development within the context of arms racing.

A related category of literature exists that is primarily focused on hypersonic weapon effects on strategic stability. This body of literature contains some discussion of a hypersonic arms race that might be underway, but makes no attempt to analyze it in depth. These authors are most concerned with the general failure to assess the impact of hypersonic weapons on strategic stability.

Michael Klare's "An 'Arms race in Speed'" is an example of this literature,.[10] In his view, the United States, China, and Russia have been pursuing hypersonic weapons without considering their follow-on effects to characterize United States, Chinese, and Russian hypersonic weapons development. He discusses the technological innovation without regard for its broader effects.[11] He briefly mentions domestic industry within the United States that is incentivized to drive development.[12] Finally, he also outlines elements of an action-reaction cycle arms race.[13]

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[8] Ekmektsioglou, "Hypersonic Weapons and Escalation Control in East Asia," 50–52.

[9] Ekmektsioglou, "Hypersonic Weapons and Escalation Control in East Asia," 63.

[10] Michael T. Klare, "An 'Arms Race in Speed': Hypersonic Weapons and the Changing Calculus of Battle," *Arms Control Today* 49, no. 5 (June 2019), 6–13.

[11] Klare, "An 'Arms Race in Speed': Hypersonic Weapons and the Changing Calculus of Battle," 8.

[12] Klare, "An 'Arms Race in Speed': Hypersonic Weapons and the Changing Calculus of Battle," 10.

[13] Klare, "An 'Arms Race in Speed': Hypersonic Weapons and the Changing Calculus of Battle," 9–10.

Klare's brief outline of the hypersonic weapon arms race elements between the United States, China, and Russia is a good start toward answering the question posed in this thesis. Nevertheless, it falls short of providing an answer because he makes no argument for or against classifying the phenomenon as an arms race, and further because he only offers a brief outline of these elements. Because he is primarily concerned with hypersonic weapons' effect on strategic stability, it is sufficient for his article to briefly mention the possibility of an arms race without systematically analyzing those arms race elements within the phenomenon.

Other articles in this category offer even less detail about possible arms racing within hypersonic weapons development. Similar to Klare's piece, these works are more focused on the potential for strategic instability that hypersonic weapons might bring rather than understanding the phenomenon surrounding their development. Dean Wilkening offers one example.[14] He observes that hypersonic weapons have the potential to kick off a broader arms race between the United States, China, and Russia. He discusses the possibility that hypersonic weapons could start a broader action-reaction cycle arms race depending on how the United States intends to use them and how the Chinese or Russians react to that perceived use.[15] The limit of Wilkening's article is that it places hypersonic weapons within a broad potential arms race, rather than assessing hypersonic arms racing specifically. Heather Williams offers another example.[16] Her article differs from Wilkening's because she recognizes the potential for hypersonic weapons to create strategic instability and attempts to determine if that instability can be corrected with arms control measures. She briefly discusses an action-reaction cycle as the cause for hypersonic weapon development, but calls it a competition rather than an arms race.[17] Matteo Frigoli goes farther than Wilkening and Williams and contends that a hypersonic arms race exists

[14] Dean Wilkening, "Hypersonic Weapons and Strategic Stability," *Survival* 61, no. 5 (October-November 2019), 129–148.

[15] Wilkening, "Hypersonic Weapons and Strategic Stability," 141.

[16] Heather Williams, "Asymmetric Arms Control and Strategic Stability: Scenarios for Limiting Hypersonic Glide Vehicles," *Journal of Strategic Studies* 42, no. 6 (2019), 789–813.

[17] Williams, "Asymmetric Arms Control and Strategic Stability: Scenarios for Limiting Hypersonic Glide Vehicles," 797.

between the United States, China, and Russia. But, similar to Wilkening and Williams, Frigoli's focus is on the potential strategic instability that hypersonic weapons might bring.[18]

None of the works reviewed above offer any perspectives on any arms racing elements within hypersonic weapon development itself. This thesis will seek to fill that gap in existing research by focusing on arms racing dynamics specifically within hypersonic weapons development.

2. Arms Race Research

Recent arms race literature has paid little attention to hypersonic weapons development. One category of this literature analyzes the Chinese military modernization effort from the 1980s to present day and searches for arms race characteristics. Tai Ming Cheung and Desmond Ball conclude in their respective articles that all elements of an action-reaction cycle arms race are present between the United States and China, but neither go so far as to label the competition an arms race.[19] In both articles aircraft carriers, nuclear missiles, and submarines are mentioned among the increased capabilities, but there is no mention of hypersonic weapons.

A subset of the Chinese modernization literature follows the same pattern as Cheung and Ball, but one major difference is that this subset declares that an arms race between the United States, China, and Russia is nonexistent. Matthew Costlow follows this pattern in his analysis of U.S. ballistic missile defense development and also determines that Chinese and Russian military modernization efforts have evolved at an expected

[18] Matteo Frigoli, "The Twenty-First Century: The Epoch of Advanced Missile Systems and Growing Vulnerabilities," *21st Century Prometheus: Managing CBRN Safety and Security Affected by Cutting-Edge Technologies*, ed. Maurizio Martellini and Ralf Trapp (Cham: Springer International Publishing, 2020), 21–47.

[19] Tai Ming Cheung, "Racing from Behind: China and the Dynamics of Arms Chases and Races in East Asia in the Twenty-First Century," *Arms Races in International Politics: From the Nineteenth to the Twenty-First Century*, ed. Thomas Mahnken, Joseph Maiolo, and David Stevenson (New York: Oxford University Press, 2016); and Desmond Ball, "Arms Modernization in Asia: An Emerging Complex Arms Race," *The Global Arms Trade: A Handbook*, ed. Andrew T.H. Tan (New York: Routledge, 2014).

pace.[20] Nevertheless,, he determines that an action-reaction cycle arms race does not exist between the United States, China, and Russia. Joshua Wild comes to a similar conclusion in his study of U.S.-Chinese arms race dynamics.[21] He concludes that most classic definitions of an arms race do not fit the competition ongoing between the United States and China. While Costlow and Wild mention hypersonic weapons sporadically throughout their pieces, they do not analyze any arms racing dynamics in their development.

A second category of recent arms race literature outlines various arms races between the United States, China, and Russia that are either ongoing or might develop. This literature covers a variety of arms races, from nuclear weapons to anti-satellite weapons, but does not extensively or systematically analyze hypersonic weapons. Caitlin Talmadge explores the potential for an action-reaction cycle nuclear arms race in the near future with China, and while she concludes that nuclear competition is likely to intensify, she declines to call it an arms race.[22] Talia Blatt discusses an action-reaction cycle anti-satellite weapon arms race currently underway among the United States, China, and Russia.[23] Primarily concerned with the effects and instability that anti-satellite weapons could cause, she states that an anti-satellite arms race is underway, but does not offer any evidence behind the claim.

This thesis applies the broader arms race theories to the hypersonic weapon development phenomenon that is ongoing between the United States, China, and Russia. It fills the gap between the existing hypersonic weapons development literature, which focuses very little on that development within the context of arms racing, and the broader theory of arms racing, which has not yet been applied to hypersonic weapons development.

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[20] Matthew R. Costlow, "The Missile Defense 'Arms Race' Myth," *Strategic Studies Quarterly*, Spring 2021, 8–9.

[21] Joshua Wild, "An Analysis of U.S.-China Arms Race Dynamics Since 1990," (master's thesis, Boston University, 2021).

[22] Caitlin Talmadge, "The US-China Nuclear Relationship: Why Competition is Likely to Intensify," *Brookings Institution Reports*, (September 2019).

[23] Talia Blatt, "Anti-Satellite Weapons and The Emerging Space Arms Race," *Harvard International Review* 41, no. 3 (Summer 2020), 29–34.

C. RESEARCH DESIGN

Within the broad literature on arms racing, Joseph Maiolo's three models for arms races encapsulate the alternative explanations for arms races that are reflected in past studies. For this reason, Maiolo's models offer a good framework for this thesis to measure and compare arms race drivers in hypersonic weapons development. Maiolo's models are: 1) technological innovation; 2) domestic political causes; and 3) an action-reaction cycle.[24]

The first model, technological innovation, "conceives of technological change as an autonomous variable, propelling arms races ahead."[25] In this model, the arms race takes place in laboratories and technological advances outpace the government's ability or willingness to evaluate their affects. In this case, "real or perceived shifts in the balance of advantage between offensive and defensive warfare, caused by technological breakthroughs, may heighten tensions between states and encourage the rapid accumulation of arms."[26] Actors that use technological breakthroughs to incrementally improve hypersonic weapons are an indicator for this model.

The second model, domestic political causes, has several different foundational elements. In one way, it has been used as an outlet for industry to produce military weapons for profit.[27] In another way, it has been used by domestic actors to conjure fear of foreign threats to justify arms production as a way of social control.[28] In addition to these factors, modern symptoms of a domestic setting that might drive arms races are "the institutionalization of armaments production, military budgeting processes, the organizational politics of armed forces, nationalist, military and corporate lobby groups, electoral politics, and of course the 'military-industrial complex'."[29] Significant budget

[24] Joseph Maiolo, "Introduction," in *Arms Races in International Politics: From the Nineteenth to the Twenty-First Century*, ed. Thomas Mahnken, Joseph Maiolo, and David Stevenson (New York: Oxford University Press, 2016), 6–7.

[25] Maiolo, "Introduction," 6.

[26] Maiolo, "Introduction," 7.

[27] Maiolo, "Introduction," 7.

[28] Maiolo, "Introduction," 7.

[29] Maiolo, "Introduction," 7.

allocation, the existence of hypersonic weapon lobby groups, and major defense industry investment in hypersonic weapon development are a few indicators for this model.

The third model, the action-reaction cycle, "places primacy on external factors."[30] Competing states "become locked into a reciprocal and self-reinforcing cycle of arming and counter-arming that either peters out or results in war."[31] This model is built on security dilemma theory, "as a state increases its own security, it may decrease that of others, inviting them to respond."[32] Indicators for this model would be actions taken by one state that are seemingly in response to the previous actions of the other state. Or, as Maiolo puts it, "country A expands its armaments chiefly in response to armaments expansion by country B, for reasons that may have been prompted by diplomatic crises or by realignments in a perilous and uncertain international environment."[33]

This thesis utilizes Maiolo's three models to identify the sources of arms race behavior in hypersonic weapons development among the United States, China, and Russia. Chapter II utilizes Colin Gray's classic criteria for arms races to evaluate how recent great power hypersonic weapons development does constitute an incipient arms race. Chapter III then applies Maiolo's three models to explain the drivers of hypersonic weapons development efforts. Chapter IV uses Robert Jervis' security dilemma theory to explore the offense-defense balance dynamic of hypersonic weapons, and to offer potential outcomes of the incipient arms race.

[30] Maiolo, "Introduction," 7.

[31] Maiolo, "Introduction," 7.

[32] Maiolo, "Introduction," 8.

[33] Maiolo, "Introduction," 7.

II. IDENTIFYING AN INCIPIENT ARMS RACE

The United States, China, and Russia have either deployed or are soon to deploy hypersonic weapons. This situation can be classified as some kind of competition, but is it an arms race? Answering that question requires addressing a prior question: what is an arms race? So many different definitions of arms races are discussed in popular media that it can be difficult to determine what an arms race is. From NBA basketball arenas to artificial intelligence to even compassion, the term arms race is used for a variety of topics, and much confusion surrounds it.[34] This chapter will select and apply a definition of the term "arms race" to the hypersonic weapons development phenomenon in the United States, China, and Russia.

A. DEFINING AN ARMS RACE

This thesis will use Colin Gray's definition of an arms race and the conditions necessary for one to take place. Gray's definition is straightforward and can be applied to the hypersonic weapon phenomenon. He provides a clear articulation of four measurable criteria, and his work focused on the general phenomenon of arms racing rather than serving as a first step in a case study. He states that "there should be two or more parties perceiving themselves to be in an adversary relationship, who are increasing or improving their armaments at a *rapid* rate and structuring their respective military postures with a *general* attention to the past, current, and anticipated military political behavior of the other parties."[35] He clarifies that "actors may…pursue a logic of military development and deployment that is strictly domestic; but this activity may serve as an arms race 'trigger' for other actors."[36] In other words, when any party seeks to pursue military developments

[34] Ben Golliver, "The NBA's Richest Owner Enters the Arena Arms Race," *Washington Post*, September 20, 2021, A1, ProQuest; Justin Sherman, "Stop Calling Artificial Intelligence Research an 'Arms Race'," *Washington Post*, March 6, 2019, A1, ProQuest; Tom Switzer, "To Reclaim Liberty, Resist an Arms Race of Compassion," *Sydney Morning Herald*, April 4, 2020, A1, ProQuest.

[35] Colin S. Gray, "The Arms Race Phenomenon," *World Politics* 24 no. 1 (October 1971), 40.

[36] Gray, "The Arms Race Phenomenon," 40.

and deployments, regardless of their intended original purpose, they have the potential to spark an arms race with an adversary.

In addition to defining arms racing, Gray also provides necessary conditions that must be met to classify an event as an arms race.

> 1. There must be two or more parties, conscious of their antagonism.
> 2. They must structure their armed forces with the attention to the probable effectiveness of the forces in combat with, or as a deterrent to, the other arms race participants.
> 3. They must compete in terms of quantity (men, weapons) and/or quality (men, weapons, organization, doctrine, deployment).
> 4. There must be rapid increases in the quantity and/or improvements in quality.[37]

He adds that "all four of these factors must be present for there to be any valid assertion that a particular relationship is an arms race."[38] This chapter will use these criteria to determine if a hypersonic arms race exists by applying each criterion to the hypersonic weapon phenomenon.

B. AN ANTAGONISTIC RELATIONSHIP

The first criteria, that there must be two or more parties that are conscious of their antagonism, is present in the hypersonic situation. In its 2018 National Defense Strategy, the U.S. government made it clear that they understood that an antagonistic relationship had evolved between the United States, China, and Russia: "It is increasingly clear that China and Russia want to shape a world consistent with their authoritarian model…China and Russia are now undermining the international order from within the system by exploiting its benefits while simultaneously undercutting its principles."[39] The U.S. policy paper also notes that "long-term strategic competitions with China and Russia are the principal priorities for the Department [of Defense]…because of the magnitude of the

[37] Gray, "The Arms Race Phenomenon," 41.

[38] Gray, "The Arms Race Phenomenon," 41.

[39] White House, National Defense Strategy of the United States of America (Washington, DC: White House, 2018), 2.

threats they pose to U.S. security and prosperity today, and the potential for those threats to increase in the future."[40] Finally, the current administration has stated that "Both Beijing and Moscow have invested heavily in efforts meant to check U.S. strengths and prevent us from defending our interests and allies around the world."[41] As these statements show, the U.S. government has on multiple occasions publicly recognized an antagonistic relationship present between the three states.

In a 2018 testimony to Congress, former Under Secretary of Defense for Research and Engineering Michael Griffin underscored the antagonistic relationship specific to hypersonic weapons development. He testified that "China has fielded or can field…hypersonic delivery systems…that can reach out thousands of kilometers from the Chinese shore and hold our carrier battle groups or our forward-deployed forces on land…at-risk."[42] He continued to add that the United States does not "have systems that can hold them at-risk in a corresponding manner, and we do not have defenses against those systems."[43] Finally, he highlighted his awareness of the antagonism present, and declared that "should [the Chinese] choose to employ [hypersonic weapons], we would be, today, at a disadvantage. It is among my very highest priorities to erase that disadvantage, creating our own systems to hold them at-risk and to provide defense."[44] This statement from a high-ranking U.S. government official made it clear that he not only understood that an antagonistic relationship was present, but also declared that it was his goal to ensure that the United States gained an upper hand in it.

Both China and Russia have taken actions to show and deepen the antagonism between them and the United States. In 2016, Russia attempted to influence the U.S.

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[40] White House, National Defense Strategy, 4.

[41] White House, *Interim National Security Strategic Guidance* (Washington, DC: White House, March 2021), 9.

[42] Accelerating New Technologies to Meet Emerging Threats: Testimony before the Subcommittee on Emerging Threats and Capabilities (April 18, 2018) (statement of Dr. Michael Griffin, Under Secretary of Defense for Research and Engineering).

[43] Griffin, testimony on Accelerating New Technologies.

[44] Griffin, testimony on Accelerating New Technologies.

presidential election with their cyber capabilities.[45] Separately, Vladmir Putin stated that Russia was forced to develop hypersonic weapons in response to U.S. anti-ballistic missile defense development and deployments.[46] In 2018, Putin stated that

> The U.S. is permitting constant, uncontrolled growth of the number of anti-ballistic missiles, improving their quality, and creating new missile launching areas. If we do not do something, eventually this will result in the complete devaluation of Russia's nuclear potential. Meaning that all of our missiles could simply be intercepted.[47]

For their part, Chinese territorial claims in the South China Sea have been interpreted by the United States and other Western states to be challenging the international order.[48] As recently as October 2021, China constructed missile testing sites with targets that closely resemble U.S. Ford-class aircraft carriers and Arleigh Burke-class destroyers.[49] The purpose of these testing sites is for the development of "carrier-killer" missiles and other anti-ship cruise missiles designed specifically to counter U.S. warships. Although neither China nor Russia have been as vocal about their desire to challenge Washington, their actions show that they recognize the antagonism present in their relationship with the United States.

C. FORCE STRUCTURE

The second of Gray's criterion for an arms race revolves around force structure; specifically, that the arms race participants must design and field a force to challenge the other arms race participants. For China and Russia, hypersonic weapons are one potential

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[45] Stephen McCombie, Allon J. Uhlmann, and Sarah Morrison, "The U.S. 2016 Presidential Election and Russia's Troll Farms," *Intelligence and National Security* 35 no 1, 2020, 95–114.

[46] David Wright and Cameron Tracy, "The Physics and Hype of Hypersonic Weapons," Scientific American, last modified August 1, 2021, https://www.scientificamerican.com/article/the-physics-and-hype-of-hypersonic-weapons/.

[47] Vladmir Putin, "Presidential Address to the Federal Assembly," March 1, 2018, http://en.kremlin.ru/events/president/news/56957.

[48] Siniša Vuković and Riccardo Alfieri, "Bumping, Precedents, and De-Escalation in South China Sea: Options for the United States and China," *Asia and the Pacific Policy Studies* 5 no 3, 2018, 665–671.

[49] H I Sutton and Sam LaGrone, "China Builds Missile Targets Shaped Like U.S. Aircraft Carrier, Destroyers in Remote Desert," USNI News, last modified November 7, 2021, https://news.usni.org/2021/11/07/china-builds-missile-targets-shaped-like-u-s-aircraft-carrier-destroyers-in-remote-desert.

answer to their concerns regarding the United States ability to threaten their nuclear arsenals and disrupt regional strategic security. For the United States, hypersonic weapons present an opportunity to hold Chinese and Russian military forces at risk while simultaneously keeping U.S. military forces out of range for Chinese and Russian weapons.

1. Chinese Force Structure

Hypersonic weapons are an answer to three Chinese concerns regarding their nuclear second-strike capabilities that Tong Zhao describes in detail.[50] Beijing is concerned that the United States and its allies might undermine China's second-strike nuclear capabilities by developing and deploying conventional long-range strike weapons, by building missile defense capabilities and proliferating missile defense systems among U.S. allies, and by bolstering antisubmarine warfare capabilities that could threaten Chinese submarines based nuclear deterrence.[51] Each of these potential capabilities could severely threaten China's relatively small nuclear arsenal, which was estimated to contain "approximately 350 nuclear warheads."[52]

As Zhao argues, U.S. conventional long-range strike weapons, such as Tomahawk cruise missiles or hypersonic missiles, threaten Chinese air and missile defenses, and could destroy "key components of China's so-called anti-access, area-denial capabilities at the early stage of a conflict."[53] Even as China continues to develop and improve its air and missile defenses, the potential for the United States to develop, field, and provide hypersonic weapons to its allies near China could negate the Chinese air and missile defense improvements.[54] If these conventional long-range strike weapons or hypersonic

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[50] Tong Zhao, "Conventional Long-Range Strike Weapons of U.S. Allies and China's Concerns of Strategic Instability," *Nonproliferation Review* 27 no 1–3, 2020, 109–122.

[51] Zhao, "Conventional Long-Range Strike Weapons of U.S. Allies and China's Concerns of Strategic Instability," 110.

[52] Hans M. Kristensen and Matt Korda, "Chinese Nuclear Weapons, 2021," *Bulletin of the Atomic Scientists* 77 no 6, 2021, 318.

[53] Zhao, "Conventional Long-Range Strike Weapons of U.S. Allies and China's Concerns of Strategic Instability," 112.

[54] Zhao, "Conventional Long-Range Strike Weapons of U.S. Allies and China's Concerns of Strategic Instability," 112.

weapons from the United States or allies evade Chinese air and missile defense systems during a conflict, there is a possibility that they could severely degrade or eliminate Chinese command and control capabilities or destroy Beijing's limited nuclear arsenal.

Ballistic missile defense (BMD) systems that the United States has developed, fielded, and provided to its allies cause another significant area of concern for Chinese security strategists, as the 2016 agreement between the United States and South Korea to install a Terminal High Altitude Area Defense (THAAD) missile defense system in South Korea highlighted. While the U.S. Department of Defense stated that the missile defense system was to "ensure the security of South Korea and protect alliance forces from North Korea's weapons of mass destruction and ballistic missile threats,"[55] China saw it as a direct threat to Chinese strategic security. They viewed that "the deployment [of the THAAD system] will severely damage regional strategic security interests and harm the regional strategic balance."[56] Instead of solely providing protection for South Korea against potential North Korean ballistic threats, the Chinese viewed that it could also be used to counter Chinese ballistic missiles. Due to China's small nuclear arsenal, any BMD systems located close enough to Chinese launch sites could severely limit China's second-strike capability, thereby reducing Chinese strategic security. After considering this lone example of a BMD system near China, it becomes obvious that China has a serious problem to overcome to maintain their nuclear credibility when adding the potential for U.S. AEGIS BMD-capable ships sailing near Chinese waters to the mix.

In addition to U.S. conventional long-range strike weapons and BMD systems, U.S. antisubmarine capabilities pose another challenge to China's nuclear arsenal. The U.S. P-8A Poseidon aircraft, MH-60R helicopters, Ticonderoga class cruisers, Arleigh Burke class destroyers, and Littoral Combat Ships, combined with the U.S. submarine force, constitute

55 "US to Deploy THAAD Missile Battery to South Korea," Defense Media Activity, September 16, 2016, https://www.army.mil/article/171316.

56 "US Will Pay Price for THAAD Deployment, Beijing Mouthpiece People's Daily Says," CNBC, October 1, 2016, https://www.cnbc.com/2016/10/01/north-korea-tensions-us-will-pay-price-for-thaad-in-south-korea-beijing-peoples-daily-says.html.

a formidable U.S. antisubmarine force.[57] These forces are deployable around the globe and their mobility can create a significant targeting challenge for potential adversaries. Most importantly, their ability to locate, target, and engage submarines makes them a legitimate threat to adversarial submarine forces.

Hypersonic weapons offer one potential Chinese answer for each of the three threats to their nuclear arsenal. Due to their extensive range—between 1,200-2,500 miles[58]—hypersonic weapons give the Chinese the ability to put adversary delivery vehicles carrying conventional long-range strike weapons at risk, and could potentially deter them from travelling an acceptable distance to effectively employ those weapons. Chinese hypersonic weapons could also potentially create a 1,200-2,500 mile barrier—U.S. antisubmarine forces would incur severe risks if they attempted to penetrate it. Hypersonic weapons also create significant challenges to current United States and partners' BMD systems. As the Congressional Research Service's report on Hypersonic Missile Defense notes, "most terrestrial-based radars cannot detect hypersonic weapons until late in the weapon's flight due to line-of-sight limitations of radar detection. This leaves minimal time for a defender to launch interceptors that could neutralize an inbound weapon."[59] The United States does not currently possess the air and missile defense systems required to intercept or disable hypersonic weapons.[60]

While the previous discussion shows how China has supplied its forces with hypersonic weapons to challenge the United States, its wind tunnel program demonstrates that it possesses the scientific and manufacturing infrastructure to support it. Wind tunnels are vital to the development of hypersonic weapons, and they are incredibly expensive due to their maximum 15 second testing windows that require sensors capable of recording data

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57 "United States Navy: Summary," Janes, October 6, 2021, https://customer.janes.com/Janes/Display/JWNA0160-JWNA.

58 James M. Acton, "Hypersonic Weapons Explainer," Carnegie Endowment for International Peace, April 2, 2018, https://carnegieendowment.org/2018/04/02/hypersonic-weapons-explainer-pub-75957.

59 Kelley M. Sayler and Stephen M. McCall, *Hypersonic Missile Defense: Issues for Congress*, CRS Report No. IF11623, (Washington, DC: Congressional Research Service, January 26, 2022), 1.

60 Griffin, testimony on *Accelerating New Technologies*. The potential influence of hypersonic missile defenses on offensive hypersonic missile arms race dynamics is considered later in this thesis.

in thousandths of a nanosecond.[61] Additionally, multiple wind tunnels are required to develop hypersonic weapons. As professor Steven Schneider explained, "the most important thing to know about hypersonics and wind tunnels is that no single tunnel can simulate everything with respect to hypersonic flow."[62] At least five types of hypersonic wind tunnels are required to test and develop hypersonic weapons: quiet, blowdown, shock, arc-jet, and ballistic wind tunnels.[63] This means that developing hypersonic weapons is not quick, easy, or cheap. It requires significant investment in infrastructure over an extended period. China has made these investments. According to the Congressional Research Service, China has 22 operational wind tunnels capable of reaching a minimum speed of Mach 5, and plan to complete construction of one capable of achieving speeds of Mach 30 sometime in 2022.[64]

2. Russian Force Structure

Russian leadership has stated that they are equipping their force with hypersonic weapons to combat U.S. anti-ballistic missile technology. In a 2018 address, Russian President Vladmir Putin characterized the United States withdrawal from the Anti-Ballistic Missile Treaty in 2002.[65] He described how his extensive attempts in 2002 to renew the anti-ballistic missile treaty were met with rejection from the United States After discussing the anti-ballistic missile treaty, Putin fast-forwarded to the present day and went on to describe the current state and deployment of U.S. anti-ballistic missile technology. He highlighted active missile defense systems in Alaska, California, and Romania, as well as

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[61] Jeffrey R. Smith, "Hypersonic Missiles are Unstoppable and They're Starting a New Global Arms Race," *New York Times*, June 19,2019, A1, ProQuest.

[62] Eric Tegler, "To Develop Hypersonic Weapons, the U.S. has to Build Some Fiendishly Complicated Wind Tunnels," Forbes, June 19, 2019, https://www.forbes.com/sites/erictegler/2020/06/19/to-develop-hypersonic-weapons-the-us-has-to-build-some-fiendishly-complicated-wind-tunnels/?sh=1a1207d4237e.

[63] Tegler, "To Develop Hypersonic Weapons, the U.S. has to Build Some Fiendishly Complicated Wind Tunnels."

[64] Kelley M. Sayler, *Hypersonic Weapons: Background and Issues for Congress*, CRS Report No. R45811, (Washington, DC: Congressional Research Service, 2022), 17.

[65] Putin, "Presidential Address to the Federal Assembly."

a nearly completed missile defense system in Poland.[66] He also mentioned that the United States planned to build new missile defense sites in Japan (that has since been canceled)[67] and South Korea, and that the United States had five cruisers and 30 destroyers available to deploy near Russian borders.[68] In his view, Russian nuclear forces were faced with the threat of being rendered obsolete by U.S. anti-ballistic missile technology.

The point of Putin's lengthy discussion on U.S. anti-ballistic missile technology policy, developments, and deployments was to explain why Russia had developed hypersonic weapons. He noted that Russia had undertaken hypersonic weapons research and development to reduce the risk to its strategic security. He quoted himself from a 2004 statement following a strategic nuclear force system test, where he said that "in the near future, the Russian Armed Forces…will receive new hypersonic-speed, high-precision new weapons systems that can hit targets at inter-continental distance and can adjust their altitude and course as they travel."[69] He concluded by stating that after numerous attempts to open negotiations with the United States and NATO to restart the anti-ballistic missile treaty, "nobody really wanted to talk to us…and nobody wanted to listen to us. So listen now."[70] After that statement, he directed assistants to play a video depicting the Avangard hypersonic missile that he claimed was fully operational and deployed with Russian units.[71]

Putin's comments regarding the Russian hypersonic weapons program suggest that Russia has designed a force structure to counter the United States, but proof that Russia has actually done it can be found by examining the type of hypersonic weapons the Russian have deployed and are developing. The Avangard hypersonic glide vehicle is launched from an intercontinental ballistic missile (ICBM), "giving it effectively 'unlimited'

66 Putin, "Presidential Address to the Federal Assembly."

67 Michael Unbehauen and Chirstian Decker, "Japan Cancels Aegis Ashore: Reasons, Consequences, and International Implications," *Journal of Indo-Pacific Affairs*, Winter 2020, 97–127.

68 Putin, "Presidential Address to the Federal Assembly."

69 Putin, "Presidential Address to the Federal Assembly."

70 Putin, "Presidential Address to the Federal Assembly."

71 Putin, "Presidential Address to the Federal Assembly."

range."[72] The effectively unlimited range, coupled with the flight profile and maneuverability of the hypersonic glide vehicle gives Russia the ability to target anti-ballistic missile systems at range. Hypersonic weapons create significant challenges for all current missile defense systems. The Avangard hypersonic weapon provides Russia with a viable weapon to counter and potentially defeat U.S. anti-ballistic missile technology.

If the Avangard is a response to U.S. land-based anti-ballistic missile systems, the Tsirkon hypersonic cruise missile is a potential Russian answer to U.S. sea-based ballistic missile defense systems. The Tsirkon is "a ship-launched hypersonic cruise missile capable of traveling at speeds between Mach 6 and Mach 8…[and] is reportedly capable of striking both ground and naval targets."[73] It has been reported that the Tsirkon's range is between 250 and 600 miles.[74] Rear Admiral Mikhail Chekmasov of the Russian navy added during an interview that the Tsirkon "is a real killer of aircraft carriers."[75] Additionally, Russian defense industry sources have claimed that the Russian nuclear-powered missile submarine *K-329 Severodvinsk* has conducted test firings of the Tsirkon from a submerged position.[76] The ability for Russian surface and subsurface units to launch the Tsirkon gives Russia the potential to use mobile, sea-based platforms to engage U.S. sea and land-based targets.

The development of the Avangard and Tsirkon missiles structures Russia's military force to counter U.S. missile defense systems and current United States force projection capabilities. Hypersonic weapons are a viable, cost-effective counter for current U.S. military capabilities, and it appears that Russia is fully committed to developing them.

3. United States Force Structure

The United States does not face the same anti-ballistic missile technology threat or threats to its nuclear arsenal that China or Russia face. Instead, Chinese and Russian

[72] Steve Trimble, "A Hypersonic Sputnik?," *Aviation Week*, January 14–27, 20.

[73] Sayler, Hypersonic Weapons: Background and Issues for Congress, 13.

[74] Sayler, Hypersonic Weapons: Background and Issues for Congress, 13.

[75] Michael Starr, "Putin: Russia Soon to Deploy New Naval Hypersonic Missiles," *The Jerusalem Post*, last modified August 4, 2022, https://www.jpost.com/international/article-713900.

[76] Franz-Stefan Gady, "Russia to Test Fire Tsirkon Hypersonic Missile from Yasen-Class Submarine," *The Diplomat*, March 11, 2020, A1, ProQuest.

hypersonic weapons deny U.S. forces the ability to operate within the requisite range to place Chinese or Russian forces at risk. Hypersonic weapons also put air and missile defense systems, systems that the United States has spent decades researching and developing, at significant risk. This risk is especially imposed on the U.S. Navy's capital ship, the nuclear aircraft carrier (CVN). CVNs provide the bulk of the United States capability to operate with forward presence, and hypersonic weapons create an opportunity for U.S. adversaries to penetrate the air and missile defenses of a carrier strike group and target the CVN. This can deny CVNs the ability to operate its airwing within a reasonable distance of assigned objectives.

Hypersonic weapons pose a significant challenge to missile defense systems due to their maneuverability, speed, range, and low flight altitude. As the Congressional Research Service's report on hypersonic missile defense issues notes, "most terrestrial-based radars cannot detect hypersonic weapons until late in the weapon's flight due to line-of sight limitations of radar detection."[77] Even detection late in a hypersonic missile's flight does not promise a high probability for intercept; their high speed and increased maneuverability make them significantly more difficult to intercept compared to traditional ballistic or anti-ship cruise missiles. Former Under Secretary of Defense for Research and Engineering Mike Griffin highlighted one of the problems that hypersonic weapons cause for missile defense systems: "hypersonic targets are 10 to 20 times dimmer than what the United States normally tracks by satellites in geostationary orbit."[78] Additionally, as the then-commander of U.S. Strategic Command General John Hyten put it more bluntly in a March 2018 Congressional testimony, "we [the United States] don't have any defense that could deny the employment of such a weapon against us."[79] Clearly, hypersonic weapons create a problem for U.S. units that desire to operate within 1,200-2,500 miles of China or Russia.

So, the problem for the United States is that Chinese or Russian hypersonic weapons disrupt the United States ability to undertake forward presence operations. How

[77] Sayler, Hypersonic Weapons: Background and Issues for Congress, 1.

[78] Sayler and McCall, Hypersonic Missile Defense: Issues for Congress, 1.

[79] Smith, "Hypersonic Missiles are Unstoppable and They're Starting a New Global Arms Race."

does the United States regain its forward presence capability? One answer is hypersonic weapons. General Hyten, speaking this time in his role as the Vice Chairman of the Joint Chiefs of Staff, commented that hypersonic weapons could enable "responsive, long-range, strike options against distant, defended, and/or time-critical threats [such as road-mobile missiles] when other forces are unavailable, denied access, or not preferred."[80] Hypersonic weapons have the potential to give U.S. units the ability to reestablish the forward presence that Chinese and/or Russian hypersonic weapons aim to deny.

A very different example of the United States structuring its forces to counter China is the new U.S. Marine operational concept of Expeditionary Advanced Base Operations (EABO). According to the *Tentative Manual for Expeditionary Advanced Base Operations*,

> EABO are a form of expeditionary warfare that involves the employment of mobile, low-signature, persistent, and relatively easy to maintain and sustain naval expeditionary forces from a series of austere, temporary locations ashore or inshore within a contested maritime area in order to conduct sea denial, support sea control, or enable fleet sustainment.[81]

As the *Marine Corps Gazette* notes, "EABO was conceived within the context of an Island Chain Strategy in a war in the Pacific with the People's Republic of China (PRC)."[82] It mentions that the Island Chain Strategy was originally conceived during the Cold War to contain the Soviet Union and PRC in the Pacific.[83] EABO is a U.S. concept designed to counter the Chinese geographic and missile-coverage advantages in the western Pacific.

Just as China and Russia used hypersonic weapons to "structure their armed forces with the attention to the probable effectiveness of the forces in combat with, or as a deterrent to"[84] the United States, the United States is developing hypersonic weapons and has adopted operational concepts such as EABO to structure its force in a way to directly

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[80] Sayler, Hypersonic Weapons: Background and Issues for Congress, 1.

[81] Headquarters Marine Corps, Tentative Manual for Expeditionary Advanced Base Operations (TMEABO), (Washington, DC: February 2021).

[82] "Expeditionary Advanced Base Operations," *Marine Corps Gazette* 106, 103.

[83] "Expeditionary Advanced Base Operations," *Marine Corps Gazette* 106, 103.

[84] Gray, "The Arms Race Phenomenon," 41.

counter Chinese and Russian forces. It meets the criterion for Gray's force structure requirement, and to this point two of the four criteria have been met.

D. QUALITATIVE COMPETITION

Gray's third criterion asserts that states must compete in terms of quantity or quality.[85] The United States, China, and Russia are each developing hypersonic weapons, but a quantitative competition for hypersonic weapons is at best not yet apparent. After decades of stagnation, however, each state has made a major qualitative jump by achieving an initial operational capability (IOC). This chapter applies the qualitative element of Gray's third criterion to the hypersonic weapon competition to determine if the states are in a qualitative arms race.

Until recently, hypersonic weapon developments and improvements could not have been classified as qualitatively competitive. The U.S. hypersonic flight program started with North American Aviation's X-15 in 1954.[86] Russia started research on hypersonic weapons technology in the 1980s, and "accelerated its efforts in response to U.S. missile defense deployments in both the United States and Europe"[87] in 2001. Around 2005, China started allowing its researchers to publish papers on hypersonic research in popular global technical journals.[88] Iain Boyd, an aerospace engineer at the University of Colorado, pointed out that the first papers coming out of China were poor quality: "they were really just copying what other people had done; really just catching up."[89] Despite this research and development effort, little progress was made toward fielding a hypersonic weapon by the United States, China, or Russia.

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[85] Gray, "The Arms Race Phenomenon," 41.

[86] D. Sziroczak and H. Smith, "A Review of Design Issues Specific to Hypersonic Flight Vehicles," *Progress in Aerospace Sciences* 84, 2016, 2.

[87] Sayler, Hypersonic Weapons: Background and Issues for Congress, 12.

[88] Keith Button, "Hypersonic Weapons Race," *Aerospace America* 56 no. 6, 2018, 23.

[89] Button, "Hypersonic Weapons Race," 23.

The lack of progress in hypersonic weapon development drastically changed around 2018. Russia claimed to field its Avangard hypersonic weapon in 2018.[90] While China lacked high quality hypersonic research papers in 2005, Keith Button stated that by 2018 "Chinese researchers are [now] respected as peers in the community of hypersonics researchers who share unclassified findings."[91] China does not only have research papers to show its improvement in hypersonic weapons; according to reports it fielded hypersonic weapons in 2020.[92] Finally, while the United States has not yet fielded a hypersonic weapon as of 2022, it expects to field one in 2023.[93]

Fielding hypersonic weapons marks a major qualitative improvement for the United States, China, and Russia. It is a major qualitative improvement because it took the states over 60 years to break the barrier to IOC. Reaching IOC achieves the first step in Gray's criterion of a qualitative and quantitative arms race; he argues that after a qualitative plateau has been overcome that states can choose to compete quantitatively or qualitatively.[94] Now that China and Russia have fielded hypersonic weapons, and the United States plans to field its own in 2023, it is possible for a qualitative or quantitative competition to begin.

There are some signs that the next step toward a full qualitative competition has already been taken. China and Russia have developed hypersonic weapons that can be equipped with nuclear warheads, meaning that the accuracy required for them to hit their intended target is less than a conventionally armed hypersonic weapon.[95] The United States, on the other hand, has committed to non-nuclear warheads for its hypersonic program. As James Acton explains, for "non-nuclear warheads…accuracy is absolutely critical for the weapon to be militarily effective. The United States wants to be landing weapons within a few meters of the target. So United States goals are much more

[90] Putin, "Presidential Address to the Federal Assembly."

[91] Button, "Hypersonic Weapons Race," 23.

[92] Sayler and McCall, Hypersonic Missile Defense: Issues for Congress, 1.

[93] Sayler, Hypersonic Weapons: Background and Issues for Congress, 1.

[94] Gray, "The Arms Race Phenomenon," 47.

[95] Sayler, Hypersonic Weapons: Background and Issues for Congress, 14–15.

demanding than Russian and Chinese goals."[96] Highly precise hypersonic weapons could be the next phase in a qualitative competition.

In sum, the recent push to achieve hypersonic missile IOC by China, Russia and the United States evinces qualitative competition, an indication of Gray's third criterion of arms racing. While outright quantitative and qualitative racing is not apparent, the momentum of recent developments points in that direction. These early indicators provide the evidence that these countries are now in an *incipient* hypersonic missile arms race – not yet fully satisfying this criterion, but clearly heading in that direction.

E. RAPID IMPROVEMENTS

The fourth criterion of Gray's arms race definition is that there must be rapid increases in weapon quantity and/or improvements in quality.[97] The United States, China, and Russia have not yet begun to compete in terms of quantity, and so far, they have not attempted to make rapid qualitative increases in hypersonic weapons either. However, by reaching an IOC after decades without operational weapons, they have each recently accomplished a rapid increase in weapon quality.

The United States, China, and Russia each fielding hypersonic weapons within a five-year period is a rapid change in the status quo. Just as reaching IOC represents a major qualitative improvement in hypersonic weapons, it also marks a significant rapid improvement. For more than 60 years the three states collectively made little progress on fielding hypersonic weapons. In a fraction of that time, each state has fully developed and fielded a weapon, and it looks as though more improvements are also likely to come rapidly.

For example, the United States, successfully tested two different designs of hypersonic cruise missiles using scramjet systems, and China is researching scramjet

[96] Acton, "Hypersonic Weapons Explainer."

[97] Gray, "The Arms Race Phenomenon," 41.

engines.[98] Unlike hypersonic glide vehicles, which are launched by a missile before separating and gliding to their target, hypersonic cruise missiles fly under their own power from launch to impact.[99] Hypersonic cruise missiles and their scramjet systems are incredibly complex and difficult to construct, and to date no state has been able to field such a weapon.[100] However, the United States and Chinese efforts to develop these missiles indicate investment in qualitative improvement of the capability.

All three competitors reaching an IOC in hypersonic weapons is enough to be considered a rapid improvement in quality. As this section shows, subsequent rapid improvements are already underway. It is likely that because each state has overcome the IOC barrier that hypersonic weapon improvements will occur at a rapid pace for the foreseeable future. Each state will pursue a qualitative edge over their competition, and this will only further drive rapid improvements. As with qualitative improvement, this recent acceleration of effort is an early indication of Gray's fourth criterion of arms racing, with evidence of further acceleration satisfying conditions for the current existence of an *incipient* hypersonic missile arms race.

F. CONCLUSION

This chapter has evaluated the hypersonic weapon competition between the United States, China, and Russia on the basis of the four criteria contained in Gray's concept of an "arms race": 1) two or more parties are conscious of their antagonism; 2) they have designed and fielded forces with a purpose to challenge the other arms race participants; 3) they must compete in quantity or quality; and 4) there must be rapid increases in the quantity and/or improvements in quality.[101] It has shown that the first and second factors are well established, and that the third and fourth are now beginning to emerge.

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[98] For U.S. hypersonic cruise missile testing, see Alex Hollings, "America May Have Just Taken the Lead in Hypersonic Cruise Missile Technology," Sandboxx, last modified April 7, 2022, https://www.sandboxx.us/blog/america-may-have-just-taken-the-lead-in-hypersonic-cruise-missile-technology/; for China's scramjet program, see Sayler, *Hypersonic Weapons: Background and Issues for Congress*, 16.

[99] Sayler, Hypersonic Weapons: Background and Issues for Congress, 2.

[100] Hollings, "America May Have Just Taken the Lead in Hypersonic Cruise Missile Technology."

[101] Gray, "The Arms Race Phenomenon," 41.

Because two of the four factors are well established and the other two are nascent, the hypersonic weapon competition between the United States, China, and Russia can be classified as an incipient arms race. It is an incipient arms race largely because hypersonic weapons have only been in existence for less than a decade, and one of the participants (the United States) has yet to field an operational hypersonic weapon. When the United States fields its first hypersonic weapon, which it expects to do in 2023,[102] each state will have fielded operational weapons. The preceding analysis also identified evidence that the two nascent factors of this incipient arms race may then emerge in full force.

A fully-developed hypersonic missile arms race will likely generate an urgent need for increased capabilities in hypersonic missile defense, a problem that the United States is already attempting to solve.[103] With successful hypersonic missile defenses will come the need for more advanced hypersonic weapons to evade or defeat these defenses, and at that point the hypersonic weapons arms race will be entrenched. It is not necessary to wait until this happens to classify this phenomenon as an arms race. To invoke a metaphor, it looks like a duck, it quacks like a duck, and we have yet to see it walk; but at this point it seems certain that it is going to be a duck.

[102] Sayler, Hypersonic Weapons: Background and Issues for Congress, 1.

[103] Sayler and McCall, Hypersonic Missile Defense: Issues for Congress.

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III. EXPLAINING AN INCIPIENT ARMS RACE

An incipient arms race in hypersonic weapons is underway between the United States, China, and Russia. What is causing the arms race, and what factors are driving it? To answer these questions, this chapter assesses the drivers of this incipient arms race utilizing Joseph Maiolo's three explanatory models for arms races: 1) an action-reaction cycle; 2) domestic political causes; and 3) technological innovations.[104]

Prior assessments, discussed in the literature review in Chapter I, suggest that an action-reaction cycle may be playing a predominant role hypersonic weapons development. To evaluate this hypothesis, this chapter first focuses on examining the evidence to support the action-reaction cycle explanation. The chapter then evaluates whether Maiolo's other two models – technological innovation and domestic factors – also play important roles.

A. THE ACTION-REACTION CYCLE

The action-reaction cycle is built on the security dilemma theory: "as a state increases its own security, it may decrease that of others, inviting them to respond."[105] This model is driven forward by countries reacting to competitors and adversaries. One thing leads to another, and after several iterations of this cycle two or more countries might be locked in an arms race.

The action-reaction cycle analysis in this section starts with Chinese observations of the U.S. military performance in the 1991 Persian Gulf War and the 1996 Taiwan Straits crisis. It then examines the Russian and Chinese reactions to the United States withdrawal from the 1972 Anti-Ballistic Missile Treaty. The section finishes by tracing the action-reaction dynamics in recent hypersonic weapon research.

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[104] Joseph Maiolo, "Introduction," in *Arms Races in International Politics: From the Nineteenth to the Twenty-First Century*, ed. Thomas Mahnken, Joseph Maiolo, and David Stevenson (New York: Oxford University Press, 2016), 6–7.

[105] Maiolo, "Introduction," 8.

1. The Persian Gulf War and Taiwan Straits Crisis

The action-reaction cycle dynamics in the incipient hypersonic weapon arms race started with the U.S. military performance in the 1991 Persian Gulf War. Chinese leaders observed how U.S. military forces quickly and efficiently defeated Iraqi military forces, and recognized the similarities in military approach that the Iraqis and Chinese shared.[106] These events forced the PRC to reconsider its previously held doctrine of focusing on economic growth while downplaying military growth. As Tai Ming Cheung explained, "the Gulf War finally forced the PLA [People's Liberation Army] to overcome its long-standing Maoist-inherited aversion to technology and embrace the central role of high technology."[107] Chinese leadership determined that the time had come for military modernization.

Another significant factor that caused Chinese leadership to reevaluate its strategic doctrine and military force structure was the potential for Taiwan to declare independence and receive U.S. military aid in any subsequent armed conflict.[108] The 1996 Taiwan Strait crisis brought this possibility to the forefront of Chinese strategic thinking. Potentially seeking to influence the 1996 Taiwanese presidential election, the PLA conducted missile firings near Taiwan's coastline in 1995.[109] In response, the United States sent the *Nimitz* carrier strike group through the Taiwan Straits in December 1995, marking the first time the United States sent a warship through the straits since the United States announced full

[106] Tai Ming Cheung, "Racing from Behind: China and the Dynamics of Arms Chases and Races in East Asia in the Twenty-First Century," *Arms Races in International Politics: From the Nineteenth to the Twenty-First Century*, ed. Thomas Mahnken, Joseph Maiolo, and David Stevenson (New York: Oxford University Press, 2016), 252; Luis Lázaro Tijerina and Muhammad Ali Baig, "China's People's Liberation Army: Restructuring and Modernization," *Open Military Studies* no. 2 (2022), 85; and Lindsay Maizland, "China's Modernizing Military," Council on Foreign Relations, last modified February 5, 2020, https://www.cfr.org/backgrounder/chinas-modernizing-military.

[107] Cheung, "Racing from Behind: China and the Dynamics of Arms Chases and Races in East Asia in the Twenty-First Century," 252.

[108] Cheung, "Racing from Behind: China and the Dynamics of Arms Chases and Races in East Asia in the Twenty-First Century," 252.

[109] Dennis van Vranken Hichey, "The Taiwan Strait Crisis of 1996: Implications for U.S. Security Policy," *Journal of Contemporary China* 7 no. 19 (1998), 406–407.

diplomatic relations with the PRC in 1979.[110] As Dennis van Vranken Hicheyk recounted, a few months later, in March 1996, "the PRC announced that it would conduct a series of 'missile tests' off Taiwan's coastline. Four days later, it declared that it would stage 'live-fire' air force and naval maneuvers at the southern end of the Taiwan Straits."[111] This time, the United States sent two carrier strike groups through the Taiwan Straits and put them on patrol near Taiwanese waters.[112]

If PRC and PLA leadership observed U.S. military superiority during the Persian Gulf war from afar, the Taiwan Straits crisis served as an up-close look. The two carrier strike groups that the United States sent through the Straits signaled United States support of Taiwan and probable military support should China attempt any direct military action against Taiwan. It also served as a stark reminder to China "that Washington remains the foremost obstacle to 'reunifying' Chinese 'lost territories' with the mainland and to ending finally the Communist Party's civil war with the Kuomintang."[113] PRC and PLA leadership took note, and Jiang Zemin, president of the PRC from 1993–2003, determined that China was ill-prepared to confront the "networked precision strike capabilities [of the United States]…in the context of potential conflict with the United States over Taiwan."[114] Determined to close the gap between the PLA and the U.S. military, Chinese leadership increased its defense spending, boosted its defense industry, and invested in new technologies.[115]

[110] Van Vranken Hichey, "The Taiwan Strait Crisis of 1996: Implications for U.S. Security Policy," 405, 407.

[111] Van Vranken Hichey, "The Taiwan Strait Crisis of 1996: Implications for U.S. Security Policy," 407.

[112] Van Vranken Hichey, "The Taiwan Strait Crisis of 1996: Implications for U.S. Security Policy," 408.

[113] Robert S. Ross, "The 1996 Taiwan Strait Crisis Lessons for the United States, China, and Taiwan," *Security Dialogue* 27 no. 4 (December 1996), 466.

[114] Burke, Gunness, Cooper, and Cozad, "People's Liberation Army Operational Concepts," 4.

[115] Maizland, "China's Modernizing Military."

As Ethan Breitenbach contends, hypersonic weapons are a technology that China has developed that give it the capability to counter U.S. military units in the Pacific.[116] With hypersonic weapons, the PLA has the ability to put its ordnance on target in Japan, South Korea, Guam, and any other United States or allied base within a matter of minutes. Plus, with the maneuvers that hypersonic weapons are capable of, the PLA can evade and defeat U.S. missile defense systems. Finally, the range of hypersonic weapons allows the PLA to reduce "the concept of distance on the battlefield', allowing for target-centric warfare.[117]" In addition to giving the PLA the ability to defeat U.S. missile defense systems, hypersonic weapons also offer the capability of defeating those systems at range. If nothing else, the presence of Chinese hypersonic weapons in the western Pacific will force U.S. leaders to consider the risk to U.S. warships prior to sending them within range. Chinese hypersonic weapons have the potential to prevent another situation such as the United States response to the 1996 Taiwan Straits crisis.

2. The Anti-Ballistic Missile Treaty Withdrawal

The first event in the action-reaction cycle involved only with United States and China; the Anti-Ballistic Missile (ABM) Treaty events involved primarily the United States and Russia, but in an indirect way also included China. It had a direct impact on Russia entering the hypersonic weapon arms race, and after the 1991 Persian Gulf War and the 1996 Taiwan Straits crisis it served as China's final straw to be broken prior to it entering the race.

As a quick overview, the ABM (officially titled the Treaty on the Limitation of Anti-Ballistic Missile Systems) was signed by the United States and Soviet Union on May 26, 1972. The ABM treaty held several agreements regarding anti-ballistic missile systems:

1. Each state was limited to one ABM site; located either at the nation's capital or around an ICBM deployment area.[118]

[116] Ethan G. Breitenbach, "Hypersonic Hype: An Analysis of the Emerging Sino-American Arms Race in the Pacific" (Thesis, University of Oregon, 2020), 45.

[117] Burke, Gunness, Cooper, and Cozad, "People's Liberation Army Operational Concepts," 14.

[118] The initial 1972 agreement allowed ABM systems at two locations (one being the state's capital, the other around an ICBM launcher), but an additional 1974 protocol limited ABM systems to one location.

2. The ABM system radius could not exceed 150 kilometers.
3. The ABM location could contain no more than 100 ABM launchers and 100 ABM interceptor missiles.
4. Limited the number and power of ABM radars at the ABM site.
5. Banned the development, testing, and deployment of sea-based, air-based, space-based, or mobile land-based ABM systems and system components.[119]

The ABM treaty was one of two agreements reached by the United States and Soviet Union during the Strategic Arms Limitation Talks (SALT); the second agreement (the Interim Agreement on the Limitation of Strategic Offensive Arms) was designed to "impose a 'freeze' on the number of launchers each country could deploy for its strategic offensive nuclear weapons."[120] As Amy Woolf observed, "together, these agreements were intended to slow, and eventually reverse, the nuclear arms race between the United States and Soviet Union."[121] The ABM treaty remained in effect even after the fall of the Soviet Union, covering the United States and the former Soviet territories: the Russian Federation, the Republic of Belarus, the Republic of Kazakhstan, and Ukraine.[122]

After being elected in 2000, U.S. President George W. Bush sought to withdrawal the United States from the ABM treaty. In his administration's view, the ABM treaty was a Cold War relic that made the United States vulnerable to ballistic missile attacks from "rogue" nations such as North Korea, Iran, and Iraq.[123] With the Soviet Union no longer in existence and therefore no longer posing a threat to the United States, in the Bush administration's estimation the most likely threat of ballistic missile attack came from

119 Amy F. Woolf, *Anti-Ballistic Missile Treaty Demarcation and Succession Agreements: Background and Issues*, CRS Report No. 98–496, (Washington, DC: Congressional Research Service, 2000), 2.

120 Woolf, Anti-Ballistic Missile Treaty Demarcation and Succession Agreements: Background and Issues, 1.

121 Woolf, Anti-Ballistic Missile Treaty Demarcation and Succession Agreements: Background and Issues, 1.

122 Woolf, Anti-Ballistic Missile Treaty Demarcation and Succession Agreements: Background and Issues, 5.

123 Paul Richter and Robin Wright, "Plan to Quite ABM Treaty Called Timely," *Los Angeles Times*, December 13, 2001, A1, ProQuest.

rogue states and terrorists.[124] ABM technology represented the best possible answer to this threat, and developing that technology would require the United States to withdrawal from the ABM treaty. Finally, in June 2002, the United States formally withdrew from the ABM treaty.[125]

a. Russian Reaction

When the United States withdrew from the ABM treaty, Russian government officials expressed regret and made it known that they had made multiple attempts renegotiate the treaty, but made few other public denunciations until years later.[126] In his 2018 presidential address, Russian President Vladmir Putin claimed that in "the entire 15 years since the withdrawal of the United States from the Anti-Ballistic Missile Treaty, we [Russia] have tried to reengage the American side in serious discussions, in reaching agreements in the sphere of strategic stability."[127] He noted that the two states had made some progress by pointing to the 2010 New START treaty, but claimed that the United States had done little else to preserve global strategic stability.[128] Putin went on to assert that "despite our [Russian] numerous protests and pleas, the American machine has been set in motion, the conveyer belt [of ABM technology] is moving forward."[129] Finally, he characterized how U.S. ABM systems were designed to counter ballistic targets from weapons that "form the backbone of our nuclear deterrence forces."[130] Clearly, in Putin's opinion, U.S. ABM systems represented a formidable threat to the Russian nuclear arsenal.

After he explained the ABM treaty narrative, Putin discussed a few weapons that Russia had been developing to defeat U.S. ABM systems. The primary weapon he

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[124] Steven A. Hildreth, *Ballistic Missile Defense: Historical Overview*, CRS Report RS22120, (Washington, DC: Congressional Research Service, January 28, 2008), 4.

[125] Hildreth, Ballistic Missile Defense: Historical Overview, 4.

[126] Richter and Wright, "Plan to Quite ABM Treaty Called Timely."

[127] Vladmir Putin, "Presidential Address to the Federal Assembly," March 1, 2018, http://en.kremlin.ru/events/president/news/56957.

[128] Vladmir Putin, "Presidential Address to the Federal Assembly."

[129] Vladmir Putin, "Presidential Address to the Federal Assembly,"

[130] Vladmir Putin, "Presidential Address to the Federal Assembly,"

discussed was the Russian Avangard hypersonic missile, which he claimed could achieve a speed that "makes it invulnerable to current missile and air defense systems, since interceptor missiles are, simply put, not fast enough."[131] Hypersonic weapons were one of Russia's primary answers to U.S. ABM systems. For Russia, the United States withdrawal from the ABM treaty served as the catalyst to enter the incipient hypersonic weapon arms race.

b. Chinese Reaction

China, in contrast to Russia, was immediately concerned and vocal about the United States development of ABM technology after withdrawing from the ABM treaty. In late 2001, the then-Chinese Foreign Ministry spokeswoman Zhang Qiyue stated bluntly that "China is not in favor of missile defense systems. China worries about the negative impact."[132] At about the same time, then-Senator Joseph Biden summed up Chinese concerns when he wrote that "China currently possesses no more than two dozen ICBMs. Our [United States] own intelligence services estimate that moving forward with national missile defense could trigger a tenfold increase in China's expansion of its nuclear capability."[133] After the United States completed its Ground-Based Mid-Course Defense interceptors at Fort Greely, Alaska and Vandenburg Space Force Base in California in 2004, top Chinese arms control negotiator Sha Zukang commented that "the acknowledged design capabilities of NMD [National Missile Defense] show that the proposed system can be directed against China and can seriously affect China's limited nuclear capability."[134] While it was unlikely that the United States could develop and field ABM technology that had the potential to counter Russia's massive nuclear arsenal, it did put the much smaller Chinese nuclear arsenal at significant risk, and Chinese leadership took note.

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131 Vladmir Putin, "Presidential Address to the Federal Assembly,"

132 Richter and Wright, "Plan to Quite ABM Treaty Called Timely."

133 Joseph R. Biden, "Missile Defense Delusion," *The Washington Post*, December 19, 2001, A1, ProQuest.

134 Reuben Steff, "Cooperative Ballistic Missile Defense for America, China, and Russia," *Contemporary Security Policy* 34 no. 1, (2013), 100.

Although the deployment of U.S. ABM systems in the western Pacific came well after China began its hypersonic weapon program in earnest, those deployments served to reinforce the Chinese need for hypersonic weapons technology. As described in Chapter II, hypersonic weapons represent a potential answer to U.S. ABM systems. They give the PLA the ability to hold U.S. military units at risk at significant range.

3. Hypersonic Weapon Research

The hypersonic weapon research and testing conducted in the mid to late 2010s will be the final event discussed in the action-reaction cycle. China entered the hypersonic weapon arms race after the observation of the U.S. military performance during the 1991 Persian Gulf war, the 1996 Taiwan Straits crisis, and ABM treaty termination; Russia jumped in the race in earnest after the ABM treaty termination. This section will focus on the entrance of the United States by examining the challenges it faced in hypersonic weapon development and the factors that pushed it to overcome them.

Although the United States started its own hypersonic research program in 1954, up until around 2018, it had not seriously committed to developing hypersonic weapons. Instead, it had an on-again off-again relationship with hypersonic research.[135] In a 2019 interview prior to his retirement, General John Hyten, then-Vice Chairman of the Joint Chiefs of Staff, summed up U.S. hypersonic weapon development:

> We [the United States] were developing hypersonics ahead of everybody in the world and the first test failed. The first test of everything fails. So the first test fails and we have two years of investigation into why did it fail…Then we launch again and it fails…and we canceled the program and we stopped.[136]

In Hyten's opinion, the crux of the U.S. hypersonic weapon development problem was that U.S. leadership became risk averse. He stated that the 2000 Quadrennial Defense Review (QDR) declared a shift from threat-based weapons development to capabilities-based

[135] D. Sziroczak and H. Smith, "A Review of Design Issues Specific to Hypersonic Flight Vehicles," *Progress in Aerospace Sciences* 84, 2016, 2.

[136] General John E. Hyten, Defense Writers Group Project for Media and National Security, George Washington School of Media and Public Affairs, October 28, 2021.

weapons development to maintain the U.S. position as the preeminent military in the world.[137] He added that the QDR said "if we [the United States] just build the capabilities we have in the United States we'll be able to stay ahead of everybody in the world forever."[138] In other words, because the United States possessed the number one military in the world, it could focus on further developing military capabilities rather than developing weapons for second-rate threats to maintain its leading military status. It caused, in Hyten's view, the United States to remove all risk from the development and testing process, and this refusal to accept failure during testing severely hampered hypersonic weapon development.[139]

In addition to shifting its focus away from risky tests and development, the United States also had little need to develop advanced weapons in the 2000s. The opponents that U.S. forces faced in Iraq and Afghanistan during this time were technologically outmatched. U.S. missile defense systems were never sufficiently challenged to the point that new technologies, such as hypersonic weapons, were necessary to win either war. The United States also had no other peers at the time that required it to make such innovations. As a result, the U.S. Congress typically restricted funding to hypersonic weapon programs.[140]

On March 6, 2018, at the Sphinx Club in Washington, Michael Griffin signaled a change when he declared the United States entrance into the hypersonic weapon arms race: "I'm sorry for everybody out there who champions some other high priority…but there has to be a first, and hypersonics is my first."[141] A high-ranking U.S. government official with the ability to allocate the necessary resources to hypersonic weapon development declared

[137] Hyten, Defense Writers Group Project for Media and National Security.

[138] Hyten, Defense Writers Group Project for Media and National Security.

[139] Hyten, Defense Writers Group Project for Media and National Security.

[140] Amy Woolfe, *Conventional Prompt Global Strike and Long-Range Ballistic Missiles: Background and Issues*, CRS Report R41464, (Washington, DC: Congressional Research Service, July 16, 2021), 3.

[141] Jeffrey R. Smith, "Hypersonic Missiles are Unstoppable and They're Starting a New Global Arms Race," *New York Times*, June 19,2019, A1, ProQuest.

that hypersonic weapons were the U.S. number one weapons development priority. With that statement, Griffin declared the United States was in the arms race.

What changed that pulled the United States out of the risk-averse behavior that Hyten described to making hypersonic weapon development Griffin's number one priority? Hyten, again, had the answer: "then other [s] start building hypersonics, others start testing…and they start moving fast, so we start the programs again."[142] Although Hyten's main point in that comment was to continue lamenting the slow pace of U.S hypersonic weapon development due to bureaucracy and risk-aversion, it also contained the answer as to why the United States restarted its hypersonic program. The "others" he mentions are China and Russia, and their possession of hypersonic weapons were the catalyst for the United States to jump into the hypersonic weapon arms race.

Comments from Vice Admiral Johnny Wolfe, head of the U.S. Strategic Systems Programs office – the entity charged with developing and fielding U.S. hypersonic weapons – further cemented the notion that the United States has entered the hypersonic weapon arms race as a reaction to Chinese and Russian hypersonic developments. At the Naval Submarine League's annual conference in November 2021, Wolfe discussed aspirations of a submarine-launched hypersonic weapon.[143] He noted that the Navy wants such a weapon as quickly as possible due to the increasing Chinese hypersonic capabilities.[144]

After the fall of the Soviet Union, the United States became risk-averse in weapons testing which resulted in stunted hypersonic weapon development. After observing the advancements China and Russia made with their hypersonic programs, specifically after each state fielded a hypersonic weapon, the United States decided that it was time to match these efforts in earnest.

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[142] Hyten, Defense Writers Group Project for Media and National Security.

[143] Megan Eckstein, "Navy Looks to Get Back on Schedule for Fielding Hypersonic Missiles on Submarines," Defense News, last modified November 18, 2021, https://www.defensenews.com/naval/2021/11/18/navy-looks-to-get-back-on-schedule-for-fielding-hypersonic-missiles-on-submarines/.

[144] Eckstein, "Navy Looks to Get Back on Schedule for Fielding Hypersonic Missiles on Submarines."

As the analysis of this section shows, the action-reaction model is the best fit of the three models for explaining the emerging hypersonic weapon arms race. It has been the primary catalyst for the arms race and is the model most likely to continue to push it forward. The United States entrance is a bit late coming to the hypersonic arms competition, but when it fields a hypersonic weapon – which it expects to do in 2023[145] – the action-reaction dynamics already in place indicate that an arms race will likely hit full speed.

B. DOMESTIC POLITICAL CAUSES

Domestic political causes for arms races have two primary foundational elements. These involve arms development being used as an outlet for industry to produce military weapons for profit or by domestic actors to conjure fear of foreign threats to justify arms production as a way of social control.[146] The evidence behind domestic political causes for the hypersonic weapon arms race does not show that it is being driven by industry, and only in the Russian case does it show that it is being used as a way of social control. Both China and Russia could adopt messaging that is intended for a domestic audience that would feed the arms race.

The United States, on the other hand, does not appear be influenced by domestic political causes in the incipient hypersonic arms race. For example, in February 2022 U.S. Secretary of Defense Lloyd Austin met with over two dozen CEOs from U.S. defense companies and encouraged them to accelerate their hypersonic weapon development.[147] If domestic industry interests were a significant driver for the United States, then meetings like those held by Secretary Lloyd would be unnecessary; the defense contractors would have already accelerated their research without government prodding, and would have then lobbied for the government to buy the products their research produced. Also, evidence of

[145] Sayler, Hypersonic Weapons: Background and Issues for Congress, 1.

[146] Maiolo, "Introduction," 7.

[147] Kristin Fisher, "Pentagon Urges CEOs of Largest Defense Companies to Accelerate Hypersonic Weapons Development as U.S. Lags Behind China," CNN, last modified February 4, 2022, https://www.cnn.com/2022/02/03/politics/pentagon-hypersonic-weapons-defense-companies-meeting/index.html.

the United States conjuring fear of foreign threats to justify hypersonic arms production as a way of social control does not exist. The primary messaging from U.S. officials regarding the justification for U.S. hypersonic weapon development fits the action-reaction model, not the domestic political cause model.[148] For these reasons, this section will focus on the domestic political causes within Russia and China to show how they are contributing to the hypersonic weapon arms race.

1. Russia's Domestic Messaging

Russian president Vladmir Putin has used his country's hypersonic weapon development to maintain his domestic support and has indirectly pushed the arms race forward. He has overseen multiple public displays of Russia's hypersonic weapons and has used them as an opportunity to showcase Russia's military and technological ability to overcome adversary capabilities. Putin and his subordinates' domestic messaging has caught the attention of the international community and has forced other countries, primarily the United States, to increase their efforts on hypersonic development.

Putin's 2018 presidential address is an excellent example of messaging that was intended to show his domestic audience how the Russian military had recognized and then overcame U.S. capabilities through technological innovation.[149] He first discussed the security challenges that U.S. missile defense technology created for Russian nuclear forces. Then, Putin explained how hypersonic weapons could overcome such missile defense systems and how several states were pursuing such technologies. Finally, he delivered his knockout blow: "friends, Russia already has such a [hypersonic] weapon."[150] He declared that the Kinzhal hypersonic missile was fully operational and deployed to Russian units, and the Avangard was in development.

[148] See Michael Griifin's statement in Aaron Mehta, "Hypersonics 'Highest Technical Priority' for Pentagon R&D Head," Defense News, last modified March 6, 2018, https://www.defensenews.com/pentagon/2018/03/06/hypersonics-highest-technical-priority-for-pentagon-rd-head/.

[149] Putin, "Presidential Address to the Federal Assembly."

[150] Putin, "Presidential Address to the Federal Assembly."

Putin's statements in his 2018 presidential address communicated to his domestic audience how his administration and military had recognized a significant strategic security threat and then overcame it. He conveyed that he is providing at minimum basic human needs to maintain his political support. Security is one of those needs. A threat to Russia's nuclear forces is arguably the greatest security threat it could face, and Putin argued that U.S. missile defense systems represented such a threat.[151] As he communicated in his address, he mitigated that threat with hypersonic weapons and in the process achieved a hypersonic capability before any other country.

Later that year, on December 26, 2018, Putin presided over a test of the Avangard hypersonic missile.[152] After a successful test, he proclaimed that the Avangard was "the perfect New Year's gift for the country."[153] Once again he used a public display of Russian hypersonic weapons to show his populace how he understood the threat U.S. missile defense systems posed to Russia and overcame it with a hypersonic weapon.

The primary purpose of Putin's announcements and public tests was to demonstrate to the Russian people how his regime is providing world-class security for Russia. The attempted display of Russian strength caught the notice of the United States, and the proclamations and demonstrations have been part of reason for increased U.S. investment in its own hypersonic weapons.[154] Putin's domestic political messaging has had an indirect effect of propelling the hypersonic weapon arms race.

2. China's Unrealized Hypersonic Recipe

All the ingredients required for the Chinese Communist Party (CCP) and People's Liberation Army (PLA) to utilize the PLAs hypersonic weapon programs as a domestic

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151 Putin, "Presidential Address to the Federal Assembly."

152 Richard Stone, "National Pride is at Stake.' Russia, China, United States Race to Build Hypersonic Weapons," Science, last modified January 8, 2020, https://www.science.org/content/article/national-pride-stake-russia-china-united-states-race-build-hypersonic-weapons.

153 Stone, "National Pride is at Stake.' Russia, China, United States Race to Build Hypersonic Weapons."

154 Amanda Macias, "Russia's New Hypersonic Missile, Which can be Launched from Warplanes, Will Likely be Ready for Combat by 2020," CNBC, last modified March 21, 2019, https://www.cnbc.com/2018/07/13/russia-new-hypersonic-missile-likely-ready-for-war-by-2020.html.

political driver in the hypersonic weapon arms race are existent, but so far have been unrealized. The People's Republic of China (PRC) president Xi Jinping's vision of the China Dream; social stability as a primary mission of China's national defense organizations; and public military displays all put hypersonic weapons in a prime position for the CCP to use them as a tangible measuring stick to reenforce its hold on power. This section will highlight each of these topics and describe how they could be used to advance the hypersonic weapon arms race further from a domestic political perspective.

Xi Jinping defines the China Dream as "a strong and prosperous state, a national revival, and a happy people."[155] Xi launched the China Dream campaign after assuming power in 2012.[156] The first part of Xi's China Dream is to create "a strong and prosperous state, [and] a national revival,"[157] creates an opening that hypersonic weapon development could potentially fill. The infrastructure alone required to test and develop hypersonic weapons is a significant investment that relatively few countries have pursued.[158] China has made the investments required and has gone beyond simply pursuing hypersonic weapons; China has actually fielded them.[159] The fact that China was able to invest in the infrastructure and educate the scientists and engineers required to produce hypersonic weapons demonstrates China's prosperous position in the world.

Hypersonic weapon development also signals a national revival of the PLA and is a contributor to the PRC becoming a strong state. The PLA, PLA Navy, and PLA Air Force have each undergone modernizations within the last few decades that have made them a formidable fighting force.[160] Those modernization efforts have gone a long way toward

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155 Lanxin Xiang, "Xi's Dream and China's Future," *Survival* 58 no. 3 (June-July 2016), 56.

156 Xiang, "Xi's Dream and China's Future," 56.

157 Xiang, "Xi's Dream and China's Future," 56.

158 Richard H. Speier, George Nacouzi, Carrie A. Lee, and Richard M. Moore, "Ongoing Hypersonic Technology Proliferation" in *Hypersonic Missile Nonproliferation: Hindering the Spread of a New Class of Weapons* RR2137 (Santa Monica, CA: RAND Corporation, 2017), 21–34, https://www.rand.org/pubs/research_reports/RR2137.html.

159 Kelley M. Sayler, *Hypersonic Weapons: Background and Issues for Congress*, CRS Report No. R45811, (Washington, DC: Congressional Research Service, 2022), 15.

160 Caitlin Campbell, *China's Military: The People's Liberation Army (PLA)*, CRS Report No. R46808, (Washington, DC: Congressional Research Service, June 4, 2021), 26–44.

establishing the PLA as the world-class force Xi described in 2017.[161] However, those modernizations alone have not established the PLA as a world-class force. Advanced weapons, such as hypersonic weapons and their capabilities to challenge and defeat adversarial militaries, have the potential to shape the PLA into a world-class force. Hypersonic weapons are a tangible object Xi can point to that proves the PLA is a world-class force, and therefore that he is achieving his goal of making the PRC a strong state.

Most modern Chinese national defense white papers include domestic concerns as a primary mission for China's national defense industry.[162] One example given in the RAND Corporation's *China's Grand Strategy* report defines domestic concerns as "stopping attempts to overthrow the state by force, [and] maintaining social stability."[163] The immediate implications of this mission is that it will result in the PLA physically assisting the CCP to maintain order. While this might be true, there is no evidence that suggests the PLA has leveraged its hypersonic weapons in any way to meet the challenge presented by domestic concerns.

The CCP and PLA have engaged in public displays of PLA hypersonic weapons, such as DF-17s, enabling the CCP and PLA to exhibit their technological achievements to the Chinese populace.[164] Xi opened his October 1, 2019 military parade on national Chinese television with the statement: "no force can shake the status of our great motherland, and no force can stop the progress of the Chinese people and the Chinese nation."[165] Similar to the domestic concerns case, however, beyond public displays and

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161 Campbell, China's Military: The People's Liberation Army (PLA), 8.

162 Andrew Scobell, Edmund J. Burke, Cortez A. Cooper III, Sale Lilly, Chad J.R. Ohlandt, Eric Warner, and J.D. Williams, "China's Grand Strategy," RR2798 (Santa Monica, CA: RAND Corporation, 2020), 31, https://www.rand.org/pubs/research_reports/RR2798.html.

163 Scobell, Burke, Cooper, Lilly, Ohlandt, Warner, and Williams, "China's Grand Strategy," 93.

164 Shaan Shaikh, "China's Hypersonic Future," Center for Strategic and International Studies, last modified December 12, 2021, https://missilethreat.csis.org/chinas-hypersonic-future/; Sakshi Tiwari, "China Flashes 'Rare Footage' of DF-17 Hypersonic Missile Ahead of Army Day Celebrations, Pelosi's Taiwan Visit," *The EurAsian Times*, last modified August 1, 2022, https://eurasiantimes.com/china-flashes-rare-footage-of-hypersonic-missile-army-day/.

165 "China Uses Communist Party's 70th Anniversary to Show Off New High-Tech Missiles," CBS News, last modified October 1, 2019, https://www.cbsnews.com/news/china-parade-70th-anniversary-communist-party-new-high-tech-missiles-hypersonic-df-17-today-2019-10-01/.

broad statements it does not appear that Xi, the CCP, or the PLA have displayed hypersonic weapons in a way that would significantly alter the hypersonic arms race; that is, China's hypersonic weapons development efforts do not appear to be *independently* driven by a motive to use this development as a means of strengthening popular support.

While it would be logical for the CCP and PLA to use their hypersonic weapon programs as proof of Xi succeeding in implementing his vision of the China Dream and to increase the CCPs hold on power in China, so far neither institution has done so. One reason why the CCP has not done so might be due to its hesitancy to disrupt economic objectives and advancing an international perception of China as a threat.[166] Another could be due to the incipience of the arms race. It is possible that because the hypersonic weapon arms race is just beginning that domestic political factors that could drive it forward have not developed. It is possible that in the coming years, especially after the United States fields its own hypersonic weapons, that the CCP will point to its own and its adversaries' hypersonic weapons in a way that will propel the arms race.

C. TECHNOLOGICAL INNOVATIONS

In the technological innovation model, actors undertaking incremental technological innovations over time end up driving arms races forward.[167] As this section will show, technological innovation has not yet been a major factor in the hypersonic weapon arms race. However, as this is an incipient arms race, it is reasonable to expect that technological innovation will play a larger role in driving the arms race as more advancements are made, specifically in hypersonic missile defense systems. This section starts with the pre-World War I Anglo-German naval arms race to illustrate how technological innovation can drive an arms race, and then examines the indicators present that show that this model's role is progressing.

[166] Scobell, Burke, Cooper, Lilly, Ohlandt, Warner, and Williams, "China's Grand Strategy," xi-xii.

[167] Maiolo, "Introduction," 6.

The Anglo-German naval arms race prior to World War I is one example of technological innovation as an arms race catalyst.[168] As Matthew Seligmann describes, after Admiral Sir John Fisher was appointed as First Sea Lord in 1904, the Royal Navy undertook a policy of 'plunging': "continuous one-upmanship when it came to specifications and design capability of the navy's future warships."[169] Plunging was a strategic decision on the Royal Navy's part that drove naval architects and ship builders to make incremental technological advancements with each ship class the British built. It was effective; the HMS *Queen Elizabeth*, commissioned in 1914, was armed with larger main guns, larger and more advanced torpedoes, equipped with more advanced radio and fire control technology, and displaced over 14,000 tons more than the HMS *Dreadnought* that was commissioned only eight years before.[170] Seligmann highlighted just how strategically successful plunging was for the British:

> there is the German admission…that by 1914, if not 1912, the naval race had been lost [for the German Empire]…the dreadnought arms race locked Germany into a type of struggle that for Britain was both easy to manage and held few terrors. The simple fact was that battleship building was an area of British strength.[171]

Plunging was an intentional, effective strategy for the Royal Navy, and it shows how technological innovation can be a driver for an arms race.

There is some technological innovation present in the incipient hypersonic weapon arms race. In fact, as discussed in the prior chapter, qualitative improvements of the technologies is an indicator that an incipient arms race exists at all. But innovation itself does not appear to be driving the arms racing. There are several reasons for this.

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168 Matthew S. Seligmann, "The Anglo-German Naval Race, 1898–1914," in *Arms Races in International Politics: From the Nineteenth to the Twenty-First Century*, ed. Thomas Mahnken, Joseph Maiolo, and David Stevenson (New York: Oxford University Press, 2016).

169 Seligmann, "The Anglo-German Naval Race, 1898–1914," 27.

170 Seligmann, "The Anglo-German Naval Race, 1898–1914," 29–31.

171 Seligmann, "The Anglo-German Naval Race, 1898–1914," 36–37.

The first is that after decades of development failed to produce an operational missile, China and Russia fielded operational missiles in 2020 and 2018, respectively.[172] The United States expects to field its own hypersonic weapon in 2023.[173] Achieving an initial operational capability (IOC) is a major technological innovation in its own right. Another technological innovation the United States, China, and Russia are pursuing are hypersonic cruise missiles.[174] Hypersonic cruise missiles differ from hypersonic glide vehicles, the hypersonic weapons most often referenced in this thesis, in that the former are powered by engines throughout their flight.[175] Because hypersonic cruise missiles are powered by their own engines and do not glide, they are able to fly on a non-ballistic trajectory that is more difficult for land-based radar systems to detect.[176] These developments mainly emerged from each country's perceived need for the security benefits of hypersonic weapons, rather than a primary interest in innovation itself.

Beyond military innovation, there has also been limited civilian innovation in hypersonic flight systems. An Atlanta-based startup company called Hermeus plans to conduct their first hypersonic passenger plane test flight in 2029.[177] Hermeus CEO A.J. Piplica sees his prospective aircraft competing with current commercial business class airfare, and admits that the market for such an aircraft is impossible to gauge because none currently exist.[178] Others in the airline industry, however, have rated Hermeus' chances

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[172] For China's hypersonic weapons, see Sayler, *Hypersonic Weapons: Background and Issues for Congress*, 15; for Russia see Vladmir Putin, "Presidential Address to the Federal Assembly," March 1, 2018, http://en.kremlin.ru/events/president/news/56957.

[173] Sayler, Hypersonic Weapons: Background and Issues for Congress, 1.

[174] For the U.S. see Sayler, Hypersonic Weapons: Background and Issues for Congress, 8; for China see Sayler, Hypersonic Weapons: Background and Issues for Congress, 16; and for Russia see Sayler, Hypersonic Weapons: Background and Issues for Congress, 15.

[175] Philip E. Ross, "Flying Beyond Mach 5 is Back, Decades After the Original Need-for-Speed Arms Race Ended: Going Hypersonic," *IEEE Spectrum* 57 no 12 (2020), 35.

[176] Ross, "Flying Beyond Mach 5 is Back, Decades After the Original Need-for-Speed Arms Race Ended: Going Hypersonic," 35–36.

[177] Jacopo Prisco, "Why a Mach 5 Passenger Plane is a Crazy Idea That Might Just Work," CNN, last modified December 28, 2021, https://www.cnn.com/travel/article/hypersonic-airplane-hermeus/index.html.

[178] Prisco, "Why a Mach 5 Passenger Plane is a Crazy Idea That Might Just Work."

for success "somewhere in the 1% range,"[179] and previous attempts at supersonic commercial flight—which is easier to achieve that hypersonic flight—failed.[180] In addition to Hermeus, the Houston-based company Venus Aerospace and the China-based company Space Transportation have both announced plans to build hypersonic commercial aircraft.[181] Venus Aerospace has released little information about their hypersonic aircraft, while Space Transportation plans to conduct their first flight test in 2024.[182]

Technological innovation does not currently appear to be a major driving factor of the incipient hypersonic weapon arms race. Although some major innovations have been realized, such as reaching IOC for hypersonic missiles, the evidence does not show that those innovations have caused the incipient arms race to take on an autonomous life of its own and push the United States, China, and Russia deeper into arms racing. Additionally, there have been very few attempts by non-defense related companies to develop products that could be repurposed to support the hypersonic weapon arms race. Those few companies that are pursuing hypersonic technology for commercial purposes have not yet reached even an IOC for their products, let alone have them developed to the point that they can assist the military defense industry with hypersonic weapons. Perhaps technological innovation will play a larger role in the hypersonic arms race in the future, but that does not appear to be the case at present.

D. CONCLUSION

The action-reaction cycle is the model that most fully explains the incipient hypersonic weapon arms race. The domestic political causes model adds to the explanation of Russia's efforts the arms race and has the potential to play a larger role in the future.

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[179] Prisco, "Why a Mach 5 Passenger Plane is a Crazy Idea That Might Just Work."

[180] Ross, "Flying Beyond Mach 5 is Back, Decades After the Original Need-for-Speed Arms Race Ended: Going Hypersonic," 36.

[181] Griffin Davis, "Top Hypersonic Commercial Aircraft Developers 2022; Will it Really be Possible?," Tech Times, last modified April 22, 2022, https://www.techtimes.com/articles/274873/20220429/top-hypersonic-commercial-aircraft-developers-2022-will-really-possible.htm.

[182] For Venus Aerospace, see Davis, "Top Hypersonic Commercial Aircraft Developers 2022; Will it Really be Possible?;" for Space Transportation see Andrew Jones, "Chinese Space Plane Company Targets Suborbital Tourism, Point-to-Point Travel by 2025," space.com, last modified January 27, 2022, https://www.space.com/private-chinese-space-plane-tourism-travel.

The technological innovation model is for the most part unrealized as things currently stand.

The fact that only one of the Maiolo's three models is firmly in evidence further indicates the hypersonic weapons arms race's incipiency. As Maiolo stated, the three models are not mutually exclusive, and often all three play important roles in arms races.[183] By monitoring technological innovation and domestic political indicators it might be possible for analysts to observe the arms race transition from incipient to full force.

[183] Maiolo, "Introduction," 8.

IV. CONCLUSIONS

This thesis examined the arms race literature and developments in hypersonic weapons, and concludes that the United States, China, and Russia are in an incipient arms race. Chapter II used Colin Gray's four arms racing criteria to determine that the hypersonic weapon development phenomenon is more than a competition, though not quite a full-blown arms race.[184] Gray's first two criteria for arms races have been met, while the third and fourth are beginning to emerge:

1. Two or more parties are conscious of their antagonism.
2. They have designed and fielded forces with a purpose to challenge the other arms race participants.
3. They must compete in quantity or quality.
4. There must be rapid increases in the quantity and/or improvements in quality.[185]

Gray asserted that all four criteria must be met for a weapon development competition to be classified an arms race.[186] To characterize the findings when applying these criteria to hypersonic weapons development, this thesis proposes a new arms race category: an incipient arms race. An incipient arms race extends Gray's criteria to include factors that are emerging alongside those that have been established. Extending the criteria does not relax them; all four criteria must still be present for a competition to be defined as an arms race. By extending the criteria, it allows for the analysis of early indicators that might show that a full-blown arms race is coming next.

Chapter III then used Joseph Maiolo's three arms racing models to investigate the causes behind the hypersonic weapon arms race.[187] This evaluation concluded that the "action-reaction" model was the strongest explanation for arms racing behavior today. Other arms race drivers, such as technological innovation for its own sake and commercial

[184] Colin S. Gray, "The Arms Race Phenomenon," World Politics 24 no. 1 (October 1971), 40.

[185] Gray, "The Arms Race Phenomenon," 41.

[186] Gray, "The Arms Race Phenomenon," 41.

[187] Joseph Maiolo, "Introduction," in Arms Races in International Politics: From the Nineteenth to the Twenty-First Century, ed. Thomas Mahnken, Joseph Maiolo, and David Stevenson (New York: Oxford University Press, 2016), 6–7.

or political domestic factors, are not currently playing major roles in driving hypersonic weapons development. In other words, the main sources of the incipient hypersonic weapons arms race emerge from the basic conditions of great power competition among the United States, China, and Russia today.

Understanding that the hypersonic weapon competition is an incipient arms race, and appreciating the drivers of that arms racing dynamic, places it in the proper context to determine the follow-on effects it might have. It raises additional questions, such as how does the arms race progress? What can the United States do to favorably shape it? How might it end? Each of these questions requires careful consideration, and policymakers must be cognizant of the options they have going forward.

A. WHERE IS THE FINISH LINE?

Potentially the most important question regarding arms racing is this: how does the race end? Does it serve as a prelude to conflict, or does it take the place of it? There are no theoretical models that exist that can explain why some arms races end in war, while others end in a negotiated settlement.[188] An arms race does give states with opposing ideologies one venue for competition other than war. However, one significant issue with the United States, China, and Russia using the hypersonic weapon arms race as a venue for competition is that due to the low likelihood that they will be intercepted, they might eventually prove too useful to resist using them.

In his discussion of arms races, Gray lists five potential outcomes: 1) war; 2) bankruptcy-exhaustion; 3) victory/defeat; 4) agreed termination at parity; and 5) resolution of political differences.[189] As one of only five potential outcomes, war is not an inevitable outcome of the hypersonic weapon arms race. It is likely that too many factors exist in the larger competition between states engaged in an arms race to systematize arms race factors into predictors for an outcome. Instead of attempting to predict the outcome, the United

[188] Maiolo, "Introduction," 3–4.

[189] Gray, "The Arms Race Phenomenon," 65–70.

States and analysts would be better served determining how the United States can use the hypersonic weapon arms race to shape the larger competition with China and Russia.

B. THE SECURITY PROBLEM

The analysis of the driving forces behind the hypersonic weapon arms race has revealed that it is primarily an incipient arms race in which the major powers are reacting to each other's development of new offensive capabilities. Robert Jervis' security dilemma theory offers an explanation on the underlying causes of offensive arms races.[190] This section will start with an overview of Jervis' security dilemma theory and then will apply it to the hypersonic weapon arms race to project the divergent courses this arms race may take in the future.

As Jervis defined it, the security dilemma is "that an increase in one state's security decreases the security of others."[191] As he continued, two very important variables are involved in the security dilemma; if offensive policies and weapons can be distinguished from defensive ones, and which of the two – offense or defense – has the advantage.[192] If offensive policies and weapons have the advantage, it creates a more dangerous situation as it is difficult to determine the intent and states can feel that their security is threatened.[193] On the other hand, if defensive policies and weapons have the advantage, the states pursuing the defensive measures do not threaten the security of other states, creating a more stable environment.[194]

The second important aspect of Jervis' security dilemma is if offensive postures can be distinguished from defensive ones.[195] Offensive postures that are not distinguishable from defensive ones have the potential to create instability; a state can

[190] Robert Jervis, "Cooperation Under the Security Dilemma," in *Conflict After the Cold War: Arguments on Causes of War and Peace*, ed. Richard K. Betts (New York: Pearson Longman, 2008), 412–27.

[191] Jervis, "Cooperation Under the Security Dilemma," 415.

[192] Jervis, "Cooperation Under the Security Dilemma," 415.

[193] Jervis, "Cooperation Under the Security Dilemma," 416–17.

[194] Jervis, "Cooperation Under the Security Dilemma," 417.

[195] Jervis, "Cooperation Under the Security Dilemma," 425.

disguise its offensive posture as defensive while developing it to prevent others from creating effective countermeasures.[196] An undistinguishable offensive posture combined with an offense that has the advantage creates an unstable situation where aggression is more likely (see table one).[197]

Table 1. The Offense-Defense Balance[198]

	OFFENSE HAS THE ADVANTAGE	*DEFENSE HAS THE ADVANTAGE*
OFFENSIVE POSTURE NOT DISTINGUISHABLE FROM DEFENSIVE ONE	1 Doubly dangerous	2 Security dilemma, but security requirements may be compatible.
OFFENSIVE POSTURE DISTINGUISHABLE FROM DEFENSIVE ONE	3 No security dilemma, but aggression possible.	4 Doubly stable.

The hypersonic weapon arms race features weapons that have an offensive posture clearly distinguishable from a defensive one, and currently the offensive capabilities have a strong advantage. This lands the current conditions in the number three block, where "there may be no security dilemma, but there are security problems."[199] The United States, China, and Russia are all pursuing offensive hypersonic capabilities because, at least presently, they are cheaper and more technologically feasible than hypersonic defensive systems. Hypersonic weapons offer an overwhelming offensive advantage, and it has resulted in each state aggressively pursuing the technology to gain that advantage.

Jervis' security dilemma explains the underlying causes of the hypersonic weapon arms race. Hypersonic weapons give the United States, China, and Russia an unambiguous offensive capability. Until defensive systems become more cost-effective and technologically feasible, it is likely that the arms race will continue. Part of Jervis'

196 Jervis, "Cooperation Under the Security Dilemma," 422–23.

197 Jervis, "Cooperation Under the Security Dilemma," 425.

198 Jervis, "Cooperation Under the Security Dilemma," 426.

199 Jervis, "Cooperation Under the Security Dilemma," 427.

observation on where this type of offense-defense balance goes has already come true: "the costliness of the defense and the allure of the offense can lead to unnecessary mistrust, hostility, and war…"[200] Necessary or not, there is certainly mistrust between the states that could lead to hostility. Jervis' theory provides additional insight to the offense-defense features of the arms race, and can serve as an important tool for determining the future of the arms race and its potential outcomes.

1. Offense-Defense Balance

A key feature of the incipient hypersonic weapon arms race is that thus far, only the offensive characteristics have been developed. Nevertheless, this may change in the foreseeable future. The United States plans to develop a hypersonic missile defense system by either 2027 or 2028.[201] China claims to have already developed an artificial intelligence system capable of estimating a hypersonic missile's course and initiating a counter response, but has given little details on system reliability.[202] It is difficult to say that hypersonic missile defense systems are even in their infancy; they are barely in an embryonic phase. The lack of hypersonic defensive development fuels the offensive capability arms race.

The two primary questions regarding hypersonic missile defense systems are: 1) are they technologically feasible; and 2) if achieved, how will they change the arms race? In 2021, Vice Admiral Jon Hill, the U.S. Missile Defense Agency director, stated that feedback from the U.S. defense industry indicated that a hypersonic missile defense is technologically feasible.[203] Developing kinetic defensive systems will take significant time and resources; interceptors and an extensive sensor network are required for tracking,

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200 Jervis, "Cooperation Under the Security Dilemma," 427.

201 Abraham Mahshie, "Hypersonic Missile Defense 'A Few Years' Away, Top Brass Tells Senators," *Air Force Magazine*, last modified May 18, 2022, https://www.airforcemag.com/missile-defense/.

202 Stephen Chen, "Chinese Researchers Say They Have Developed AI to Predict Course of Hypersonic Missiles," *South China Morning Post*, last modified June 1, 2022, https://www.scmp.com/news/china/science/article/3179898/chinese-researchers-say-they-have-developed-ai-predict-course.

203 Jen Judson, "Raytheon, Northrop Advance in Competition to Develop Hypersonic Weapons Interceptor," Defense News, last modified June 24, 2022, https://www.defensenews.com/pentagon/2022/06/24/raytheon-northrop-advance-in-competition-to-develop-hypersonic-weapons-interceptor/.

targeting, and engaging hypersonic missiles.[204] Beyond kinetic defense systems, electronic warfare systems and directed energy systems are potential options for hypersonic missile defense.[205]

2. Kinetic Defensive System Outcome

How will hypersonic missile defense systems change the arms race? The answer depends on which defensive systems are developed and employed. Kinetic defensive systems will likely contain missiles that intercept offensive missiles by direct impact or fragments that critically damage the offensive missile. If the defensive systems are missiles as described, then it will be difficult to distinguish them from the offensive missiles; at minimum, kinetic defensive systems must have the same capabilities as the offensive missiles. Thus, if kinetic defensive systems are employed, it is likely that the conditions will fall under Jervis' doubly dangerous or security dilemma categories (blocks one or two).[206]

Additionally, it is more likely that the offensive capability will have an advantage over the kinetic defensive systems. Even if kinetic defensive systems can be developed and deployed to the point that they are reliable against offensive hypersonic weapons, they remain limited by the number of interceptors in the system's magazine. An adversary could simply fire more offensive hypersonic weapons than the defensive system has interceptors and there is a high probability that the offensive weapons will defeat the defensive system.

The result is that if kinetic defensive systems are pursued, it is likely that they hypersonic weapon arms race will transition into Jervis' doubly dangerous box.[207] States will be unable to determine the intent behind the employment of hypersonic offensive or defensive weapon systems, and that could lead to a misunderstanding that brings conflict. In the doubly dangerous scenario, aggression and attack are the best ways for states to

[204] Kelley M. Sayler and Stephen M. McCall, *Hypersonic Missile Defense: Issues for Congress*, CRS Report No. IF11623, (Washington, DC: Congressional Research Service, January 26, 2022).

[205] Tom Karako and Masao Dahlgren, *Complex Air Defense*, (Washington, DC: Center for Strategic and International Studies, 2022), 14–15.

[206] Jervis, "Cooperation Under the Security Dilemma," 426.

[207] Jervis, "Cooperation Under the Security Dilemma," 426.

protect their possessions, and cooperation is difficult to achieve.[208] The doubly dangerous scenario is the least desirable of all four scenarios.

3. Directed Energy Systems Outcome

Directed energy (DE) systems represent an additional option for hypersonic missile defense. The U.S. Department of Defense includes high-energy lasers and high-powered microwave weapons as DE systems.[209] These DE systems offer potentially promising capabilities that are defensive in nature due to range and atmospheric limitations.[210] Additionally, it might be possible for them to provide hypersonic missile defense.[211]

If DE weapons can be developed to defeat hypersonic weapons, they will represent a defensive capability that is distinguishable from an offensive one. This would move the hypersonic weapon arms race into Jervis' block three or four, where no security dilemma exists but aggression is possible (block three), or a doubly stable situation (block four).[212] The effectiveness of DE weapons will determine if the arms race transitions to block three or four; if DE weapons have an advantage over hypersonic weapons, it will result in a doubly stable situation, whereas if hypersonic weapons maintain an advantage over DE weapons aggression will still be possible. The doubly stable scenario is the most desirable of all four, but even the block three scenario is preferable to block one (doubly dangerous) or two (security dilemma). Further studies on the feasibility and effectiveness are necessary to determine if DE weapons can adequately fill this role in the near future.

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[208] Jervis, "Cooperation Under the Security Dilemma," 425.

[209] Kelley M. Sayler, Andrew Feickert, John R. Hoehn, Ronald O'Rourke, *Department of Defense Directed Energy Weapons: Background and Issues for Congress*, CRS Report No. R46925 (Washington, DC: Congressional Research Service, September 28, 2021), 1.

[210] Sayler, Feickert, Hoehn, O'Rourke, Department of Defense Directed Energy Weapons: Background and Issues for Congress, 16.

[211] Sayler, Feickert, Hoehn, O'Rourke, Department of Defense Directed Energy Weapons: Background and Issues for Congress, 1–2.

[212] Jervis, "Cooperation Under the Security Dilemma," 426.

C. IMPLICATIONS FOR U.S. POLICY

The incipient hypersonic weapon arms race has several important implications for U.S. policy. The most important one to consider is how the United States can shape the arms race to its advantage while decreasing, or at minimum not increasing, the possibility for conflict. Would it be possible for the United States to execute a strategy of plunging, similar to the Royal Navy's strategy during the Anglo-German naval arms race? At first glance a plunging strategy might seem unlikely, given the United States is currently behind China and Russia in hypersonic weapon development. However, the British began their shipbuilding campaign after Germany started building its ships, and the British managed to emerge victorious. Now that the United States is fully focused and investing adequate resources into its own hypersonic programs, a plunging-like strategy might be an option.

Offensive capabilities have so far dominated the incipient hypersonic weapon arms race; if defensive capabilities catch up, how will that change the arms racing dynamics? Policymakers must consider how hypersonic missile defensive technologies might influence the arms race prior to further investment and development. Technologies that are unmistakably defensive in nature are more desirable than ones that can be interpreted as offensively natured, because they are more likely to create stability. U.S. policymakers need to consider what is technically feasible as well as stabilizing.

To date, the incipient hypersonic weapon arms race is limited to three main participants: the United States, China, and Russia. Other states have their own hypersonic programs, but they lag behind the top three.[213] This makes hypersonic weapon nonproliferation another area of concern. It is unrealistic to expect the United States, China, or Russia to seriously consider hypersonic testing or development bans, so eliminating the possibility of proliferation by banning the weapons is not possible. Nevertheless, it is possible that the three states could negotiate a framework for a nonproliferation agreement. This would keep the weapons out of the hands of nonstate actors and states that do not possess the technological ability or finances to develop them, and would keep the arms

[213] For a comprehensive overview of other states' hypersonic programs, see Richard H. Speier, George Nacouzi, Carrie A. Lee, and Richard M. Moore, *Hypersonic Missile Nonproliferation: Hindering the Spread of a New Class of Weapons*, RR2137 (Santa Monica, CA: RAND, 2017), 53–99.

race confined to three major participants. The extreme cost of infrastructure, materials, and personnel required to build hypersonic weapons serves as an effective barrier to entry for most states. The United States, China, and Russia must come together and ensure that the barrier is not lowered by distributing weapons to states that cannot develop them on their own.

D. AVENUES FOR FUTURE RESEARCH

This thesis focused on the existence of a hypersonic weapon arms race and factors driving the race. The potential that hypersonic weapons have to create strategic instability was briefly mentioned in this thesis, but has not been fully analyzed. It could be argued that while hypersonic weapons have the capability to be strategically destabilizing, they lack they psychological impact caused by nuclear weapons. A study focused on how much strategic instability hypersonic weapons could create might shed additional light on their total political impact.

Another future avenue for research is to determine if hypersonic missile defense systems are necessary. The discussion in this chapter on defensive systems and Jervis' offense-defense balance examined the potential outcomes of different defensive technologies. That discussion showed that the different types of defensive technologies and the varying effectiveness they may have relative to offensive hypersonic missiles are important factors for stability outcomes. One outcome that it did not consider is the possibility that choosing not to develop defensive technologies might be the best option to slow the arms race, if maintaining that status quo is more stable than pursuing unrealistic technologies and risking conflict by increasing uncertainties.

This thesis has proposed that DE weapons might be an answer to slowing the hypersonic weapon arms race. For this to be true, further study needs to be done in the scientific community to determine the feasibility of using DE weapons in this manner. Also, this thesis assumes that DE weapons would be seen as primarily defensive in nature. Additional analysis on the offensive capabilities and impression of DE weapons is required prior to endorsing them as an answer to the arms race.

E. CONCLUSION

The primary research question of this thesis has been whether hypersonic weapon research and development in the United States, China, and Russia is competitive enough to be considered an arms race, and if so what factors are most important in driving this competition. The thesis research has found that hypersonic weapon development in the United States, China, and Russia has evolved into an incipient arms race, and the states are on the cusp of a full arms race. This incipient arms race has primarily been driven by an action-reaction cycle, but elements of domestic political forces are present, and technological innovation is likely to push it into a full-scale arms race.

At a more theoretical level, this thesis proposes "incipient arms race" as a new category to describe arms racing. An incipient arms race can be used as an early recognition of competition that will develop into an arms race. Extending Gray's arms race criteria, an incipient arms race is characterized by either the presence of these criteria or evidence that they will be emerging soon. Attention to the conditions of an incipient arms race can inform analysts of other arms competitions that may develop into arms races.

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