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Discerning the Drivers of China's Nuclear Force Development: Models, Indicators, and Data

by David C. Logan and Phillip C. Saunders

Center for the Study of Chinese Military Affairs
Institute for National Strategic Studies
National Defense University

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Cover image: DF-26 intermediate-range ballistic missiles on display at military parade in Beijing, September 3, 2015
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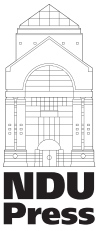
China Strategic Perspectives, No. 18

Series Editor: Phillip C. Saunders



National Defense University Press
Washington, D.C.
July 2023

First printing, July 2023

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Acknowledgments

For helpful comments on earlier versions of this study, we thank Justin Anderson, Christopher Andrews, Paul Bernstein, Rod Lee, Brad Roberts, Joel Wuthnow, and experts from the Center for the Study of Weapons of Mass Destruction and the Center for Strategic Research at National Defense University's Institute for National Strategic Studies, the Naval Postgraduate School, and the Center for Global Security Research at Lawrence Livermore National Laboratory.

For valuable research support, we thank Andrew D. May and the Office of Net Assessment at the Department of Defense.

We also thank the NDU Press team for copyediting, proofreading, and design services. Thanks also go to the team at the Defense Office of Prepublication and Security Review.

Thanks to Alexis Dale Huang, Kyung Joo Joen, Amanda Moodie, Andrew Taffer, Major Luke Tyree, USA, and Luke Bellocchi for final proofreading assistance.

Executive Summary

For decades following its first test in 1964, China maintained a small nuclear force and a doctrine emphasizing deterrence and no-first-use of nuclear weapons. China has recently embarked on an unprecedented campaign of expansion and modernization, which is changing the size, structure, and operational posture of its nuclear forces. The growing discrepancy between China's restrained declaratory policy and advancing nuclear capabilities raises important questions about the status and future trajectory of China's nuclear forces, with major implications for the United States.

Competing Models to Explain China's Nuclear Force Development

This study addresses these issues by developing six competing models of China's nuclear strategy: 1) secure second strike, 2) nuclear shield, 3) Great Power status, 4) theater deterrence, 5) bureaucratic politics, and 6) nuclear superiority. Each model implies a different set of drivers, goals, and resulting force structures:

- In the *secure second-strike* model, China seeks to maintain a reasonably secure nuclear deterrent in the face of advancing adversary capabilities. In this model, actual and projected advances in U.S. offensive and defensive capabilities increase the nuclear force requirements for a survivable deterrent.
- The *nuclear shield* model is a stronger version of the secure second-strike model. Here, China seeks not only to maintain a secure second strike to deter strategic nuclear attacks but also to use a more survivable and capable nuclear force to deter adversary limited use of theater nuclear weapons and conventional military intervention to gain freedom of action, particularly in a conflict over Taiwan.
- The *Great Power status* model posits a China no longer content with a "lean and effective" deterrent focused on maintaining a survivable second strike and that is now pursuing a nuclear force more like U.S. and Russian nuclear forces for prestige and status reasons.
- The *theater deterrence* model sees China fielding forces capable of executing battlefield nuclear strikes either to redress a perceived capability gap that might weaken deterrence of lower-level nuclear strikes or to develop military leverage over other states.
- The *bureaucratic politics* model understands China's nuclear forces and strategy as the result of bargaining between the bureaucratic actors involved in setting nuclear policy,

such as civilian political leaders, the different military services, the nuclear weapons establishment, and civilian strategists.

- The *nuclear superiority* model sees China seeking to achieve quantitative and qualitative dominance over other nuclear-weapon states, at either the regional or global level.

For each of the six models, we develop predictions for the features of the nuclear forces that would be most likely to emerge under that model. We also identify additional observable indicators of other aspects of China's approach to nuclear force development. These include sensitivity to U.S. policy, nuclear infrastructure, doctrine and signaling, policymaking and process, and supporting elements.

Assessing the Explanatory and Predictive Power of Competing Models

Based on a thorough review of the secondary literature, Chinese primary sources, and new open-source data, we test the predictions of each model against China's current and projected nuclear force structure and the assessed values of the observable indicators.

We find strong evidence for the secure second-strike, nuclear shield, and Great Power status models. We find weak support for the bureaucratic politics model. We find that the theater deterrence and nuclear superiority models have the least support.

Implications for China's Nuclear Force Development

- China is likely to continue to increase the overall size of its nuclear forces to increase their survivability, to deter U.S. military threats and intervention, and to bolster its status by differentiating itself from second-tier nuclear states.
- Great Power status drivers might eventually encourage China to seek both quantitative and qualitative parity with U.S. and Russian nuclear capabilities.
- A decision to seek quantitative parity might be constrained by the increased costs and operational risks that accompany a larger nuclear force, tradeoffs with conventional force modernization, and political costs given China's desired image as a peaceful power different from the superpowers.
- A decision to deploy low-yield or tactical nuclear forces would signal a significant shift in Chinese thinking about the military and political utility of these weapons.

Implications for U.S. National Security Policy

- China is determined to maintain a survivable second-strike capability. The United States should anticipate that China will respond to advances in U.S. offensive nuclear capabilities and ballistic missile defense systems and factor these responses into its investment decisions.
- A Chinese nuclear shield intended to deter U.S. intervention and nuclear use would place a greater premium on the local conventional military balance and force U.S. policymakers to make difficult choices about allocating defense dollars across nuclear and conventional forces.
- U.S. nuclear force development will set the benchmark for what it means to be a nuclear Great Power; China is likely to seek to match or outpace perceived U.S. technological advances to showcase its status as an aspiring superpower.
- China will likely remain reluctant to enter arms control negotiations if it views such agreements as constraining its efforts to enhance force survivability or limiting its prestige by locking it into an inferior position vis-à-vis the United States and Russia.
- Given China's focus on prestige, attempts to enlist Chinese participation in arms control should highlight the distinction that comes from participating in arms control negotiations with the nuclear superpowers as a near peer rather than as a second-tier nuclear power.

Future Directions for Research

Our analysis relies solely on open sources, which, while valuable, have inherent limitations. The framework presented in this report could potentially employ alternative and updated data sources to validate or revise our findings. The analysis could be repeated as more information about Chinese nuclear force modernization becomes available over time, or U.S. intelligence analysts could replace our open-source assessments with classified data and recode the values for China's current and projected nuclear force structure and the additional indicators.

Introduction: China's Evolving Nuclear Force Development

For decades following its first successful nuclear test in 1964, China maintained a relatively small, immature, and unalerted nuclear force. From the development of its first intermediate-range ballistic missiles (IRBMs) and intercontinental ballistic missiles (ICBMs) in the 1970s until the early 1990s, China's nuclear forces consisted almost entirely of liquid-fueled, inaccurate, ground-based missiles operating in silo or rollout-to-launch basing modes.[1] These missiles were equipped with single, high-yield warheads suitable only for use against cities. China did not have any meaningful air- or sea-based components to its nuclear forces, and it lacked strategic early-warning capabilities.[2] For the first several decades of China's nuclear era, the Chinese nuclear establishment confronted several constraints. The chaos of the Cultural Revolution wreaked havoc on many of the institutions involved in China's strategic missile and nuclear programs.[3] Mao Zedong's statement after China's first nuclear test, about the limited political and military utility of nuclear weapons and the ultimate goal of nuclear disarmament, set the parameters of Chinese nuclear policy.[4] Even as many of the initial institutional, budgetary, and technological constraints eased over time, top-level political guidance has continued to follow Mao's guidelines and constrain China's nuclear ambitions. As recently as 2005, China was assessed to have only the world's fifth-largest nuclear arsenal, behind those of the United States, Russia, France, and the United Kingdom.[5]

These modest forces were matched by a relatively restrained nuclear doctrine consisting of an unconditional no-first-use policy, negative security assurances to nonnuclear-weapon states, and a pledge not to engage in arms races.[6] China's nuclear forces were much smaller than those of most other nuclear-armed states. The operational characteristics of these forces were similarly modest. China is believed to have kept nuclear warheads, delivery vehicles, and launchers stored separately and at relatively low levels of readiness.[7] People's Liberation Army (PLA) exercises simulated Chinese forces launching a retaliatory nuclear strike only after China had suffered a nuclear attack itself; readiness was measured in terms of days and even weeks.[8]

China has since embarked on an unprecedented campaign of expansion and modernization of its nuclear forces, which has changed—and will continue to change—the size, structure, and capabilities of those forces. China's nuclear force is now larger, more diverse, and significantly more advanced. In 2011, just over a decade ago, China was estimated to have fewer than 180 nuclear warheads, fewer than 40 of which could reach the United States.[9] Today, China is believed to possess about 400 total warheads, nearly 200 of which can reach the United States.[10] The number of missile brigades assigned to the PLA Rocket Force, the military organization that operates

China's land-based ballistic and cruise missiles, has increased from 29 to 40 in just three years.[11] China is also making progress to a full nuclear triad consisting of ground, air, and sea legs. China has launched six *Jin*-class Type 094 nuclear-powered ballistic missile submarines, which the U.S. Department of Defense (DOD) assesses have likely already begun near-continuous at-sea deterrence patrols.[12] Beijing will likely soon begin construction on its quieter next-generation Type 096 ballistic missile submarines (SSBNs) with longer range JL-3 sea-launched ballistic missiles (SLBMs).[13] Some late-production Type 094 submarines, sometimes identified as Type 094A vessels, are also being equipped with JL-3 SLBMs.[14] The PLA Air Force has been reassigned a nuclear mission, and China is developing a next-generation stealth bomber that will likely be nuclear-capable.[15] Sometime between 2020 and 2021, China began construction of more than 300 new silos, which could significantly expand the size of its silo-based ICBM force.[16] China is also investing in more exotic and advanced nuclear capabilities, including hypersonic boost-glide systems and possibly a fractional orbital bombardment system.[17]

China's nuclear forces are becoming more sophisticated. The PLA's land-based nuclear missiles are increasingly mobile, accurate, and solid-fueled, and many carry multiple independently targetable reentry vehicles (MIRVs).[18] The PLA is developing and deploying hypersonic weapons systems, which might be armed with nuclear warheads.[19] In addition to increases in the size, composition, and capabilities of the nuclear forces, the PLA is developing increasingly sophisticated supporting capabilities and infrastructure, such as advanced strategic intelligence, surveillance, and reconnaissance (ISR) systems and more reliable command and control structures.[20] There are also hints that China may be revising the operational characteristics of its nuclear forces by mating warheads to some delivery vehicles in peacetime or conducting training, exercises, and alerts, which demonstrate higher levels of readiness.[21] Table 1 captures many of these changes.

Despite these advancing capabilities, China's declaratory nuclear strategy has remained relatively consistent. Since its first successful nuclear test in 1964, the country's nuclear strategy has consisted of several features including an unconditional no-first-use policy, negative security assurances pledging not to use or threaten to use nuclear weapons against nonnuclear-weapon states, and a commitment not to engage in arms races.[22] Authoritative Chinese sources such as remarks from senior Chinese officials, Chinese defense white papers, PLA curricular materials, and interviews with Chinese experts have consistently indicated that Chinese officials have yet to significantly alter the country's nuclear strategy.[23] Though there have been periodic internal debates about adjusting nuclear policies, there is no clear-cut evidence that senior leaders have agreed to shift any of the core features of China's nuclear strategy.[24]

Table 1. China's Advancing Nuclear Capabilities

Capability	2011	2022	2031
Total warheads	178	~400	1,000
Total warheads that can reach the continental United States	~40	~200	~600–700†
Land-based ICBMs	✓	✓	✓
SSBNs		✓	✓
Nuclear bombers		½	✓
MIRV		✓	✓
Solid-fueled	½	✓	✓
Mobile ICBMs	✓	✓	✓
Early-warning satellites		½	✓
Large phased-array radars	½	✓	✓
Over-the-horizon radars		✓	✓
Regional nuclear forces	½	✓	✓
Tactical nuclear weapons			?
Hypersonic systems		½	✓

✓ = completed development, ½ = incomplete or ongoing, ? = uncertain
† Includes all ICBMs and SLBMs.

Sources: *Annual Report to Congress: Military and Security Developments Involving the People's Republic of China 2011* (Washington, DC: Office of the Secretary of Defense, 2011); Hans M. Kristensen and Robert S. Norris, "Chinese Nuclear Forces, 2011," *Bulletin of the Atomic Scientists* 67, no. 6 (2011); Hans M. Kristensen, "China's Strategic Systems and Programs," in *China's Strategic Arsenal: Worldview, Doctrine, and Systems*, ed. James M. Smith and Paul J. Bolt (Washington, DC: Georgetown University Press, 2021), 93–124; and *Annual Report to Congress: Military and Security Developments Involving the People's Republic of China 2022* (Washington, DC: Office of the Secretary of Defense, 2022).

Despite this consistency in policy and doctrine, the growing discrepancy between China's declaratory policy and its advancing nuclear capabilities has raised questions about both the status and the future trajectory of China's nuclear forces and strategy.[25] What political and military value does China place on additional nuclear forces? What are the goals of China's ongoing nuclear modernization and expansion? What might China's nuclear forces and strategy look like in the next decade? What are the drivers of China's nuclear strategy? How does China envision using its nuclear weapons? What risks and implications do China's nuclear forces present for U.S. national security policy, and how can the United States most effectively reduce and manage those risks?[26]

This disjuncture between China's stated policy and advancing capabilities also suggests that previous models of a "minimal deterrent" or a "lean and effective" nuclear deterrent may no longer apply. Even if China's goal is still to maintain a reliable second-strike capability, this may entail a different nuclear force structure, different supporting capabilities, and different policies to fit altered strategic circumstances. The disjuncture suggests that new goals and drivers, rather than simply the maintenance of a secure second-strike capability, may be influencing China's nuclear force structure.

Answering these questions and understanding the drivers of China's nuclear strategy is important for at least three related reasons. First, a better understanding of strategic drivers can help forecast the future trajectory of China's nuclear force development. Different strategies imply different sizes, compositions, and practices for China's nuclear forces. Determining which drivers, or combination of drivers, have the most impact on China's nuclear thinking can help identify the different paths its nuclear forces may take in the future. Second, understanding the drivers can help predict when and how China's nuclear force structure might change in response to shifts in domestic and international conditions. Third, and most important, understanding the drivers can help U.S. policymakers devise better approaches to reducing and managing the risks associated with China's nuclear force development.

Identifying the drivers of Chinese nuclear force development can also highlight potential areas where U.S. policy can influence Chinese decisionmaking. For example, if China is likely to respond to advances in U.S. offensive nuclear capabilities and ballistic missile defense (BMD) systems with force development efforts that negate the anticipated gains, U.S. policymakers should take this likely response into account. By contrast, if China's nuclear policies are driven by considerations of prestige and reputation, then U.S. policy might downplay the status gains sometimes afforded to nuclear weapons. If China's nuclear policies are driven by new Chinese strategic thinking about the utility of nuclear weapons and theater deterrence, then U.S. policy might best influence Chinese policy through a combination of integrated deterrence and calibrated arms control. Adjustments to nuclear forces and plans often require significant lead time, given the need to develop, deploy, and operationalize new systems and concepts. A more accurate understanding and better forecasting of future changes to China's nuclear force structure can help the United States anticipate Chinese reactions, allocate resources more efficiently, and make necessary policy adjustments.

This study contributes to these efforts by developing an analytical framework for evaluating potential drivers of China's nuclear force development and then using that framework to identify which drivers have the largest impact on China's nuclear forces and strategy. We assess

the ability of each model to explain past Chinese nuclear force developments and to generate predictions of future Chinese nuclear force developments that can be tested against independent estimates. We present and evaluate six competing models of China's nuclear strategy: 1) secure second strike, 2) nuclear shield, 3) Great Power status, 4) theater deterrence, 5) bureaucratic politics, and 6) nuclear superiority.

The study proceeds as follows: The first section presents six competing models for development of China's nuclear forces and strategy. We identify the underlying logic of each model and describe the nuclear forces and strategy consistent with that model's assumptions. The second section develops nine specific features for each model in terms of predicted force structure, operational practices, and supporting elements. The third section codes China's current and projected nuclear force development in terms of these nine features to determine which of the six models best fit China's observed and predicted nuclear force structure. We also examine how each model would explain current and potential anomalous developments. The fourth section details additional observable indicators for each model; these provide additional analytical power because many features of nuclear forces and strategy are deliberately hidden, difficult to observe, or slow to emerge. We then use open-source evidence to evaluate which models best fit the assessed values of the indicators. We conclude by considering the implications of our findings for China's future nuclear force development and U.S. national security policy. We also include an appendix with the full coding rules, data sources, and coding decisions for our analysis.

Six Models: Nuclear Force and Strategy Features

This study presents six competing models for China's nuclear strategy: 1) secure second strike, 2) nuclear shield, 3) Great Power status, 4) theater deterrence, 5) bureaucratic politics, and 6) nuclear superiority.

First, China's nuclear forces and strategy might be explained by a *secure second-strike* model based on its desire to maintain a reasonably secure nuclear deterrent in the face of advancing adversary capabilities. In this model, actual and projected advances in U.S. offensive and defensive capabilities would increase the nuclear force requirements for maintaining survivability.[27] Second, a *nuclear shield* model implies that China would seek a survivable and capable nuclear force to deter a wide range of adversary nuclear and conventional actions and potentially enable greater Chinese freedom of action. Third, a *Great Power status* model implies that China would no longer be content with a lean and effective deterrent focused on maintaining a survivable second strike and would pursue a nuclear force more like U.S. and Russian nuclear forces for prestige and status reasons. Fourth, in the *theater deterrence* model, China would field forces

capable of executing battlefield nuclear strikes either to redress a perceived capability gap that might weaken deterrence of lower level nuclear strikes or to develop military leverage over other states. Fifth, the *bureaucratic politics* model understands China's nuclear forces and strategy as the result of bargaining between the bureaucratic actors involved in setting nuclear policy, such as civilian political leaders, the different military services, the nuclear weapons establishment, and civilian strategists. Finally, the *nuclear superiority* model implies that China would seek to achieve quantitative and qualitative dominance over other nuclear-weapon states. The models are ideal types and may not fully capture the complexity of drivers at play. Further, multiple models may help explain different elements of China's approach to nuclear weapons. However, together these models identify the most likely drivers of China's nuclear thinking and help to bring coherence to our understanding of it.

We considered several other models for this study, including minimum deterrent, technology trajectory, and strategic export models. The *minimum deterrent* model implies a force structure smaller than what China currently deploys, resembling China's nuclear force structure in the 1980s. This model implies small force size, political compatibility with disarmament and nonproliferation activities, and an emphasis on the higher material, political, and operational costs associated with a larger and more capable force. The *technology trajectory* model implies that China's nuclear force development would be guided primarily by the desire to explore technological advances in nuclear weapons, delivery systems, and enabling capabilities. This model had some explanatory value in the early stages of China's development of nuclear weapons and delivery systems, when weapons scientists had more influence, but appears less relevant today. It also overlaps heavily with the bureaucratic politics model. The *strategic export* model implies a nuclear force and industry oriented toward exporting nuclear and missile systems abroad to bolster China's defense industry, satisfy important domestic economic interests, and improve China's diplomatic relations with foreign buyers. We ultimately decided not to include any of these models given the lack of credible evidence for them.

Although the models we examine are not mutually exclusive, each employs a different core logic and implies different nuclear forces and strategy. For example, whereas the secure second-strike model might imply a force composed of large-yield warheads for use against adversary population centers, the theater deterrence model implies a force composed of lower and variable-yield warheads and highly accurate delivery systems for use against a wider range of theater-level military targets.[28] In table 2, we summarize the logic underpinning each model and the characteristics of the resulting nuclear force and strategy associated with that model.

Table 2. Six Competing Models for Chinese Nuclear Behavior

	Secure second-strike	Nuclear shield	Great Power status	Theater deterrence	Bureaucratic politics	Nuclear superiority
Underlying logic	Maintain secure second-strike capacity; advancing U.S. BMD, ISR, nuclear, and conventional precision-strike capabilities drive a larger and more survivable force.	Develop robust nuclear forces to deter U.S. strategic nuclear, limited theater nuclear, and conventional actions and enable greater PRC freedom of action.	Achieve clear #3 nuclear status to stand out from second-tier nuclear powers and then seek parity with Russia and the United States, largely for domestic and international prestige.	Develop limited nuclear options to deter possible theater/tactical nuclear use or seek nuclear advantages to deter U.S. allies and U.S. conventional intervention.	Military services and nuclear establishment promote specific nuclear capabilities to capture greater budgets, influence, autonomy, and prestige.	Political and military value in nuclear superiority; first seek superiority over second-tier nuclear powers; then seek parity with U.S./Russia; and finally aim for comprehensive nuclear superiority.

Secure Second Strike

The secure second-strike model emphasizes maintaining a secure second-strike capability to deter nuclear attack and predicts a Chinese nuclear force structure and strategy highly responsive to actual and potential developments in U.S. nuclear, precision conventional-strike, ballistic missile defense, and strategic ISR capabilities that might undermine China's nuclear deterrent.[29] This model sees high returns on investments that increase the survivability of China's nuclear forces or improve their ability to penetrate missile defenses, but very limited returns on additional nuclear forces once a secure second-strike capability is attained.[30] A secure second-strike model has some continuity with China's historic approach to nuclear weapons, but past approaches were shaped to a greater degree by economic, technology, and political constraints, which are not tied to the model's core logic and may not apply in the future.[31]

China's initial nuclear force structure was a small, ground-based force of inaccurate ICBMs and IRBMs with large warheads; deterrence was based on an adversary's uncertainty about whether it could locate and destroy all of China's missiles before a retaliatory strike. China's second-generation nuclear force structure was somewhat larger, featured more accurate solid-fueled missiles with a range of yields, and used mobility to enhance survivability. A future force structure using this logic would be highly responsive to U.S. capabilities in terms of size, but might also seek greater survivability through mobility, diversification of delivery systems, attacks on U.S. strategic ISR, penetration aids to defeat U.S. missile defenses, or even a shift to a "launch-on-warning" doctrine.[32]

Under this model, while China still would see relatively limited uses for its nuclear forces, it might perceive greater threats to the survivability of its deterrent that would require creation of a larger, more survivable force. The secure second-strike model does not imply a significant revision of the no-first-use policy, except possibly refining "first use" to include confirmed incoming nuclear strikes that have not yet reached Chinese soil. Significantly, this model implies a continued belief that it would be very difficult to contain a nuclear conflict, that nuclear use is therefore both unwise and unlikely, and that significantly larger nuclear arsenals provide very little additional benefit.

Nuclear Shield

The nuclear shield model builds on the logic of the secure second-strike model by emphasizing the need to maintain a survivable nuclear deterrent. However, while in the secure second-strike model China is primarily concerned about maintaining a survivable nuclear force to deter strategic nuclear strikes, the nuclear shield model sees more capable nuclear forces as

necessary for defending against U.S. military threats and maintaining freedom of action by deterring a wide range of potential U.S. military actions.[33] Under the nuclear shield model, Chinese decisionmakers would want more obviously survivable strategic nuclear forces to deter U.S. attempts at disarming first strikes or damage limitation strategies. By reducing or removing U.S. escalation dominance, China would also reduce U.S. confidence in its ability to control escalation in a nuclear conflict and extend deterrence to the theater level and to conventional intervention. These broader deterrence goals would rest on the risk that a limited theater nuclear exchange or a major conventional conflict might escalate to the strategic nuclear level.[34] Chinese decisionmakers might also want to deter U.S. theater limited nuclear strikes by building sufficient retaliatory capabilities at lower rungs of the nuclear ladder.

By deterring U.S. actions, a nuclear shield logic might give China more freedom of action to initiate and escalate military actions, especially against Taiwan.[35] For instance, Chinese strategists have expressed concern that "the United States would use low-yield [nuclear] weapons against its Taiwan invasion fleet, with related commentary in official media calling for proportionate response capabilities."[36] U.S. analysts have found some evidence that Chinese strategists may believe nuclear weapons can do more than just deter strategic nuclear attacks.[37] Recent wargames by U.S. analysts concluded that "[a] more survivable and diverse nuclear arsenal provided [China] with more coercive options."[38]

Like the secure second-strike model, the nuclear shield model predicts a nuclear force that is larger, more diverse, and more survivable. Although the emphasis would be primarily on the strategic level, China would also want some theater nuclear systems to deter theater threats. The model predicts a greater level of force transparency to maximize the deterrent benefits of the force.

This model differs from the secure second-strike model in several ways. First, Chinese strategists and political leaders would attach greater strategic value to nuclear weapons. Historically, China's leaders have believed that nuclear weapons had only limited political and military utility, viewing them primarily as tools for deterring strategic nuclear attack, protecting against nuclear threats and intimidation, and retaliating for nuclear strikes. However, in this model, Chinese thinking about nuclear weapons would also envision them as potentially useful for controlling escalation by eroding adversary escalation dominance, deterring limited nuclear use, deterring intervention in a crisis, and deterring conventional military operations. Second, the force structure implied by the nuclear shield model would be markedly larger than that implied by the secure second-strike model, to clearly communicate to U.S. decisionmakers the futility of attempting to neutralize China's nuclear deterrent and the escalation risks of crossing the nuclear

threshold. Finally, the nuclear shield model suggests strong sensitivity to U.S. nuclear strategy, including concerns about deterring possible U.S. nuclear first use, particularly in a conventional conflict over Taiwan.

Great Power Status

Under the Great Power status model, China's nuclear forces and strategy would be aimed not merely at deterring nuclear attacks and threats, but also at bolstering the country's domestic and international prestige. Considerations of status, reputation, and prestige have shaped the nuclear behavior of other states, such as India and France.[39] Chinese leaders have historically attributed relatively limited political value to large numbers of nuclear weapons but have been attuned to the ways nuclear force structure and policy decisions can generate political costs and benefits. For instance, China has criticized Russia and the United States as irresponsibly engaging in arms races and failing to adopt no-first-use nuclear policies.[40] Recently, some scholars have argued that considerations of status have played a greater role in Chinese nuclear behavior.[41] The growth in China's economic, political, and military power may have caused Chinese leaders to desire a nuclear force commensurate with its Great Power or aspirational superpower status.[42]

This model predicts a nuclear force that is larger, more diverse, and more technologically advanced, particularly in ways that would allow China to associate itself with the United States and Russia in terms of advanced weapons and supporting capabilities while differentiating itself technologically from second-tier nuclear powers such as Britain, France, India, and Pakistan. In terms of size, this model predicts China building a nuclear force structure significantly larger and more sophisticated than other second-tier nuclear-weapon states and seeking to maintain quantitative and qualitative superiority over them. China might ultimately seek parity with the United States and Russia to affirm its superpower status, or it might decide to maintain a status as a responsible number-three nuclear power that differentiates itself from the Cold War behavior of the United States and USSR.

The model predicts Chinese investment in sophisticated nuclear and enabling technologies associated with international prestige, such as hypersonic systems, launch-detection satellites, and systems that incorporate artificial intelligence. Chinese officials and media would highlight China's advances in these areas to bolster the country's prestige. Because the goal of nuclear force development is more political than strategic, this model does not necessarily predict higher levels of alert. In fact, under this model Chinese leaders might perceive political costs to a nuclear force that is more forward-leaning operationally if it exposed China to criti-

cisms from the international community over irresponsible or aggressive nuclear behavior.[43] Chinese leaders have long attempted to portray their country as a responsible stakeholder on nuclear weapons by emphasizing a "lean" nuclear posture, highlighting the country's participation in disarmament forums, claiming to never engage in arms races, and criticizing other nuclear-weapon states for not adopting a no-first-use policy.[44] However, China's rapidly increasing nuclear arsenal and celebrations of its nuclear forces make it harder for Beijing to portray itself as a more responsible nuclear power than the United States and Russia. Officials from Europe to Japan have already criticized China's nuclear buildup.[45] Under this model, Chinese efforts to derive status by expanding its nuclear forces could lead other nuclear-weapon states to respond by expanding the size, sophistication, and importance of their own nuclear arsenals or to further criticize Chinese advances as violating Beijing's disarmament commitments.[46]

The Great Power status model does not generate clear predications about China's no-first-use policy. If Chinese strategists perceived possible nuclear first use as the hallmark of a Great Power nuclear strategy, then they might revise it, though they would likely perceive political costs to doing so.

Theater Deterrence

Under the theater deterrence model, Chinese nuclear thinking would be driven by a desire to deter "low-level" theater or tactical nuclear strikes from other states or by a desire to attain superiority at lower rungs of the nuclear ladder for coercive purposes. The first strand of this thinking would emphasize concerns that the United States might resort to limited nuclear strikes in a regional conflict to offset its perceived conventional inferiority vis-à-vis Beijing.[47] Strategists have long worried that strategic nuclear forces might be unable to deter limited nuclear strikes, given the inherent credibility problems of threatening to launch strategic nuclear attacks that invite massive retaliation and that a lack of low-yield and tactical nuclear weapons options could be exploited by an adversary that has these capabilities. The model predicts small-scale deployments of low-yield and tactical nuclear weapons to enhance nuclear deterrence by filling these capability gaps. A theater deterrence model focused on deterring U.S. theater or tactical nuclear strikes does not necessarily imply a change to China's no-first-use policy.

A more robust version of this logic would have China seeking superiority at lower rungs of the nuclear ladder to deter U.S. or Japanese nuclear or conventional involvement in a regional conflict. This version of the model predicts a Chinese nuclear force capable of conducting robust theater and tactical nuclear strikes, with a significant number of medium- and intermediate-range ballistic and cruise missiles equipped with lower yield and variable-yield warheads. The

ground, air, and naval forces operating these systems would be placed on higher levels of alert in a crisis. This variant also predicts development and deployment of the supporting capabilities necessary to support theater deterrence, such as advanced ISR, theater BMD, and possibly counterspace capabilities. The theater deterrence model does not imply anything about the size, structure, or capabilities of China's strategic nuclear forces.[48] Efforts to use nuclear weapons to intimidate adversaries and to deter conventional attack would require at least tacit threats to conduct nuclear first strikes, and the force structure and training required to make such threats credible would be inconsistent with China's no-first-use policy. (China would not need to make significant changes in its nuclear force structure or operational practices to intimidate Japan, but use of nuclear threats against a nonnuclear-weapon state would violate its negative security assurances.) In contrast to the secure second-strike and nuclear shield models, the robust variant of this model implies a belief that it would be possible to control a nuclear conflict and that limited nuclear use is manageable.

Bureaucratic Politics

The bureaucratic politics model explains China's nuclear force development as the product of bargaining between top civilian leaders, the PLA, and China's nuclear establishment. It sees China's military services promoting the development and deployment of nuclear capabilities associated with their services to capture greater budgets, influence, autonomy, and prestige. China's nuclear weapons design and production establishment would support a general expansion of China's nuclear arsenal and the role of nuclear weapons in Chinese strategy. Under this model, there would be no overarching strategic logic to China's nuclear forces and strategy. Rather, decisions about nuclear force development would be the product of bargains between civilian leaders and an array of actors pursuing their narrow bureaucratic interests.[49] Analysts have long recognized the role that bureaucratic politics and interservice rivalries can play in shaping military strategy, including strategy in the nuclear domain.[50]

This model predicts a moderately sized nuclear force, larger than predicted by the secure second-strike model but likely smaller than predicted by either the Great Power status or nuclear superiority model.[51] It predicts a nuclear force diversified across the military services and across a wide range of weapon platforms and an emphasis on the force's qualitative and operational characteristics. There would probably be more redundancy in systems and missions across services and platforms. The PLA might push for a larger role in setting China's nuclear strategy, which might lead to the adoption of more expansive and assertive nuclear missions. To enhance autonomy, the PLA might also push for changes such as pre-delegation of launch authority or

the adjustment or abandonment of China's no-first-use policy. The Politburo Standing Committee of the Chinese Communist Party (CCP) makes final decisions about China's nuclear force development, but CCP civilian leaders have generally been relatively uninformed about nuclear weapons issues.[52] The PLA and defense industry might be able to exploit their own information asymmetries and agenda-setting powers to significantly influence decisions by top leadership.

Nuclear Superiority

The nuclear superiority model sees high political and military value in superior nuclear capabilities and envisions China pursuing quantitative and qualitative overmatch to obtain first-strike capabilities against other nuclear-armed states. This goal might be pursued in three stages: (1) nuclear superiority against second-tier nuclear powers, such as India; (2) nuclear parity that erodes U.S. and Russian military advantages from quantitative and qualitative superiority of nuclear forces and supporting capabilities; and (3) nuclear superiority over the United States and Russia. This model, and the resulting nuclear force structure and strategy, represents the most significant departure from China's traditional approach to nuclear weapons. It implies a major change in the beliefs of senior Chinese leaders about the coercive value of nuclear weapons, about the potential to successfully execute a disarming first strike, and about the value of dealing with adversaries from a position of nuclear superiority.

This model predicts a nuclear arsenal that surpasses those of second-tier nuclear powers and eventually approaches or surpasses the size and sophistication of the U.S. and Russian arsenals. It implies a wide variety of nuclear warhead designs, delivery systems, and launchers. The model also predicts significant investments in supporting capabilities, such as advanced ISR and BMD capabilities necessary to execute a first strike. The model implies significant investment in both strategic and theater nuclear capabilities and that Chinese nuclear developments would be relatively insensitive to cost and force economy considerations. Chinese nuclear superiority over the United States and Russia would likely require economic or political developments that would make those states unwilling or unable to compete with China. In contrast to the secure second-strike model, and like the theater deterrence model, the nuclear superiority model implies a belief that it would be easy to control a nuclear conflict and that limited nuclear use is manageable.

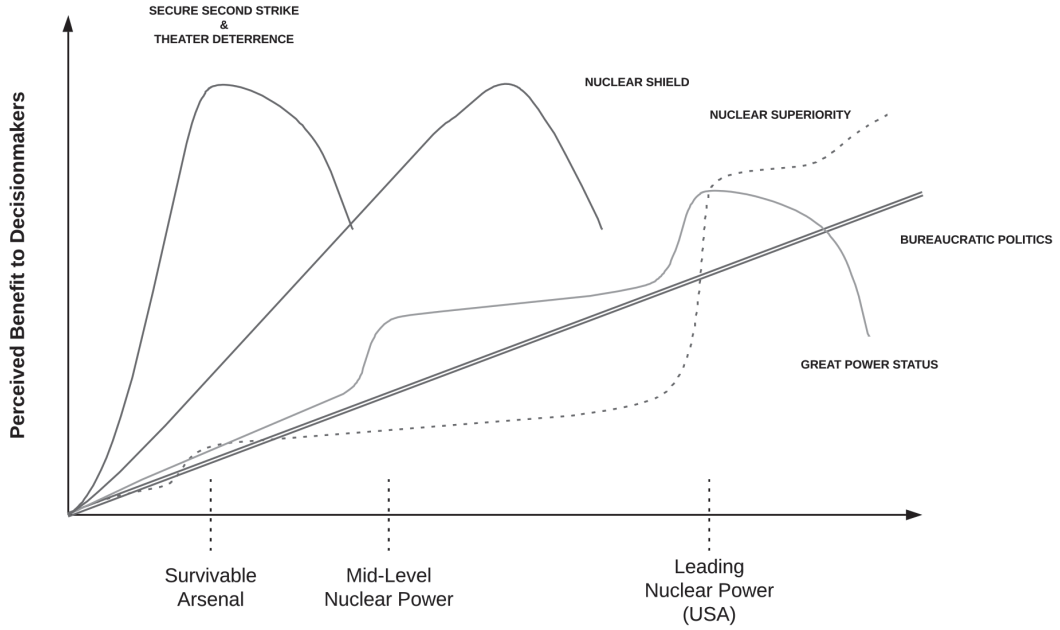
Value of Additional Nuclear Weapons

Models that imply advanced force postures, such as the theater deterrence and nuclear superiority models, may impose operational costs on the PLA. China has historically prioritized

strong political control over the country's nuclear forces and been sensitive to the potential high costs of arms races. A larger, more diversified, more capable, and more alerted nuclear force could require China to remove its traditional political controls and invest greater resources in developing the necessary doctrine, equipment, infrastructure, and training to support a more forward-leaning nuclear posture. This transformation could entail higher political costs for China, as discussed in the Great Power status model, and the diversion of scarce resources from both conventional military forces and domestic investment needs.

Some of the ways these models differ can be understood by illustrating the marginal benefits Chinese decisionmakers would expect from acquiring a more capable nuclear force under each model. These benefits should be considered separately at the strategic and theater/tactical levels. Figure 1 depicts the perceived benefits of increased strategic nuclear force capability for each of the models. The secure second-strike model implies that decisionmakers would perceive rapidly rising benefits to even modest enhancements to China's nuclear forces up until acquiring a survivable second-strike capacity. After this point, however, there would be diminishing or even negative returns as a more capable force imposed greater political or operational costs

Figure 1. Perceived Benefits of Strategic Nuclear Capabilities by Model

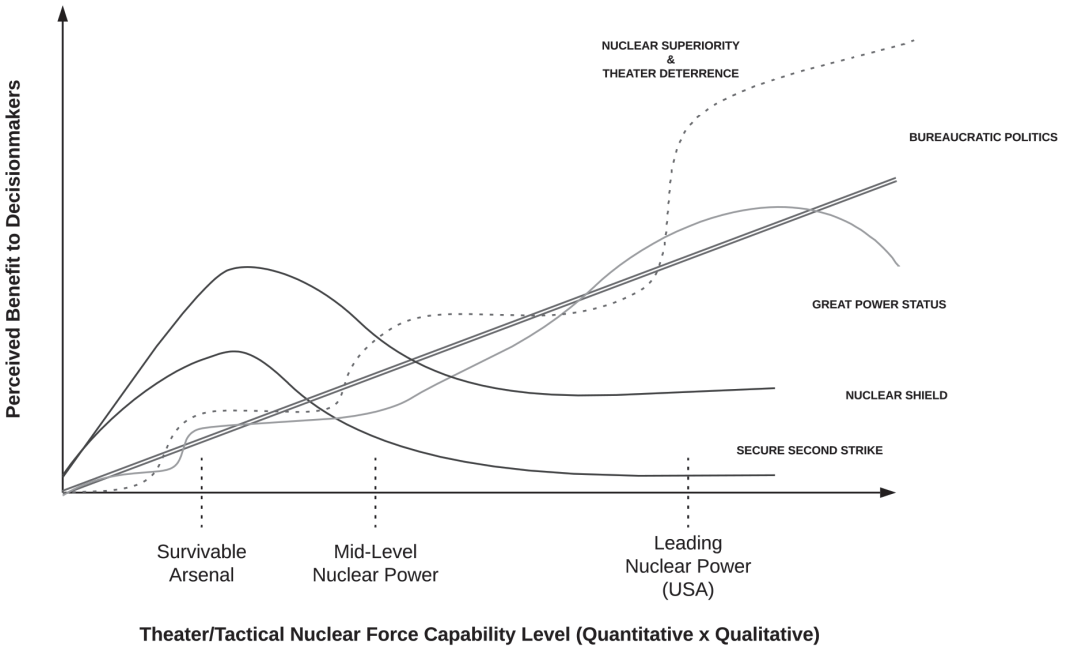


Note: The curves in the figure are notional and not meant to precisely reflect scale or movement.

and siphoned resources away from more usable conventional military programs. The nuclear shield model sees increasing returns to a larger strategic force beyond what would be technically survivable until China clearly establishes a strategic force sufficient to deter adversary strategic or theater nuclear strikes and to give adversaries pause about conventional intervention, after which decisionmakers might see decreasing benefits. The theater deterrence model, which focuses on potential limited war using theater or tactical nuclear weapons, also sees limited value in increased strategic nuclear forces past the point of a secure second strike. The nuclear superiority model sees the largest benefits from additional strategic capabilities coming as China nears and surpasses the capabilities of the leading nuclear powers, primarily the United States.[53] (Tactical capabilities are much more relevant to theater competition with powers such as India.) The Great Power status model sees the largest benefits coming as China first surpasses the capabilities of the second-tier nuclear states and then, later, as it approaches and surpasses those of the leading nuclear powers, the United States and Russia.[54] However, after China achieves the status of the leading nuclear power, the Great Power status model sees decreasing returns to additional strategic forces and perhaps even greater costs. Finally, the bureaucratic politics model implies roughly constant gains in perceived benefits regardless of the nuclear capabilities of other states.

Figure 2 depicts the marginal benefits perceived by Chinese decisionmakers of increased theater/tactical nuclear force capability for each of the models. The secure second-strike model implies some added benefits from theater forces that are survivable against second-tier nuclear powers such as India. However, beyond this level, the benefits decrease and quickly turn negative. The nuclear shield model envisions relatively more utility to theater/tactical nuclear forces created by both providing China response options to potential limited U.S. nuclear strikes and raising the escalation risks of such strikes. But like the secure second-strike model, the nuclear shield model envisions decreasing returns beyond a sufficient point. By contrast, the nuclear superiority and theater deterrence models perceive rising benefits to increased theater and tactical capabilities at three points: as these forces become survivable, as they surpass those of the second-tier powers, and finally as they near and surpass those of the leading nuclear powers. The nuclear superiority and theater deterrence models imply significant military benefits if China can dominate lower rungs of the nuclear escalation ladder (for the theater deterrence model) or achieve a clear military advantage at the theater or tactical level. The bureaucratic politics model implies roughly constant perceived benefits to more capable forces regardless of how they compare with the forces of other states. Finally, the Great Power status model suggests a curve where benefits would rise rapidly as China's nuclear capabilities surpassed those of mid-level powers, with perceived benefits continuing to accrue until China nears, reaches,

Figure 2. Perceived Benefits of Theater and Tactical Nuclear Capabilities by Model



Note: The curves in the figure are notional and not meant to precisely reflect scale or movement.

or surpasses the leading nuclear powers. After this point, the Great Power status model sees China receiving decreasing or negative returns to additional investments in theater or tactical nuclear capabilities.

Nuclear Force Development Implied by Each Model

In this section, we identify core features of the nuclear forces that would likely emerge from each model. We identify nine features across three dimensions: force structure, operational practices, and supporting elements. *Force structure* refers to size, diversification, strategic/tactical emphasis, and capabilities of nuclear forces. *Operational practices* refer to alert status, launch authorization, and warhead-handling practices. *Supporting elements* refer to BMD and ISR capabilities that support the nuclear forces. Together, these three dimensions describe the type of nuclear forces and strategy that would be most consistent with a model's assumptions. Like the models themselves, these dimensions are ideal types, necessarily simplifying the details of nuclear forces

and strategies that China might adopt. However, they can nonetheless help analysts better understand and anticipate potential future shifts in China's nuclear force development.

Force Structure

Overall Size. This attribute refers to the overall size of China's nuclear forces, generally measured in terms of total warheads that can be delivered against an adversary. In some of the models, overall force size is a dynamic and subjective measure that will move with other attributes and with Chinese estimates of adversary current and future capabilities. Some models may value strategic or theater/tactical nuclear forces more highly.

Force Diversification. Force diversification may vary by the number and type of delivery systems or platforms and by the number and type of military organizations that operate them. Strategies that view nuclear weapons as having utility for a greater variety of missions are likely to feature greater platform diversification. Strategies that conceive of a narrower deterrent role for nuclear weapons are likely to have fewer delivery platforms. Models that emphasize the political and military value of nuclear weapons and assign them more expansive roles in China's overall national and military strategy imply greater service diversification. Similarly, models that include a large role for bureaucratic actors predict greater service diversification.

Strategic/Theater/Tactical Emphasis. China might place different degrees of emphasis on strategic, theater, and tactical weapons. This variation would be evident in the number and range of delivery systems and the design of warheads. Longer range systems suggest an emphasis on the strategic level, whereas shorter range systems are likely for theater and tactical missions. Warhead designs might vary by yield (low, high, variable), size (large, miniaturized), and configuration (single warhead, MIRV). Some nuclear strategies may be fulfilled with a small number of relatively simple, high-yield warhead designs, but other strategies may demand a greater number of more sophisticated lower yield and variable-yield designs. For instance, the theater deterrence and nuclear superiority models imply a greater array of theater and tactical systems, and the secure second-strike model implies an arsenal constructed primarily of strategic nuclear systems.

Precision-Strike Capabilities. Different models imply different degrees of investment in delivery vehicles with high accuracy to support nuclear precision-strike missions. For instance, models that achieve deterrence by threatening to strike adversary cities do not require high levels of accuracy, whereas models that imply a battlefield role for nuclear weapons require more precise strike capabilities. This attribute is likely interactive with both warhead design and the level at which the nuclear forces are focused (strategic, theater, tactical).

Operational Practices

Alert Status. China's nuclear forces may be placed on different levels of alert depending on the perceived vulnerability of the nuclear deterrent or the specific system, the perceived need to execute rapid response nuclear strikes, and the parochial interests of the organizations involved. In general, strategies that envision nuclear weapons being used in multiple different military campaigns and those that are more influenced by the military imply higher levels of alert status.

Delegation. China may choose whether to delegate launch authority to its nuclear forces. This attribute is likely to vary with the alert status and the missions assigned to the force. As with alert status, strategies that feature higher military requirements and those that reflect greater military influence imply more delegation.

First Use. Models vary in the implicit willingness to use nuclear weapons first. The secure second-strike model would likely maintain China's no-first-use policy; this might also be true of the nuclear shield model. By contrast, the bureaucratic politics model implies a loosening of the no-first-use policy to give the military more autonomy in nuclear decisionmaking, and the nuclear superiority model implies a loosening of the policy to potentially execute disarming first strikes. The theater deterrence model implies a willingness and capability to at least threaten first strikes, especially in efforts to intimidate U.S. allies such as Japan.

Supporting Elements

Role for BMD. The competing models imply different roles for BMD capabilities in supporting China's overall nuclear strategy. For instance, models such as secure second-strike, Great Power status, and nuclear superiority all feature some role for BMD capabilities, which can increase the survivability of China's nuclear forces, showcase advanced technological achievements, empower domestic technological constituencies, and aid first-strike options. By contrast, the theater deterrence and bureaucratic politics models imply less of a role for BMD assets. Further, the type and extent of BMD infrastructure may vary by model, with theater deterrence implying a larger role for theater BMD assets and the secure second-strike and nuclear superiority models implying a larger role for national BMD systems.

Strategic ISR Capabilities. ISR capabilities may play an important role in either enhancing force survivability or executing nuclear strikes against counterforce targets. The importance of ISR capabilities varies across models but is likely greater in the theater deterrence and nuclear superiority models and less important in the secure second-strike and Great Power status models. ISR systems that provide launch detection capability and warning of incoming adversary attacks would have significant value under all models (and would be essential for a secure second

strike that relied on a launch-on-warning posture), so our discussion of strategic ISR focuses on capabilities for targeting adversary nuclear command and control systems and theater and tactical nuclear assets.

The features predicted by each model are summarized in table 3. These features not only help depict different alternative futures for China's nuclear forces but can also help analysts identify which future may be more likely based on current trends. Some attributes may function as leading indicators for future shifts, given the long time frames involved in the development of nuclear weapons systems and operations.

Evaluating China's Current and Future Nuclear Forces

Having described the six competing models and examined the nuclear forces and strategies most likely to emerge from each model, we can now assess China's current and future nuclear force development in terms of the nine core features and use these assessments to evaluate which of the six competing models best explain China's nuclear force development.

Coding Decisions for China's Current and Future Nuclear Force Features

We begin by assessing China's current nuclear force development for each of the nine core features. We also estimate, based on current trends depicted in open-source reports, the anticipated trajectory of change for each feature. Finally, based on these trajectories, we present estimates of how each feature might be coded in 2031. These findings are summarized in table 4.

In the category of force structure, we assess the *overall size* of China's nuclear force structure as currently low to medium. China currently has a nuclear weapons stockpile estimated in the low 400s, which would place it third among the nine nuclear-weapon states.[55] Despite this middling to high ranking, the Chinese stockpile is still significantly smaller than the roughly 1,750 deployed U.S. nuclear weapons and the roughly 1,600 deployed Russian strategic warheads.[56] China's overall force size is increasing, and we expect that by 2031 it will be at least medium. China is adding nuclear units to three of its services, and DOD assesses that its total nuclear warhead stockpile could number 1,000 by 2031.[57]

We assess China's current *force diversification* as low to medium. Although DOD assesses that China "has possibly already established a nascent nuclear triad," most of China's nuclear forces still consist of ground-based missiles assigned to the Rocket Force.[58] Further, while China is currently modernizing, expanding, and diversifying these forces, they still largely consist of a few types of intercontinental and regional ballistic missiles and do not feature a diverse array of delivery systems distributed across multiple domains like the U.S. and Russian arsenals or

Table 3. Core Features of Nuclear Forces and Strategies Under Each Model

Force structure	**Secure second-strike**	**Nuclear shield**	**Great Power status**	**Theater deterrence (theater only)**	**Bureaucratic politics**	**Nuclear superiority**
Overall size	Low	Medium	Medium†/ High‡	Medium	Medium	Medium†/ High‡
Force diversification	Medium	Medium	Medium	High	High	High
Strategic/ Theater/ Tactical emphasis	Strategic	Strategic	Strategic	Theater/ Tactical	No Preference	Theater/ Tactical†/ Strategic‡
Precision-strike capabilities	Low	Low	Low	High	Medium/High	Medium/ High
Operational practices	**Secure second-strike**	**Nuclear shield**	**Great Power status**	**Theater deterrence**	**Bureaucratic politics**	**Nuclear superiority**
Alert status	Low/ Medium*	Low/ Medium	Low/ Medium	High	High	High (in a crisis)
Delegation	Low/ Medium*	Low/ Medium	Low/ Medium	High	High	High
First use	No*	No*	Uncertain	Yes, for some scenarios	Yes?**	Yes
Supporting elements	**Secure second-strike**	**Nuclear shield**	**Great Power status**	**Theater deterrence**	**Bureaucratic politics**	**Nuclear superiority**
Role for BMD	Low	Low	Low	High	Low	High
Strategic ISR capabilities	Medium*	Medium*	Low/ Medium	High	Low/Medium	High

* Secure second-strike and Nuclear shield might have high levels of alert status, delegation, and strategic ISR to enhance survivability in launch-on-warning postures.

** Likely *Yes*, but impact on no-first-use policy depends on bureaucratic bargaining.

† For lead over second-tier nuclear states.

‡ For parity with United States and Russia.

Table 4. Coding Decisions for China's Current and Future Nuclear Force Features

Force structure	**Current status**	**Trajectory**	**2031 predictions**
Overall size	Low/Medium	Increasing	Medium
Force diversification	Low/Medium	Increasing	Medium
Strategic/Theater/ Tactical emphasis	Strategic	Some increase in Theater/Tactical emphasis	Strategic
Precision-strike capabilities	Low/Medium	Increasing	Medium/High
Operational practices	**Current status**	**Trajectory**	**2031 predictions**
Alert status	Low	Increasing	Medium
Delegation	Low	No change	Low
First use	No	Increasing ambiguity	Ambiguous
Supporting elements	**Current status**	**Trajectory**	**2031 predictions**
Role for BMD	Low	Slightly increasing	Low/Medium
Strategic ISR capabilities	Low	Increasing	Medium

even those of France, Pakistan, or India. However, the development of new delivery systems and their introduction to multiple military services mean that the diversification of China's forces is increasing; we assess that by 2031 it will be medium.

We assess that China's current *force structure emphasis* is at the strategic level. According to one estimate of the 258 warheads assigned to its ground-based nuclear forces, 186 are believed to be assigned to missiles with intercontinental range. (This number rises to 198 if it includes the older DF-4 and DF-31 systems, which are sometimes classified as ICBMs given that their ranges are greater than 5,500 kilometers.) Similarly, all of China's SSBNs are likely to serve a strategic role. China has developed additional new theater nuclear systems such as the DF-26 and DF-21E, and we assess that, given these trends, by 2031 it may increasingly emphasize the theater and tactical levels alongside the strategic level.

We assess China's *precision-strike capabilities* as low to medium. Although China is increasing the accuracy of its missile forces across the board, DOD assesses that the newly deployed DF-26 "is the PRC's first nuclear-capable missile system that can conduct precision strikes."[59]

China's older systems, especially its ICBM force, do not yet have the accuracy needed for precision strikes. As China introduces increasingly accurate systems, we predict that its nuclear precision-strike capabilities will increase and that by 2031 it may be medium to high, especially at the theater level.

In the category of operational practices, we assess China's nuclear forces as currently maintaining low *alert status*. As discussed earlier, there have been indications that China may be placing a portion of its ground-based nuclear forces on a higher alert status.[60] However, as DOD notes, "the PRC almost certainly keeps the majority of its nuclear force on a peacetime status—with separated launchers, missiles, and warheads," indicating that, on the whole, China's nuclear forces remain at a low level of alert.[61] The alert status of China's SSBNs is difficult to evaluate, though there is no open-source evidence clearly indicating that they patrol with warheads mated to delivery vehicles. Based on this limited information, we assess that China's alert status may be increasing and that by 2031 it may be medium.

We assess that China currently has tight central control over nuclear forces and low levels of *delegation*. The available evidence indicates that authority to use nuclear weapons rests with the Politburo Standing Committee and the Central Military Commission, although Xi Jinping's strengthened role in both organizations suggests he would be the individual with the most influence over nuclear decisions.[62] We find no evidence of changes in delegation and assess that in 2031 it will continue to be low.

We also assess that China largely continues its *no-first-use* policy despite increasing ambiguity about the conditions under which that policy applies. As DOD notes, "There is some ambiguity about conditions where Beijing's no-first-use policy would no longer apply; there has also been no indication that national leaders are willing to publicly attach such additions, nuances, or caveats."[63] Although we do not predict a wholesale change in China's no-first-use policy, we do anticipate continued or increased ambiguity for it in the future. If China adopted a launch-on-warning posture, it would likely define an adversary inbound attack with nuclear missiles as a "first use" even if the missiles had not yet struck.

In the category of supporting elements, we assess a small *role for BMD* capabilities in China's current nuclear strategy. Some of the PLA's surface-to-air missile systems may provide limited capability against tactical ballistic missiles, but China has yet to develop or deploy a dedicated BMD infrastructure, and Chinese discussions of nuclear strategy rarely feature discussions of its own prospective BMD assets.[64] These capabilities will increase modestly, and we assess that by 2031, they will be at a low to medium level.

We also assess a low status for strategic *ISR capabilities*. China is investing in strategic ISR systems and has deployed several assets that would provide these capabilities, including large phased-array radars, over-the-horizon radars, and at least one early-warning satellite.[65] However, China would need a more robust set of space- and ground-based assets to have meaningful early-warning and targeting capabilities (especially assets that provide the ability to locate adversary nuclear forces for counterforce strikes). We assess that, given ongoing investments, China may field medium-level strategic ISR capabilities by 2031.

Adjudicating Between Models Based on Nuclear Force Features

Based on these coding decisions, we then compare China's current nuclear force structure and strategy with the predictions generated by each of the six models. This process allows us to assess, based on these features, which of the models might best explain China's nuclear force development to date. These results are presented in table 5. Indicators providing strong evidence for a model are green, those providing moderate evidence are yellow, and those providing no or contradictory evidence are red. There are five potential values from low to high given possible low/medium and medium/high codings; values within one step of the prediction are green; values two steps away are yellow; values three or more steps away are red. (In evaluating the force structure features, we divided the nuclear superiority model into two categories: a theater category reflecting local nuclear superiority in a regional conflict and a strategic category reflecting nuclear superiority over the United States and Russia.)

The results indicate strongest support for the secure second-strike, nuclear shield, and Great Power status models. For these three models, most of the current features of China's nuclear force development match those predicted by the model and there are no features that conflict. By contrast, the theater deterrence and bureaucratic politics models have very little support, with many of the features of China's current nuclear force development conflicting with the values predicted by the model. We have not seen changes in Chinese nuclear policy, doctrine, or training that would be associated with an emphasis on nuclear warfighting consistent with the theater deterrence model. There is little support for the nuclear superiority model, either in its theater or strategic variants.

However, to a certain extent, China's current force development reflects decisions made in the past. It is not surprising that China's current nuclear force development reflects the outcomes predicted by the secure second-strike model; experts agree that this model's logic has guided China's historical approach to nuclear weapons. However, as discussed throughout this study, many features of China's nuclear forces are changing, and the country's nuclear force

Table 5. Evaluating China's Current Nuclear Force Features Against the Models

Force structure	**Secure second-strike**	**Nuclear shield**	**Great Power status**	**Theater deterrence**	**Bureaucratic politics**	**Nuclear superiority** **Theater**	**Strategic**
Overall size	Low	Medium	Medium†/ High‡	Medium	Medium	Medium†	High‡
Force diversification	Medium	Medium	Medium	High	High	High	High
Strategic/ Theater/ Tactical emphasis	Strategic	Strategic	Strategic	Theater/Tactical	No Preference	Theater/ Tactical†	Strategic‡
Precision-strike capabilities	Low	Low	Low	High	Medium/High	Medium/ High	Medium/ High
Operational practices	**Secure second-strike**	**Nuclear shield**	**Great Power status**	**Theater deterrence**	**Bureaucratic politics**	**Nuclear superiority** **Theater**	**Strategic**
Alert status	Low/Medium*	Low/Medium	Low/Medium	High	High	High (in a crisis)	High (in a crisis)
Delegation	Low/Medium*	Low/Medium	Low/Medium	High	High	High	High
First use	No*	No*	Uncertain	Yes, for some scenarios	Yes?	Yes	Yes
Supporting elements	**Secure second-strike**	**Nuclear shield**	**Great Power status**	**Theater deterrence**	**Bureaucratic politics**	**Nuclear superiority** **Theater**	**Strategic**
Role for BMD	Low	Low	Low	High	Low	High	High
Strategic ISR capabilities	Medium*	Medium*	Low/Medium	High	Low/Medium	High	High

Key: Green = strong support; Yellow = moderate support; Red = no support

* Secure second-strike and nuclear shield might have high levels of alert status, delegation, and strategic ISR to enhance survivability in launch-on-warning postures.

† For lead over second-tier nuclear states.

‡ For parity with the United States and Russia.

Table 6. Evaluating China's Predicted Nuclear Force Features in 2031 Against the Models

Force structure	**Secure second-strike**	**Nuclear shield**	**Great Power status**	**Theater deterrence**	**Bureaucratic politics**	**Nuclear superiority** **Theater**	**Strategic**
Overall size	Low	Medium	Medium†/ High‡	Medium	Medium	Medium†	High‡
Force diversification	Medium	Medium	Medium	High	High	High	High
Strategic/ Theater/ Tactical emphasis	Strategic	Strategic	Strategic	Theater/Tactical	No Preference	Theater/ Tactical†	Strategic‡
Precision-strike capabilities	Low	Low	Low	High	Medium/High	Medium/ High	Medium/ High
Operational practices	**Secure second-strike**	**Nuclear shield**	**Great Power status**	**Theater deterrence**	**Bureaucratic politics**	**Nuclear superiority** **Theater**	**Strategic**
Alert status	Low/Medium*	Low/ Medium*	Low/Medium	High	High	High (in a crisis)	High (in a crisis)
Delegation	Low/Medium*	Low/ Medium*	Low/Medium	High	High	High	High
First use	No*	No*	Uncertain	Yes, for some scenarios	Yes?	Yes	Yes
Supporting elements	**Secure second-strike**	**Nuclear shield**	**Great Power status**	**Theater deterrence**	**Bureaucratic politics**	**Nuclear superiority** **Theater**	**Strategic**
Role for BMD	Low	Low	Low	High	Low	High	High
Strategic ISR capabilities	Medium*	Medium*	Low/Medium	High	Low/Medium	High	High

Key: Green = strong support; Yellow = moderate support; Red = no support

First use is coded as ambiguous for 2031, so this row is uncolored.

* Secure second-strike and nuclear shield might have high levels of alert status, delegation, and strategic ISR to enhance survivability in launch-on-warning postures.

† For lead over second-tier nuclear states.

‡ For parity with the United States and Russia.

development may look very different in the future. To assess how ongoing trends may affect China's nuclear force development, we also developed coding decisions for 2031 based on expected changes to China's nuclear force development, presented in column 3 (2031 predictions) of table 4. Using these forward-looking coding decisions, we reevaluated the six models based on predicted values of China's nuclear forces along each of the nine features. The results are presented in table 6.

The findings here support three tentative conclusions. First, as noted in the codings for China's future nuclear force development, China's nuclear capabilities are improving, and its forces will increasingly be able to support more ambitious political and military goals. Second, despite these advances, the secure second-strike, nuclear shield, and Great Power status models remain the most compelling, even with predicted 2031 nuclear force developments. Third, however, the consistency of the other models with China's projected nuclear force development improves significantly, highlighting the ambiguity in China's ongoing nuclear force development and the challenge in inferring the underlying drivers. Greater emphasis on theater nuclear forces or the deployment of tactical nuclear weapons would constitute a major shift in China's nuclear posture and nuclear policy; analysts should closely monitor potential indicators of developments in this area. Changes in China's nuclear policy, operational doctrine, and training associated with such a shift would constitute strong support for the theater deterrence model.

Another way of exploring the relative explanatory and predictive value of the models is to apply them to current or future puzzles in China's nuclear force development. For instance, several experts have hotly debated the purpose of China's decision to construct nearly 300 new ICBM silos, given their high vulnerability.[66] The secure second-strike model would interpret the new silo construction as an attempt to increase the survivability of China's nuclear deterrent and would predict that the silo-based missiles will adopt a launch-on-warning posture to reduce their vulnerability. If the missiles based in these silos are MIRV-capable, they have the additional benefit of reducing the number of missile crews, thereby also reducing material and operational costs. The nuclear shield model would understand the silos as a highly visible indicator of China's nuclear forces meant to deter potential U.S. actions at the strategic nuclear, theater nuclear, or conventional level. The Great Power status model would understand the silos as a marker of achievement, one that can clearly differentiate China from second-tier nuclear powers. The bureaucratic politics model might explain the silos as a demonstration of the greater power of the Rocket Force's nuclear constituency over those of the Chinese navy and air force.[67] The nuclear superiority model would view the silos as a first step toward nuclear parity under the assumption that the size of the nuclear arsenal matters more than its operational

capabilities. The theater deterrence model, given its emphasis on the theater and tactical levels, would not provide a clear explanation for the silos.

Similarly, the models would offer different explanations for possible Chinese interest in developing and deploying new low-yield warheads, as discussed in the Office of the Secretary of Defense's 2021 report on China's military power.[68] This development would strongly support the theater deterrence model, which would interpret development and deployment of low-yield warheads as intended to deter potential U.S. use of tactical or theater nuclear weapons or to create more credible nuclear options to prevent Japanese intervention in a conflict. The nuclear shield model might understand new low-yield warheads as an attempt to deter possible U.S. theater nuclear strikes by giving China options to respond at different rungs of the escalation ladder. The bureaucratic politics model might understand new low-yield warheads as an attempt by the military, particularly the navy and air force, to gain more resources and autonomy within the nuclear domain. The Great Power status model would explain new warheads as a marker of technological achievement, one that differentiates China from second-tier nuclear powers. The secure second-strike and nuclear superiority models, given their emphasis on the strategic level, would not provide clear explanations for new low-yield nuclear warheads.

The features of possible nuclear forces and strategies constructed here help us depict and analyze China's nuclear force development. However, these core features may be insufficient on their own to forecast China's nuclear future. Many features are likely to be hidden and difficult to observe. Other features will take time to be developed and fielded and may not be visible until it is too late for U.S. policy to react. To identify the most probable future trajectory more accurately and quickly for China's nuclear forces, analysts must be able to use indicators across multiple dimensions that are observable, mutually exclusive, and leading. In the next section, we introduce additional observable indicators that can serve as indirect and leading evidence of China's nuclear force development and that may shed additional light on the drivers of China's nuclear force development.

Additional Observable Indicators for Evaluating Models

In this section, we identify observable indicators to provide additional insight into how well each model explains China's approach to nuclear force development. Many of the attributes of nuclear forces and strategy discussed in the previous section may be hidden or ambiguous, and therefore less helpful for evaluating the utility of the models. For example, the degree of launch authorization delegated to military operators is likely to vary significantly across the models, but is difficult to determine, especially from open-source analysis. In addition, some

of the force and strategy attributes may not vary sufficiently across models. A larger force size might be driven by a desire to either increase the survivability of the nuclear deterrent or by a desire to achieve strategic parity or overmatch. Additional observable indicators can help distinguish between these contrasting motives and expand and diversify our evidence base, strengthening the validity of our conclusions.

We identify several observable indicators that can help adjudicate between competing models and identify the actual underlying drivers. For example, a nuclear force largely influenced by Great Power status considerations would likely feature greater levels of transparency to acquire the domestic and international political benefits of becoming a nuclear Great Power. The Great Power status model, therefore, implies that Chinese media and leaders would highlight China's nuclear technological achievements, its status as an actual or near peer to Russia and the United States, and its leadership in the nuclear domain. By contrast, a nuclear force largely influenced by secure second-strike considerations would likely feature significantly greater opacity, to obscure the numbers, types, locations, and alert status of China's nuclear weapons. Some of the features of nuclear forces and strategy discussed in the previous section may also function as direct indicators.

Observable Indicators

Here, we identify 13 additional observable indicators, which we have grouped into five clusters: sensitivity to U.S. policy, nuclear infrastructure, doctrine and signaling, policymaking and process, and supporting elements. These indicators, and their expected values under each model, are listed in table 7. We begin with a general overview of each of the dimensions and their indicators.

Sensitivity to U.S. Policy

Sensitivity to U.S. Strategic Intentions. China's nuclear strategy might respond to changes in perceived U.S. strategic intentions toward China and to the overall state of the U.S.-China bilateral relationship. Perceived U.S. efforts to contain China or to overthrow CCP rule would exacerbate Chinese general suspicions, but the intensity of U.S.-China strategic competition and expectations about the likelihood of conflict would have a more direct impact on China's nuclear force development. Models that ascribe high strategic or military utility to China's nuclear weapons imply greater sensitivity to perceived changes in U.S. strategic intentions. For example, the secure second-strike, nuclear shield, theater deterrence, and nuclear superiority models suggest high responsiveness to changes in perceived U.S. strategic intentions, given that

the logic of these models focuses on responding to threats to Chinese interests. If Chinese leaders believe that the bilateral relationship is poor and deteriorating and that conflict is becoming more likely, these models predict greater investment in China's nuclear forces. Conversely, these same models predict less investment if Chinese analysts perceive the state of the relationship positively and the likelihood of conflict as low. By contrast, relatively nonstrategic models such as the bureaucratic politics model predict less sensitivity to perceptions of U.S. strategic intentions and the state of the bilateral relationship. In these models, although domestic actors may seek to use the bilateral relationship and claims about U.S. threats to pursue their narrower bureaucratic goals, the drivers of China's nuclear force development are primarily internal. The Great Power status model implies that heightened U.S.-China competition would produce increased investment in nuclear forces to garner prestige and that China would be less satisfied with an inferior nuclear position vis-à-vis the United States.

Sensitivity to U.S. Nuclear Policy. U.S. nuclear forces and policy might drive Chinese nuclear strategy. A larger, more advanced force and a more expansive doctrine would encourage similar nuclear choices by China. Some models imply a greater responsiveness to different aspects of U.S. nuclear policy. For instance, the secure second-strike and nuclear shield models imply that China's nuclear forces would be highly responsive to U.S. nuclear policies if China perceived those policies as seeking a first-strike capability that would undermine the survivability of China's nuclear deterrent. However, the secure second-strike model implies that once China became confident in its ability to maintain a survivable second-strike capability, its nuclear policies should be less responsive to changes in U.S. nuclear policy. By contrast, the Great Power status and nuclear superiority models both suggest a Chinese nuclear policy that is highly responsive to U.S. nuclear policy at all levels, either to indicate that China is keeping pace with the world's leading nuclear powers or to maintain the operational ability to execute a nuclear first strike. The nuclear shield and theater deterrence models imply high sensitivity to possible U.S. limited theater nuclear use.

Sensitivity to U.S. BMD Policy. China's nuclear strategy might also respond to U.S. BMD policy, with different models implying different levels of sensitivity. A more advanced, expansive, and integrated U.S. BMD architecture would encourage China to invest more in its nuclear forces, though the strength of this relationship would vary depending on the actors driving China's nuclear strategy and the goals of those actors. However, the strength of this relationship would vary across models. Further, different models imply sensitivity to different kinds of U.S. BMD systems, with the secure second-strike, nuclear shield, and nuclear superiority models

Table 7. Additional Observable Indicators for Evaluating Models

Sensitivity to U.S. policy	**Secure second-strike**	**Nuclear shield**	**Great Power status**	**Theater deterrence (theater only)**	**Bureaucratic politics**	**Nuclear superiority**	
						Theater	**Strategic**
Sensitivity to U.S. strategic intentions	High	High	Medium	High	Low	High	High
Sensitivity to U.S. nuclear policy	Medium	High	High	Medium	Low	High	High
Sensitivity to U.S. BMD policy	High	High	Low	Medium	Low/Medium	Medium	Medium
Nuclear infrastructure	**Secure second-strike**	**Nuclear shield**	**Great Power status**	**Theater deterrence**	**Bureaucratic politics**	**Nuclear superiority**	
						Theater	**Strategic**
Investment intensity	Low	Medium	Medium	High	Medium	Medium	High
Warhead-handling practices	Centralized*	Centralized*	Centralized	Distributed	Distributed	Distributed	Distributed
Doctrine and signaling	**Secure second-strike**	**Nuclear shield**	**Great Power status**	**Theater deterrence**	**Bureaucratic politics**	**Nuclear superiority**	
						Theater	**Strategic**
Force transparency	Low	High	High	High	High (domestic-oriented)	Medium	Medium
Doctrinal transparency	High	High	Medium	High	Medium	Medium	Medium
Policymaking and process	**Secure second-strike**	**Nuclear shield**	**Great Power status**	**Theater deterrence**	**Bureaucratic politics**	**Nuclear superiority**	
						Theater	**Strategic**
Bureaucratic posturing	Low	Low	Medium	High	High	Low	Low

Leadership involvement	Low	Low	High	Low	Low	High	High
Nuclear narratives	Threat, Survival	Threat, Survival, Escalation control	Achievement, Status	Escalation control	Indeterminate	Escalation control, Status	Escalation control, Status
Supporting elements	**Secure second-strike**	**Nuclear shield**	**Great Power status**	**Theater deterrence**	**Bureaucratic politics**	**Nuclear superiority** **Theater**	**Strategic**
Nuclear industry	Limited	Moderate	Moderate/ Expansive	Expansive	Expansive	Expansive	Expansive
Nuclear testing	Low	Low/ Moderate	Moderate†/ Extensive‡	Extensive	Moderate	Extensive	Moderate
Nuclear PME	Low/Medium	Low/Medium	Medium	Medium	Medium	High	High

* Secure second-strike and nuclear shield might have distributed warhead handling infrastructure to enhance survivability in launch-on-warning postures.

† For clear number-three status.

‡ For parity with the United States and Russia.

implying a greater sensitivity to national BMD and the theater deterrence model implying a greater sensitivity to theater BMD.

Nuclear Infrastructure

Intensity of Investment. The models predict different intensities in Chinese investments in nuclear forces. Low levels of intensity, which are likely true of the secure second-strike model, might feature the slower introduction of new systems, the extension of system service times, and the presence of life cycle extension programs. By contrast, models such as Great Power status, nuclear superiority, and bureaucratic politics imply a relatively higher level of intensity, to maintain China's status as a nuclear Great Power, to secure nuclear overmatch against nuclear competitors, or to satisfy the budgetary demands of the military services. The nuclear shield and theater deterrence models imply moderate levels of intensity, focused on either developing stronger deterrence effects or incorporating recent technological advancements. Intensity can be measured relative to the investment being made in conventional forces.

Warhead-Handling Infrastructure. Warhead-handling infrastructure might be highly centralized in specialized units at relatively high levels of command authority (for example, at the missile base level or higher) or distributed across all nuclear-armed units at low levels of command authority (for example, at the brigade level or lower). Under some models, such as the secure second-strike, nuclear shield, and Great Power status models, warhead handling would likely be highly centralized and controlled. Other models, such as theater deterrence and nuclear superiority, imply much more decentralized and looser systems of warhead handling to accommodate the higher readiness requirements of the force. A shift to a launch-on-warning doctrine would require decentralized warhead handling for units operating under that status.

Doctrine and Signaling

Force Transparency. Models imply differing degrees of transparency about the size, composition, and configuration of China's deployed nuclear forces as well as its planned future nuclear force structure. The secure second-strike model, for instance, implies relatively low levels of transparency to enhance the survivability of the limited deterrent. By contrast, the theater deterrence model implies a higher level of transparency, at least about theater and tactical nuclear systems and China's willingness to use them to deter nuclear use by the adversary. Similarly, the nuclear shield, Great Power status, and nuclear superiority models imply higher levels of force transparency to bolster China's prestige or deter nuclear competitors.

Doctrinal Transparency. China might also practice differing levels of doctrinal transparency, offering varying degrees of information about the operational practices of its nuclear forces, the missions to which they are assigned, and the conditions under which they might be used.

Policymaking and Process

Bureaucratic Posturing. Different models suggest different degrees of competitive posturing by military services and other actors within China's defense bureaucracy. In particular, the bureaucratic politics model implies the highest levels of bureaucratic posturing from military services and defense industry organizations competing for greater resources, autonomy, and prestige. By contrast, the secure second-strike, nuclear shield, and Great Power status models imply relatively more political control over China's nuclear behavior and relatively less bureaucratic posturing.

Leadership Involvement. China's civilian leadership is more likely to be involved in and associated with the nuclear forces under certain models. For instance, under the secure second-strike model, which implies the continuation of a relatively limited nuclear strategy, senior leaders would not adopt a dramatically different approach to nuclear weapons. Similarly, the bureaucratic politics model suggests a relatively low level of leadership involvement because the core logic of this model implies that changes in China's nuclear forces would be largely driven by competition between the nuclear constituencies and negotiation between these constituencies and senior CCP and military leadership. By contrast, models that imply a greater shift in China's nuclear strategy, such as the nuclear superiority model, suggest a greater role for party leaders in revising the principles underlying the country's nuclear strategy. The Great Power status model also predicts a higher degree of association between China's leadership and nuclear weapons, with leaders attempting to burnish their individual reputation through affiliation with a nuclear force contributing to China's prestige.

Nuclear Narratives. The models make different predictions about how Chinese sources will discuss the country's nuclear forces and the types of narratives that they will employ. For instance, the secure second-strike model suggests nuclear narratives highlighting China's need to safeguard the survivability of its nuclear deterrent against powerful external threats. By contrast, the Great Power status model implies narratives highlighting China's nuclear achievements and the ways China's nuclear forces reflect positively on the country's status and reputation. The nuclear shield model suggests nuclear narratives focused on the legitimacy of using enhanced Chinese nuclear capabilities to deter potential U.S. nuclear threats, nuclear use, and conventional intervention. Conversely, the theater deterrence model implies discus-

sions of the possibility of a limited nuclear conflict and what China must do to be prepared (or, alternatively, the disappearance of the current Chinese narrative that nuclear use *cannot* be controlled and limited nuclear war is impossible). Relevant sources for identifying these narratives include statements and speeches by senior CCP and military leaders, materials produced by the PLA and its affiliated strategists, and public-facing media such as *PLA Daily* or *People's Daily*.

Supporting Elements

Nuclear Industry. Different models imply different requirements for the nuclear industry that supports China's nuclear forces. This includes research and design institutes, weapons production facilities, warhead and missile testing sites, and fissile material production centers. Models such as Great Power status and nuclear superiority, which imply a larger nuclear force, also imply a larger nuclear industry.

Nuclear Testing. The facilities and associated activities that support nuclear warhead testing are core components of China's nuclear industry. Nuclear testing may be an important leading indicator of the types of nuclear forces China will deploy in the future. For instance, China has already developed several high-yield warhead designs, which should support the kinds of missions demanded under a secure second-strike model. However, China has not developed the kind of low- or variable-yield warheads that would likely be demanded under the theater deterrence or nuclear superiority models. Therefore, a resumption of nuclear testing indicating attempts to develop and field new warhead designs would be strong evidence supporting the more expansionary and assertive models.

Nuclear Professional Military Education. An additional leading indicator of the size and composition of the nuclear force may be the size and composition of nuclear professional military education (PME) positions in Rocket Force and PLA educational institutions. A growth in nuclear PME positions might indicate future growth in the force, with new personnel recruitments necessary to operate additional future weapons systems. A significant increase in nuclear PME positions is more likely under the Great Power status and nuclear superiority models. By contrast, the secure second-strike and nuclear shield models imply more modest increases. Similarly, the curricular emphasis in these cohorts might provide indications about the future composition of the nuclear forces or their operational practices. For instance, the bureaucratic politics and nuclear superiority model imply a greater diversity of military service representation at educational institutions associated with nuclear forces.

Coding Decisions for Observable Indicators

In the previous section, we constructed 13 observable indicators. In table 7 we identify the codings expected on each of these indicators for each of the competing models. In this section, for each indicator, we identify the status of China's nuclear behavior as well as the change trajectory along that indicator. These decisions are presented in table 8 and summarized in the following paragraphs. The full coding decisions and supporting data are detailed in the appendix.

We assess that China's nuclear force development is highly responsive to perceived changes in U.S. national security and military policies. We find it highly responsive to *U.S. strategic intentions*, *U.S. nuclear policy*, and *U.S. BMD policy*. Statements from Chinese government sources, PLA-affiliated strategists, and academic initiatives consistently show that Chinese observers are

Table 8. Coding Decisions for Observable Indicators

	Current Status	Trajectory
Sensitivity to U.S. Policy		
Sensitivity to U.S. strategic intentions	High	Increasing
Sensitivity to U.S. nuclear policy	High	No change
Sensitivity to U.S. BMD policy	High	No change
Structure and Infrastructure		
Intensity of investment	Medium	Increasing
Warhead-handling practices	Centralized	Uncertain
Doctrine and Signaling		
Force transparency	Low	No change
Doctrinal transparency	Medium	No change
Policymaking and Process		
Bureaucratic posturing	Low	No change
Leadership involvement	Low/Medium	No change
Nuclear narratives	Threat, Survival; Achievement-Accomplishment-Status	Increasingly emphasizing status
Supporting Elements		
Nuclear industry	Moderate	Increasing
Nuclear testing	Low	No change
Nuclear PME	Low	Possibly increasing

highly concerned about U.S. strategic intentions, that they believe the bilateral relationship to be poor and deteriorating, and that the risk of conflict is rising. Authoritative Chinese sources consistently cite the combination of new U.S. nuclear and BMD developments as a potential threat to China's nuclear deterrent. We assess that there is no change in these two indicators and that they will continue to remain high in the future.

In the category of force structure and infrastructure, we assess that China has medium *investment in nuclear forces* and maintains centralized *warhead-handling practices*. As detailed in the appendix, despite China's ongoing modernization and expansion of its nuclear forces, the country has still invested considerably more resources in its conventional forces. Personnel associated with conventional units and missions appear more likely to be promoted than their nuclear-oriented counterparts, and China continues to expand its conventional forces at a much faster rate than its nuclear ones. Further, authoritative Chinese sources regularly highlight the supposed limitations and disadvantages of nuclear weapons in comparison with conventional ones. We assess that China will invest more in its nuclear forces going forward.

We assess that China maintains centralized political control over its nuclear warheads but that some warheads may be stored locally to support periodic nuclear alerts. It is unclear whether China will maintain its tradition of centralized warhead storage or whether it will increasingly opt for a distributed approach to support higher levels of alert across the force and a possible launch-on-warning posture.

In the category of doctrine and signaling, we assess China as practicing low *force transparency* and medium *doctrinal transparency*. We assess China as having very low force transparency. China has historically published very little information about the size and composition of its nuclear forces.[69] We find no evidence that this low level of force transparency will change in the future. In contrast to China's very low force transparency in the nuclear realm, we assess China's doctrinal transparency as medium. China regularly specifies the overall purpose and components of its nuclear strategy and doctrine, describing it as consisting of self-defense, limited development, counterattack, and avoidance of arms races. Not only are these principles repeated in official documents such as defense white papers, they are also consistently repeated in internal PLA materials and even materials classified as Top Secret within China, suggesting that the information in public documents largely reflects China's actual policies.[70] We find no evidence that China's level of doctrinal transparency is shifting, though analysts should monitor for evidence that China's operational planning and practices are diverging from its declaratory nuclear doctrine.

In the category of policymaking and process, we find evidence of low *bureaucratic posturing*, low to medium *leadership involvement*, and *nuclear narratives* emphasizing threats to the survival of China's nuclear deterrent. There are some indications that Chinese strategists view nuclear weapons as useful for deterring nuclear threats, nuclear use, and conventional intervention.[71] Our review of secondary sources and of PLA-affiliated reports and publications does not reveal significant evidence of the PLA services emphasizing existing nuclear missions or lobbying for new ones. However, the diversification of China's nuclear forces through the addition of viable sea and air legs suggests at least some service-level interest in nuclear capabilities. As the PLA creates and empowers new nuclear communities, it is possible that the military services may push for expanded nuclear missions in ways that increase bureaucratic posturing in the future. We would expect the PLA Air Force and PLA Navy to resist efforts at joint planning and operations that put them under Rocket Force control, instead advocating for service control as a national asset or a new joint structure where they are represented at senior levels. As discussed elsewhere in this report, if anything we find an emphasis on conventional capabilities, given the perceived limitations of nuclear ones.[72]

There is little evidence of an increased interest by senior CCP officials in nuclear or missile matters, but there is evidence that senior party officials, including Xi Jinping, have a different view of nuclear weapons and strategy than in the past and that this view is beginning to be reflected in authoritative party and military documents. Xi, for instance, has issued public calls for the PLA to "accelerate the creation of high-level strategic deterrence," suggesting greater attention to strategic nuclear issues.[73] Traditionally, Chinese leaders have reportedly attributed limited political and military utility to nuclear weapons, viewing them as useful only for deterring nuclear strikes, preventing nuclear blackmail, and launching nuclear counterattacks.[74] But recent statements suggest other roles or purposes for nuclear weapons beyond simply deterring nuclear strikes against China.[75] We find no strong evidence that the Chinese leadership will increase its involvement in nuclear matters, although, as discussed below, an increasing association between nuclear weapons and international status may encourage Chinese leaders to speak more publicly about nuclear weapons issues.

A review of authoritative sources, including official government documents, PLA curricular materials, official military reporting, and research published by PLA-affiliated strategists, provides strong evidence of threat-survival and achievement-accomplishment-status *nuclear narratives*. Chinese sources consistently highlight the threats to the survivability of China's nuclear deterrent.[76] There is also growing discussion by Chinese strategists of a need to develop a strategic nuclear force that is not only survivable from a military-technical standpoint but so

clearly survivable that the United States would not even attempt a disarming first strike or damage-limitation strategy against China.[77] We also find evidence of a greater association between, on the one hand, China's nuclear and strategic missile forces and programs and, on the other, its status as a Great Power and nation of great achievement. Senior military and CCP officials increasingly mention China's nuclear forces and the Rocket Force as markers of the country's Great Power status. Since the establishment of the Rocket Force in 2016 as the successor organization to the Second Artillery Corps, official references to the missile forces consistently include the following refrain: "The Rocket Force is the core force of our country's strategic deterrent, the strategic support for our country's great power status, and an important cornerstone for safeguarding national security" [火箭军是我国战略威慑的核心力量,是我国大国地位的战略支撑,是维护国家安全的重要基石].[78] This stance is also reflected in PLA curricular materials. For instance, the most recent edition of *Science of Military Strategy*, published by the PLA National Defense University, explains, "We will strive to build a lean and effective strategic nuclear force *commensurate with China's international status* and commensurate with national security and development interests."[79] We expect narratives of power and status to become more prominent in the future. There is some evidence that Chinese strategists might increasingly view nuclear weapons as capable of not only deterring strategic nuclear attacks but also controlling escalation, deterring theater limited nuclear strikes, and deterring conventional military operations, though the evidence remains indirect and uncertain.[80]

Finally, in the category of supporting elements, we assess China as having a moderate *nuclear industry*, low *nuclear testing*, and low levels of *nuclear PME*. We assess China as currently having a limited military nuclear industry, though it will likely expand through construction of new facilities or refurbishment of old ones. China ceased production of fissile material for military purposes in the late 1980s and currently has relatively limited fissile material stockpiles, below those of Russia, the United States, the United Kingdom, France, and even Japan. Recent reports indicate that China is expanding its civilian nuclear industry, and the country is also investing more in its missile production facilities.

We find little open-source evidence that China has resumed testing related to development of nuclear weapons, though more detailed data may be available at higher classification levels. The strongest evidence comes from U.S. State Department reports on adherence to and compliance with arms control, nonproliferation, and disarmament agreements and commitments. However, despite the concerns about possible Chinese activities, these tentative statements stand in stark contrast to the more definitive language used to describe accusations of Russia's violation of the zero-yield testing moratorium.[81] Indeed, in the wake of the 2018 Nuclear Posture Review

and suggestions by some Chinese commentators that China should perhaps revise its nuclear policies, several Chinese experts repudiated calls for China to consider new low-yield nuclear weapons and adopt nuclear warfighting.[82] Analysts should nonetheless continue to monitor evidence of possible Chinese interest in and activities aimed toward resumed testing and new warhead designs.

We assess that there are currently few students and faculty in nuclear-related programs at Rocket Force educational institutions, suggesting relatively low future growth levels for the nuclear forces. Overall admissions at the Rocket Force University of Engineering have doubled over the past decade.[83] However, admissions for nuclear-related areas of study have grown modestly, suggesting that future missile force growth might emphasize conventional units rather than nuclear ones.

Adjudicating Between Models Based on Observable Indicators

Having coded each of the 13 observable indicators, we can now determine which models best align with China's current and projected nuclear behavior.

Given these coding decisions, we assess that the secure second-strike model and nuclear shield models best align with the observable indicators. We find that the Great Power status model also aligns closely with the observable indicators. The theater deterrence and nuclear superiority models have the least support, according to the indicators. In table 9 we illustrate the degree of support for each model across each indicator. As in tables 5 and 6, cells are coded green to indicate strong support if the coding decision matches or is within one step of that predicted by the model, yellow to indicate moderate support if the coding decision is close (two steps) to that predicted by the model, and red to indicate no support if the coding decision differs significantly from that predicted by the model.

For the secure second-strike model, nine out of the 13 indicators provide strong support and four provide moderate support. The nuclear shield model also has strong explanatory power, with 10 indicators providing strong support, two providing moderate support, and one providing no support. The Great Power status model performs moderately well at explaining China's nuclear force development. For this model, six out of 13 indicators provide strong support, and another four provide moderate support. These patterns are reinforced by the strong findings in the nuclear narrative section attesting to the growing importance of status and prestige. Here, as in the adjudication based on nuclear force features, we find less support for the bureaucratic politics, theater deterrence, and nuclear superiority models. The bureaucratic politics model receives strong support on three indicators and no support on six. The theater deterrence

Table 9. Evaluating Observable Indicators Against Model Predictions

Sensitivity to U.S. policy	**Secure second-strike**	**Nuclear shield**	**Great Power status**	**Theater deterrence (theater only)**	**Bureaucratic politics**	**Nuclear superiority** **Theater**	**Strategic**
Sensitivity to U.S. strategic intentions	High	High	Medium	High	Low	High	High
Sensitivity to U.S. nuclear policy	Medium	High	High	Medium	Low	High	High
Sensitivity to U.S. BMD policy	High	High	Low	Medium	Low/Medium	Medium	Medium
Nuclear infrastructure	**Secure second-strike**	**Nuclear shield**	**Great Power status**	**Theater deterrence**	**Bureaucratic politics**	**Nuclear superiority** **Theater**	**Strategic**
Investment intensity	Low	Medium	Medium	High	Medium	Medium	High
Warhead-handling practices	Centralized*	Centralized*	Centralized	Distributed	Distributed	Distributed	Distributed
Doctrine and signaling	**Secure second-strike**	**Nuclear shield**	**Great Power status**	**Theater deterrence**	**Bureaucratic politics**	**Nuclear superiority** **Theater**	**Strategic**
Force transparency	Low	High	High	High	High (domestic-oriented)	Medium	Medium
Doctrinal transparency	High	High	Medium	High	Medium	Medium	Medium

Policymaking and process	**Secure second-strike**	**Nuclear shield**	**Great Power status**	**Theater deterrence**	**Bureaucratic politics**	**Nuclear superiority**	
						Theater	**Strategic**
Bureaucratic posturing	Low	Low	Medium	High	High	Low	Low
Leadership involvement	Low	Low	High	Low	Low	High	High
Nuclear narratives	Threat, Survival	Threat, Survival, Escalation control	Achievement, Status	Escalation control	Indeterminate	Escalation control, Status	Escalation control, Status
Supporting elements	**Secure second-strike**	**Nuclear shield**	**Great Power status**	**Theater deterrence**	**Bureaucratic politics**	**Nuclear superiority**	
						Theater	**Strategic**
Nuclear industry	Limited	Moderate	Moderate/ Expansive	Expansive	Expansive	Expansive	Expansive
Nuclear testing	Low	Low/ Moderate	Moderate†/ Extensive‡	Extensive	Moderate	Extensive	Moderate
Educational appointments	Low	Low/Medium	Medium	Medium	Medium	High	High

Key: Green = strong support; Yellow = moderate support; Red = no support

* Secure second-strike and Nuclear shield might have distributed warhead handling practices to enhance survivability in launch-on-warning postures.

† For clear number-three status.

‡ For parity with the United States and Russia.

model has only two indicators with strong support and five with no support. The theater variant of the nuclear superiority model has only five indicators with strong support and four with no support; the strategic variant has four indicators with strong support and three with no support.

These findings largely confirm the adjudication based on current and projected nuclear force structure and provide further evidence that China's nuclear force development is driven by a continued desire to maintain a secure second strike and by a desire to build a nuclear shield; considerations of status and prestige are also increasingly prominent.

One additional way to evaluate the models is to consider which nuclear force developments would most strongly confirm or refute each model. We summarize the confirming and refuting evidence in table 10. For instance, the strongest confirming evidence for the secure second-strike model would be rapid and tailored Chinese responses to major U.S. policy changes that affected the survivability of China's nuclear deterrent. By contrast, the strongest refutation of the model might be if major U.S. policy changes or new capabilities that affected China's

Table 10. Confirming and Refuting Evidence for Each Model

Model	Strongest Confirmation	Strongest Refutation
Secure second-strike	Rapid and tailored responses to major U.S. policy changes or new capabilities that affect survivability and ability to penetrate U.S. BMD systems	No responses to major U.S. policy changes or new capabilities that affect survivability and ability to penetrate U.S. BMD systems
Nuclear shield	Explicit discussion of the value of nuclear weapons in deterring U.S. conventional intervention and first use of nuclear weapons	No or minimal responses to major U.S. policy changes or new capabilities, including both strategic and theater nuclear forces
Great Power status	Increasing number of deliverable warheads explicitly compared with U.S. and Russian force levels	Defining an upper limit on Chinese nuclear forces comparable to second-tier nuclear powers
Theater deterrence	Deployment of extensive tactical nuclear weapons capability and associated operational practices	No tactical nuclear weapons deployments
Bureaucratic politics	Development and deployment of expensive service nuclear capabilities that are redundant	Halting unproductive delivery system development efforts and reallocating resources
Nuclear superiority	Large expansion of missile, fissile material, and warhead production facilities	Unilaterally halting expansion of PRC nuclear forces

nuclear deterrent were met with no responses. The strongest confirming evidence for the Great Power status model would likely be an increase by China in the number of deliverable strategic warheads accompanied by explicit comparisons to U.S. and Russian nuclear force levels. By contrast, the strongest refutation of the Great Power status model might be China establishing an upper limit on its nuclear forces (through either cooperative arms control measures or unilateral declarations) comparable to the number of warheads deployed by second-tier nuclear powers. Analysts can continue to monitor for evidence of these developments to further evaluate the models.

Conclusions and Implications for U.S. Policy

This study makes several contributions to the understanding of China's nuclear force development. First, it develops six competing models for understanding the underlying logic of China's nuclear force development. Second, it identifies the features of nuclear forces and strategy most likely to emerge under each model. Third, it develops additional observable indicators that can help adjudicate between the competing models. Finally, using new open-source data on China's nuclear forces and supporting elements, it assesses which models best explain China's ongoing nuclear force development.

Our analysis suggests that the secure second-strike, nuclear shield, and Great Power status models are most consistent with China's current and projected nuclear force development. These findings suggest specific predictions about China's near-term nuclear force development. Specifically, they suggest that China is likely to continue to increase the overall size of its nuclear forces. The logic of nuclear expansion differs between the models, with the secure second-strike model emphasizing the need for larger nuclear forces to increase their survivability against possible counterforce strikes and BMD capabilities, nuclear shield emphasizing the need to deter U.S. nuclear threats and conventional intervention, and Great Power status emphasizing the desire to win increased status and prestige for China by distinguishing it from second-tier nuclear states. Each therefore predicts a different ultimate size for Chinese nuclear forces, with the size predicted by the secure second-strike model at the lower end, that predicted by Great Power status at the higher end, and that predicted by nuclear shield in the middle. The findings suggest that the primary drivers of China's nuclear force development are ensuring survivability, deterring U.S. military threats and intervention, and bolstering status.

In the long run, Great Power status drivers might encourage China to continue its nuclear buildup to seek quantitative and qualitative parity with U.S. and Russian nuclear capabilities, though such a buildup would generate increasing operational costs and risks, might come at

the expense of conventional capabilities and missions that the Rocket Force and the PLA still appear to prioritize, and could have costs in terms of China's desire to project a benevolent and peaceful image that differs from that of the superpowers. These models also imply that China's nuclear force development probably will not emphasize advanced precision-strike capabilities to satisfy military requirements, though China may incorporate more advanced technologies into its nuclear force development if they are seen as markers of prestige and achievement.

These three models predict that China is likely to retain a relatively restrained operational posture featuring moderate levels of alert status, low levels of launch authority delegation, and maintenance of a no-first-use policy. However, if China chooses to adopt a launch-on-warning posture to compensate for the limited survivability of its large silo-based ICBM force, this move may be accompanied by a higher alert status, greater delegation of launch authority, a more distributed model of nuclear warhead handling, and formal revision of China's no-first-use policy to interpret inbound adversary nuclear missiles as a "first use" that justifies a retaliatory launch. China may also increase the readiness of its nuclear forces if it decides that qualitative and quantitative enhancements to its nuclear forces are insufficient to secure their survivability or if it considers higher alert status or greater delegation hallmarks of a nuclear Great Power.

Finally, these models imply a small role for BMD capabilities and a moderate role for strategic ISR assets. China is likely to continue investing in BMD systems but is unlikely to deploy an extensive BMD architecture beyond what would be necessary to demonstrate its technological achievements in this area. In contrast, it is likely to develop and deploy more robust ISR strategic warning capabilities to support a launch-on-warning posture and to distinguish itself as only the third country ever to obtain a missile early-warning system. (An additional finding of the analysis is that enhanced strategic warning capabilities are valued in all the models.) These predictions are summarized in table 11.

In addition to these first-order changes, however, ongoing shifts in China's nuclear force development may generate second-order effects, which could encourage additional shifts in the medium to long term. For instance, although bureaucratic dynamics appear to exhibit a low to moderate influence on China's current nuclear force development, the creation and empowerment of nuclear constituencies within the Chinese military could generate new bureaucratic drivers. As China more fully develops the air and sea legs of its nuclear triad, there will be new organizations with a vested interest in maintaining and expanding China's nuclear forces and missions.

In addition, the introduction of new capabilities will further ease previous technological constraints and may promote the development of operational concepts that alter China's

Table 11. Predicted Force Developments

Force structure	**Secure second-strike**	**Nuclear shield**	**Great Power status**
Overall size	Low	Medium	Medium†/High‡
Force diversification	Medium	Medium	Medium
Strategic/Theater/ Tactical emphasis	Strategic	Strategic	Strategic
Precision-strike capabilities	Low	Low	Low
Operational practices	**Secure second-strike**	**Nuclear shield**	**Great Power status**
Alert status	Low/Medium*	Low/Medium	Low/Medium
Delegation	Low/Medium*	Low/Medium	Low/Medium
First use	No*	No*	Uncertain
Supporting elements	**Secure second-strike**	**Nuclear shield**	**Great Power status**
Role for BMD	Low	Low	Low
Strategic ISR capabilities	Medium*	Medium*	Low/Medium

* Secure second-strike and nuclear shield might have high levels of alert status, delegation, and strategic ISR to enhance survivability in launch-on-warning postures.
† For lead over second-tier nuclear states.
‡ For parity with the United States and Russia.

nuclear strategy. For example, the growing diversification of PLA nuclear forces may lead to the creation of formal institutions and policies for coordinating and deconflicting nuclear planning, operations, and force structure development across the various services, which could give the PLA more say in the formulation of nuclear strategy and policy. The introduction of truly dual-capable systems such as the DF-26 may further blur the lines between conventional and nuclear forces and promote the bleed-over of more forward-leaning operational concepts from conventional to nuclear units.[84] If nuclear forces are viewed as more prestigious, service in nuclear units may be viewed as an avenue to professional success, perhaps further empowering personnel from nuclear communities.[85]

Our analysis relies on open sources, which, while valuable, have certain inherent limitations. The framework presented in this report can potentially employ alternative and updated data sources to validate or revise our findings. U.S. intelligence analysts could replace our open-

source assessments with classified data and recode the values for China's current and projected nuclear force structure and the additional indicators. Beyond validating or revising the specific conclusions of this study, using this framework with classified data could help illuminate the promise and pitfalls of open-source analysis of the PLA more generally.

The findings presented here have several important implications for U.S. policy. First, the United States should anticipate that China will respond to changes in U.S. strategic forces as necessary to maintain a survivable second strike. If China is likely to respond to advances in U.S. offensive nuclear capabilities and defensive BMD systems with force development efforts of its own that negate the anticipated gains, U.S. policymakers should take this response into account in decisions about U.S. force investments.

Second, China's efforts to deter U.S. military threats and intervention through a larger nuclear force will place a greater premium on the local conventional force balance. U.S. policymakers will face difficult choices about allocating defense dollars across nuclear and conventional forces.[86]

Third, beyond considerations of survivability and deterrence, China's nuclear force development is likely to respond to perceived U.S. strategic policy developments because U.S. nuclear force developments will establish the benchmark for what it means to be a nuclear Great Power. This effect may cause China to pursue capabilities that, at least qualitatively, match those of the United States.

Fourth, China will likely remain reluctant to enter into arms control agreements if it views such agreements as hindering efforts to enhance the survivability and deterrent value of its nuclear forces or formally locking it into an inferior position.[87] However, if concerns about status continue to play an increasing role in Chinese nuclear thinking, future attempts to enlist Chinese participation in arms control could highlight the distinction that comes from participating in arms control negotiations with the nuclear superpowers as a near peer rather than as a second-tier nuclear power.

Notes

[1] The DF-21 medium-range ballistic missile, a solid-fuel mobile missile initially deployed in 1991, is the main exception.

[2] China's initial nuclear weapons were air-deliverable on A-5 fighter-bombers and B-6 bombers, but these aircraft could not reliably penetrate air defenses. The advent of ground-based missiles in the 1970s was what allowed China's deterrent to become operational.

[3] For histories of China's nuclear and missile forces, see Jeffrey Lewis, *Paper Tigers: China's Nuclear Posture* (New York: International Institute for Strategic Studies, 2014); John Wilson Lewis and Xue Litai, *China Builds the Bomb* (Stanford, CA: Stanford University Press, 1988).

[4] M. Taylor Fravel and Evan S. Medeiros, "China's Search for Assured Retaliation: The Evolution of Chinese Nuclear Strategy and Force Structure," *International Security* 35, no. 2 (Fall 2010), 48–87.

[5] Hans M. Kristensen and Robert S. Norris, "Global Nuclear Weapons Inventories, 1945–2013," *Bulletin of the Atomic Scientists* 69, no. 5 (2013), 75–81; *Annual Report to Congress: The Military Power of the People's Republic of China 2005* (Washington, DC: Office of the Secretary of Defense, 2005), 28–29, 45.

[6] "Declaration of the Government of the People's Republic of China" [中华人民共和国政府声明], *People's Daily* [人民日报], October 17, 1964, 1 (for English translation, see "Statement by Peking on Nuclear Test," *New York Times*, October 17, 1964, 10, https://www.nytimes.com/1964/10/17/archives/statement-by-peking-on-nuclear-test.html); Fiona S. Cunningham and M. Taylor Fravel, "Assuring Assured Retaliation: China's Nuclear Posture and U.S.-China Strategic Stability," *International Security* 40, no. 2 (Fall 2015), 7–50.

[7] See, for example, Li Bin, "China and Nuclear Transparency," in *Transparency in Nuclear Warheads and Materials: The Political and Technical Dimensions*, ed. Nicholas Zarimpas (New York: Oxford University Press, 2003), 51–53; "A Brigade of the Rocket Army Refined and Improved the Synthetic Training Evaluation System: An Innovative Mechanism to Test the Battalion's Independent Combat Capability" [火箭军某旅细化完善合成训练考评体系创新机制检验营独立作战能力], *PLA Daily* [解放军报], April 14, 2019, http://www.81.cn/jfjbmap/content/2019-04/14/content_231587.htm. On China's nuclear command and control, see Fiona Cunningham, *Nuclear Command, Control, and Communications Systems of the People's Republic of China*, NAPSNet Special Report (Berkeley, CA: Nautilus Institute for Security and Sustainability, July 18, 2019), https://nautilus.org/napsnet/napsnet-special-reports/nuclear-command-control-and-communications-systems-of-the-peoples-republic-of-china/. On China's nuclear warhead–handling practices, see Mark Stokes, *China's Nuclear Warhead Storage and Handling System* (Arlington, VA: Project 2049 Institute, March 12, 2010), https://project2049.net/wp-content/uploads/2018/05/chinas_nuclear_warhead_storage_and_handling_system.pdf.

[8] For recent examples, see "Direct Attack on '2020 Training': A Rocket Force Brigade's 'Dongfeng Express' Works for Victory Day and Night in Sub-Zero Temperatures" [直击"2020开训": 火箭军某旅 零下20度"东风快递哥"昼夜兼程为胜战], CCTV-7 National Defense Military Channel [国防军事频道], January 10, 2020; Niu Xiaoli [牛小立], Xiao Yunjian [肖云舰], and Tian Liang[田亮], "One Difficult Night" [艰难一夜], *Rocket Force News* [火箭兵报], January 14, 2017, 2; and Liu

Wanghu [刘王虎], "Second Artillery Soldiers Hidden in Underground Caverns for 8-Day Exercise Eat Leeks and Sweet Peppers" [二炮士兵隐蔽在地下洞库8天生吃韭菜甜椒], *PLA Daily* [解放军报], May 6, 2013, http://mil.news.sina.com.cn/2013-05-06/0420723740.html. For recent comments by a former senior Rocket Force official suggesting that the readiness levels of the missile forces have increased substantially, see Yang Chengjun [杨承军], "Nuclear Strategy Expert Yang Chengjun: It Is Not Appropriate to Hype Nuclear-Related Issues on the Internet" [核战略专家杨承军: 不宜在网络上炒作涉核问题], *Motherland* [祖国], May 13, 2020.

[9] *Annual Report to Congress: Military and Security Developments Involving the People's Republic of China 2011* (Washington, DC: Office of the Secretary of Defense, 2011), 34–35, 78; Hans M. Kristensen and Robert S. Norris, "Chinese Nuclear Forces, 2011," *Bulletin of the Atomic Scientists* 67, no. 6 (2011), 81–87.

[10] For slightly different but roughly comparable assessments, see *Annual Report to Congress: Military and Security Developments Involving the People's Republic of China 2022* (Washington, DC: Office of the Secretary of Defense, 2022), 94; Hans M. Kristensen and Matt Korda, "Chinese Nuclear Forces, 2021," *Bulletin of the Atomic Scientists* 77, no. 6 (2021), 318–336.

[11] P.W. Singer and Ma Xiu, "China's Missile Force Is Growing at an Unprecedented Rate," *Popular Science*, February 25, 2020, https://www.popsci.com/story/blog-eastern-arsenal/china-missile-force-growing/.

[12] *Annual Report to Congress 2022*, 94, 96.

[13] *Annual Report to Congress: Military and Security Developments Involving the People's Republic of China 2021* (Washington, DC: Office of the Secretary of Defense, 2021), 49, 91; Tong Zhao, *Tides of Change: Nuclear Ballistic Missile Submarines and Strategic Stability* (Washington, DC: Carnegie Endowment for International Peace, 2018).

[14] *Annual Report to Congress 2022*, 94; Anthony J. Cotton, *FY24 Strategic Forces Posture*, Testimony before the House Armed Services Committee on Strategic Forces, 118th Cong., 1st sess., March 8, 2023; Minnie Chan, "China's New Nuclear Submarine Missiles Expand Range in U.S.: Analysts," *South China Morning Post,* May 2, 2021, https://www.scmp.com/news/china/military/article/3131873/chinas-new-nuclear-submarine-missiles-expand-range-us-analysts; Hans M. Kristensen, Matt Korda, and Eliana Reynolds, "Chinese Nuclear Weapons, 2023," *Bulletin of the Atomic Scientists* 79, no. 2 (2023), 125.

[15] Michael S. Chase, "Nuclear Bomber Could Boost PLAAF Strategic Role, Create Credible Triad," *China Brief* 17, no. 9 (2017); *Annual Report to Congress 2021*, 91–92.

[16] Matt Korda and Hans Kristensen, "A Closer Look at China's Missile Silo Construction," *Federation of American Scientists*, November 2, 2021, https://fas.org/blogs/security/2021/11/a-closer-look-at-chinas-missile-silo-construction/.

[17] David E. Sanger and William J. Broad, "China's Weapon Tests Close to a 'Sputnik Moment,' U.S. General Says," *New York Times*, October 27, 2021, https://www.nytimes.com/2021/10/27/us/politics/china-hypersonic-missile.html.

[18] Phillip C. Saunders and David C. Logan, "China's Regional Nuclear Capability, Nonnuclear Strategic Systems, and Integration of Concepts and Operations," in *China's Strategic Arsenal: Worldview, Doctrine, and Systems*, ed. James M. Smith and Paul J. Bolt (Washington, DC: Georgetown University Press, 2021), 125–157.

[19] *Annual Report to Congress 2021*, 60–61; Peter Wood and Roger Cliff, *A Case Study of the PRC's Hypersonic Systems Development* (Maxwell AFB, AL: China Aerospace Studies Institute, August 25, 2020).

[20] *Annual Report to Congress 2021*, 91, 93–94.

[21] See, for example, Li Zhong [李忠] and Zhang Fan [张帆], "Snowy Battlefield Military Exercises Are Busy: Account of a Brigade's Winter Training Camp Confrontation Exercise" [雪域战场演兵忙：某旅冬训场营营对抗演练目击记], *Rocket Force News* [火箭兵报], January 7, 2017, 1; Yang Chengjun, "It Is Not Appropriate to Hype Nuclear-Related Issues on the Internet"; *Annual Report to Congress 2021*, 91, 93–94.

[22] "Declaration of the Government of the People's Republic of China," 1; *China's National Defense in the New Era* (Beijing: State Council Information Office of the People's Republic of China, 2019); and Deng Bibo [邓碧波], "The Chinese Army Has Always Been a Defender of World Peace" [中国军队始终是世界和平的捍卫者], *PLA Daily* [解放军报], October 18, 2018, 4.

[23] Cunningham and Fravel, "Assuring Assured Retaliation"; *Annual Report to Congress 2021*, 90–91.

[24] For examples of periodic debates, see Alastair Iain Johnston, "China's New 'Old Thinking': The Concept of Limited Deterrence," *International Security* 20, no. 3 (Winter 1995–1996), 5–42; Gregory Kulacki, *China's Military Calls for Putting Its Nuclear Forces on Alert* (Cambridge, MA: Union of Concerned Scientists, January 2016).

[25] We note that this consistency appears in publicly stated policy and doctrine. It is possible that the Chinese military has adopted new internal guidance that involves more significant changes to China's nuclear policy and doctrine, though we find little evidence of this in open sources.

[26] For a survey of views on the implications for the United States, see Caitlin Talmadge and Joshua Rovner, "The Meaning of China's Nuclear Modernization," *Journal of Strategic Studies*, May 31, 2023, https://doi.org/10.1080/01402390.2023.2212871.

[27] Where appropriate, we will consider other potential Chinese adversaries, but for the most part these can be considered lesser included cases.

[28] The secure second-strike and the theater deterrence models mirror what Vipin Narang has described as, respectively, the assured retaliation and asymmetric escalation strategies. Vipin Narang, *Nuclear Strategy in the Modern Era: Regional Powers and International Conflict* (Princeton: Princeton University Press, 2014). The secure second-strike model might imply a larger or more alert force, depending on the state's views about the best way to maintain the efficacy of its nuclear deterrent.

[29] See, for example, Henrik Stålhane Hiim, M. Taylor Fravel, and Magnus Langset Trøan, "The Dynamics of an Entangled Security Dilemma: China's Changing Nuclear Posture," *International Security* 47, no. 4 (2023), 147–187.

[30] Jeffrey Lewis, "The Minimum Means of Reprisal," in *The Minimum Means of Reprisal: China's Search for Security in the Nuclear Age* (Cambridge, MA: MIT Press, 2007).

[31] *Annual Report to Congress: Military and Security Developments Involving the People's Republic of China 2020* (Washington, DC: Office of the Secretary of Defense, 2020), 86.

[32] Shou Xiaosong [寿晓松], ed., *Science of Military Strategy* [战略学] (Beijing: Military Science Press [军事科学出版社], 2013), 175; Kulacki, *China's Military Calls for Putting Its Nuclear Forces on Alert*.

[33] For a similar discussion of these logics, see Abraham Denmark and Caitlin Talmadge, "Why China Wants More and Better Nukes: How Beijing's Nuclear Buildup Threatens Stability," *Foreign Affairs*, November 19, 2021.

[34] Extending deterrence in this way rests on adversary perceptions of escalation risks. Unlike theater deterrence, this model assumes traditional Chinese views that nuclear conflicts are hard to control and will tend to escalate to the strategic level.

[35] See, for example, Phillip C. Saunders and David C. Logan, "The Implications of the PLA's Nuclear Expansion and Modernization for China's Crisis Behavior," in *China's Military Decision-making in Crisis and Conflict*, ed. Roy D. Kamphausen (Seattle: National Bureau of Asian Research, 2023, forthcoming); and Jacob Stokes, *Atomic Strait: How China's Nuclear Buildup Shapes Security Dynamics with Taiwan and the United States* (Washington, DC: Center for a New American Security, 2023).

[36] *Annual Report to Congress 2022*, 98.

[37] Christopher P. Twomey, "China's Nuclear Doctrine and Deterrence Concept," in Smith and Bolt, *China's Strategic Arsenal*, 53–57; Christopher P. Twomey, *China's Nuclear Forces*, Testimony before the U.S.-China Economic and Security Review Commission Hearing, 117th Cong., 1st sess., June 10, 2021, https://www.uscc.gov/sites/default/files/2021-06/Christopher_Twomey_Testimony.pdf.

[38] Stacie Pettyjohn and Hannah Dennis, *Avoiding the Brink: Escalation Management in a War to Defend Taiwan* (Washington, DC: Center for a New American Security, 2023), 6, 11.

[39] Lawrence Scheinman, *Atomic Energy Policy in France Under the Fourth Republic* (Princeton: Princeton University Press, 1965); Wilfred L. Kohl, *French Nuclear Diplomacy* (Princeton: Princeton University Press, 1971); Peter R. Lavoy, "Nuclear Myths and the Causes of Nuclear Proliferation," *Security Studies* 2, no. 3–4 (1993), 192–212; and Itty Abraham, *The Making of the Indian Atomic Bomb: Science, Secrecy, and the Postcolonial State* (New York: Zed Books, 1998).

[40] "Ministry of National Defense: The United States Is the Biggest Risk to International Security" [国防部: 美国才是国际安全的最大风险源], Ministry of National Defense [国防部], January 27, 2022, http://www.mod.gov.cn/jzhzt/2022-01/27/content_4903948.htm; "Ministry of Foreign Affairs: The U.S. Claims That China Is Intensifying an Arms Race, in an Act of Unfounded Accusations" [外交部：美方声称中国加剧军备竞赛 纯属倒打一耙], *People's Daily* [人民日报], October 20, 2021, https://cn.chinadaily.com.cn/a/202110/20/WS616f82e3a3107be4979f39cb.html.

[41] Susan Turner Haynes, "The Power of Prestige: Explaining China's Nuclear Weapons Decisions," *Asian Security* 16, no. 1 (2020), 35–52; Nicola Leveringhaus, "How China's Nuclear Past Shapes the Present: Ideological and Diplomatic Considerations in Nuclear Deterrence," in *Modernizing Deterrence: How China Coerces, Compels, and Deters*, ed. Roy D. Kamphausen (Washington, DC: National Bureau of Asian Research, 2023), 29–42; and Nicola Leveringhaus, "The Politics of Nuclear Commemoration in Asia: The China Case," presentation to the Australian National University, video, 1:16:32, August 5, 2021, https://www.youtube.com/watch?v=B6o-TM-exUM.

[42] M. Taylor Fravel, *A "World-Class" Military: Assessing China's Global Military Ambitions*, Testimony before the U.S.-China Economic and Security Review Commission Hearing, 116th Cong., 1st sess., June 20, 2019.

[43] The remainder of this paragraph draws from Saunders and Logan, "The Implications of the PLA's Nuclear Expansion and Modernization for China's Crisis Behavior."

[44] Han Hua, "China, the Increasingly Responsible Nuclear Stakeholder," *Bulletin of the Atomic Scientists*, October 25, 2016, https://thebulletin.org/roundtable_entry/china-the-increasingly-responsible-nuclear-stakeholder; Wang Jia, "China's Views on the Road Map to Nuclear Disarmament," in *Understanding Chinese Nuclear Thinking*, ed. Li Bin and Tong Zhao (Washington, DC: Carnegie Endowment for International Peace, 2016), 103–125; and Fan Jishe, "Nuclear Nonproliferation: China's Thinking and Practices," in Li Bin and Tong Zhao, *Understanding Chinese Nuclear Thinking*, 193–218.

[45] "NATO Must Pay Attention to China, Stoltenberg Says," Deutsche Welle, June 13, 2020, https://www.dw.com/en/natos-jens-stoltenberg-sounds-warning-on-chinas-rise/a-53795384; Tim Kelly, "Japan's Defence Minister Slams Nuclear Neighbours Who 'Ignore Rules,'" Reuters, June 11, 2022, https://www.reuters.com/world/asia-pacific/japans-defence-minister-slams-nuclear-neighbours-who-ignore-rules-2022-06-11.

[46] "Blinken's Warning on China's Nukes," *Wall Street Journal*, August 9, 2021; Natasha Bertrand, "China's Latest Missile Test Raises the Stakes for Biden's Nuclear Weapons Review," CNN, November 3, 2021, https://www.cnn.com/2021/10/22/politics/china-hypersonic-missile-joe-biden-nuclear-policy/index.html; and Amelia Morgan and Heather Williams, "Implementing the Integrated Review's Nuclear Doctrine," King's College London, May 19, 2022, https://www.kcl.ac.uk/implementing-the-integrated-reviews-nuclear-doctrine.

[47] *Annual Report to Congress 2021*, 93.

[48] China would not hope to have escalation dominance against a much larger U.S. strategic nuclear force, and nuclear warfighting involving strategic weapons would be difficult or impossible to control, with costs and risks incommensurate with the stakes of a conflict.

[49] For a discussion, see Phillip C. Saunders and Isaac Kardon, "Reconsidering the PLA as an Interest Group," in *PLA Influence on China's National Security Policymaking*, ed. Phillip C. Saunders and Andrew Scobell (Stanford, CA: Stanford University Press, 2015), 33–57.

[50] Ian Burns McCaslin and Andrew S. Erickson, *Selling a Maritime Air Force: The PLAAF's Campaign for a Bigger Maritime Role* (Maxwell AFB, AL: China Aerospace Studies Institute, April 1, 2019).

[51] Unlike the nuclear shield model, the bureaucratic politics model would imply investment in strategic, theater, and tactical nuclear systems, though the degree of investment in each would depend on the relative strength of different bureaucratic actors.

[52] For example, nuclear deterrence and nuclear strategy are not taught to cadres at the Central Party School. Saunders 2002 discussion with Central Party School faculty member.

[53] The value in approaching the United States and Russia is to prevent these states from intimidating or blackmailing China. The value in surpassing these states is that China could intimidate or blackmail them.

[54] For a discussion of second-tier nuclear powers, or what Narang calls "regional nuclear powers," see Narang, *Nuclear Strategy in the Modern Era*.

[55] The nuclear stockpile estimate of low 400s comes from recent Department of Defense reports and would put the Chinese stockpile behind the American and Russian stockpiles. See *Annual Report to Congress 2022*, 94.

[56] Hans M. Kristensen and Matt Korda, "United States Nuclear Forces, 2020," *Bulletin of the*

Atomic Scientists 76, no. 1 (2020), 46–60; and Hans M. Kristensen and Matt Korda, "Russian Nuclear Weapons, 2022," *Bulletin of the Atomic Scientists* 78, no. 2 (2022).

[57] *Annual Report to Congress 2021*, 90.

[58] Ibid., 90.

[59] Ibid., 93.

[60] *Annual Report to Congress 2021*, 91; Li Zhong and Zhang Fan, "Snowy Battlefield Military Exercises Are Busy."

[61] *Annual Report to Congress 2021*, 91.

[62] See, for example, Mark Stokes, *China's Nuclear Warhead Storage and Handling System*; David C. Logan, *China's Future SSBN Command and Control Structure*, INSS Strategic Forum No. 299 (Washington, DC: NDU Press, November 2016); and Cunningham, *Nuclear Command, Control, and Communications of the People's Republic of China*.

[63] *Annual Report to Congress 2021*, 90.

[64] On the ability of the surface-to-air inventory to offer limited ballistic missile defense capability, see *Annual Report to Congress 2021*, 80.

[65] "China's Nuclear Forces: Moving Beyond a Minimal Deterrent," in *2021 Report to Congress* (Washington, DC: U.S.-China Economic and Security Review Commission, November 2021), 358–359; Hans M. Kristensen, "China's Strategic Systems and Programs," in Smith and Bolt, *China's Strategic Arsenal*, 93–124.

[66] For some competing interpretations, see Matthew Kroenig, "China's Nuclear Silos and the Arms-Control Fantasy," *Wall Street Journal*, July 7, 2021; Tong Zhao, "What's Driving China's Nuclear Buildup?" Carnegie Endowment for International Peace, August 5, 2021, https://carnegieendowment.org/2021/08/05/what-s-driving-china-s-nuclear-buildup-pub-85106; and James Cameron, "China's Silos: New Intelligence, Old Problems," *War on the Rocks*, August 12, 2021, https://warontherocks.com/2021/08/beijings-silos-new-intelligence-old-problems/.

[67] Alternatively, the bureaucratic politics model might see logrolling, with each service getting permission to pursue its own new nuclear capabilities.

[68] *Annual Report to Congress 2021*, 93.

[69] Wu Riqiang, "How China Practices and Thinks About Nuclear Transparency," in Li Bin and Tong Zhao, *Understanding Chinese Nuclear Thinking*, 219–243.

[70] However, these sources are increasingly outdated.

[71] Twomey, "China's Nuclear Doctrine and Deterrence Concept," 53–55.

[72] See, for example, Xiao Tianliang [肖天亮], ed., *Science of Military Strategy* [战略学] (Beijing: National Defense University Press [国防大学出版社], 2020), 129, 382.

[73] Xu Kun [徐锟], "When Attending the Plenary Meeting of the Delegation of the People's Liberation Army and People's Armed Police, Xi Jinping Emphasized That the National Defense and Military Construction Period of the '14th Five-Year Plan' Will Have a Good Start" [习近平在出席解放军和武警部队代表团全体会议时强调实现 '十四五' 时期国防和军队建设良好开局], *China Daily* [中国日报], March 9, 2021, https://cn.chinadaily.com.cn/a/202103/09/WS60476672a3101e7ce97432f7.html.

[74] Shou, *Science of Military Strategy*, 171–174; Xu Weidi, "China's Security Environment and the

Role of Nuclear Weapons," in Li Bin and Tong Zhao, *Understanding Chinese Nuclear Thinking*, 19–49; and Cunningham and Fravel, "Assuring Assured Retaliation."

[75] "Expert Analysis: Xi Jinping Meets with Representatives of the Second Artillery to Stress the Great Significance of 'Strategic Deterrence'" [专家解读：习近平会见二炮党代表强调"战略威慑"意义重大], People's Daily Online [人民网], December 6, 2021, https://web.archive.org/web/20130127235109/http://military.people.com.cn/n/2012/1206/c1011-19817252.html.

[76] See, for example, "'Incoming' Is a Choice Between Mutual Loss and Collective Wins" ['即将到来的' 是俱损或共赢的选择题], *PLA Daily* [解放军报], February 3, 2017, 6; Yao Yunzhu, "China Will Not Change Its Nuclear Policy," *China-U.S. Focus*, April 22, 2013, http://www.chinausfocus.com/peace-security/china-will-not-change-its-no-first-use-policy/; Lu Yin [鹿音], "The Evolution of Sino-U.S. Strategic Stability" [中美战略稳定关系的演进], *Contemporary American Review* [当代美国评论], no. 2 (2017), 20–38; and Fan Jishe [樊吉社], "The Basic Logic and Prospects of China's Nuclear Policy" [中国核政策的基本逻辑与前景], *Foreign Affairs Review* [外交评论], no. 5 (2018), 1–20.

[77] For some evidence, see David C. Logan, "Chinese Views of Strategic Stability," paper prepared for the Los Alamos National Laboratory Director's Strategic Resilience Initiative workshop on "PLA Actions and Behavior in a Crisis," July 16–17, 2022.

[78] "Commander and Political Commissar of the Rocket Force: Enhance Credible and Reliable Nuclear Deterrence and Nuclear Counterattack Capabilities" [火箭军司令政委: 增强可信可靠的核威慑和核反击能力], Xinhua News [新华网], January 31, 2016, http://www.xinhuanet.com/mil/2016-01/31/c_128688644.htm.

[79] Xiao Tianliang, *Science of Military Strategy*, 387. Quote in English taken from the China Aerospace Studies Institute translation. Emphasis added.

[80] Twomey, "China's Nuclear Doctrine and Deterrence Concept," 53–55.

[81] *Adherence to and Compliance with Arms Control, Nonproliferation, and Disarmament Agreements and Commitments* (Washington, DC: Department of State, June 2020), 50.

[82] Lu Yin [鹿音], "Confronting the New U.S. Nuclear Posture Review, China Must Maintain Confidence in Its Policy and Capabilities" [面对美国新核态势审议 中国更应保持政策与力量自信], Xinhua News [新华网], February 7, 2018; Cui Maodong [崔茂东], "The Newest U.S. *Nuclear Posture Review* Is Released, How Should China Respond?" [美国新版"核态势评估"报告出台 中国应如何回应], *China Youth Daily* [中国青年报], February 14, 2018, http://m.cyol.com/yuanchuang/2018-02/14/content_16951636.htm. Lu Yin is affiliated with the PLA National Defense University.

[83] For an earlier example of research applying this type of methodology, see David C. Logan, "Rocket Force Personnel in the Age of Xi Jinping," in *The People of the PLA 2.0*, ed. Roy D. Kamphausen (Carlisle, PA: U.S. Army War College Press, 2021), 60–63.

[84] See, for example, Eric Heginbotham, Jacob L. Heim, and Christopher P. Twomey, "Of Bombs and Bureaucrats: Internal Drivers of Nuclear Force Building in China and the United States," *Journal of Contemporary China* 28, no. 118 (2019), 538–557; David C. Logan, "Are They Reading Schelling in Beijing? The Dimensions, Drivers, and Risks of Nuclear-Conventional Entanglement in China," *Journal of Strategic Studies* 46, no. 1 (2023); and David C. Logan and Phillip C. Saunders, *Addressing Conventional-Nuclear Entanglement Risks in a U.S.-China Conventional Conflict*, report commissioned by the Defense Threat Reduction Agency, August 21, 2020.

[85] This stands in contrast to historical patterns. See David C. Logan, "Career Paths in the PLA Rocket Force: What They Tell Us," *Asian Security* 15, no. 2 (2019), 103–121.

[86] Saunders and Logan, "The Implications of the PLA's Nuclear Expansion and Modernization for China's Crisis Behavior."

[87] Phillip C. Saunders, "China," in *Arms Control in an Era of Strategic Competition*, ed. Jeffrey A. Larsen and M. Shane Smith (Boulder, CO: Lynne Rienner, forthcoming).

Appendix

The appendix is divided into two sections. The first defines each observable indicator used in our analysis and describes the data sources, the coding levels, and the metrics for evaluating that indicator. The second presents the specific coding decision reached for each indicator, along with a detailed explanation and analysis of relevant data.

Data Sources and Coding Rules for Observable Indicators

Here we present the data sources and coding rules for each of the observable indicators in the framework. First, in table A1, we recreate the table summarizing the predicted values for each indicator across each of the six models. Next, for each indicator we provide a brief description, the data sources used to code it, and the specific coding rules used to assign a value for the indicator. For example, in assessing the degree of leadership involvement, we examined the number of senior Chinese Communist Party (CCP) leadership visits to nuclear or missile force units relative to units of other services, the number of Politburo study sessions dedicated to nuclear or missile topics, and the frequency of media reporting that associates nuclear forces with the top leader.

***Sensitivity to U.S. Strategic Intentions*:** A measure of the responsiveness of China's nuclear policies to shifts in perceived U.S. strategic intentions and the state of the bilateral relationship.

Data sources: Defense white papers, *PLA Daily* reporting, research published by People's Liberation Army (PLA)-affiliated strategists, and Tsinghua University Institute of International Relations (TUIIR) Database of China–Great Power Relations.

- Low: Chinese statements do not identify U.S. strategic intentions as an important factor in Chinese nuclear force development. Little to no temporal correlation between perceived shifts in the bilateral relationship and shifts in China's nuclear force development.
- Medium: Chinese statements identify U.S. strategic intentions as an important factor in Chinese nuclear force development but not as the only or primary factor. No explicit connection between specific Chinese nuclear force developments and perceived shifts in American strategic intentions or the state of the bilateral relationship. A moderate correlation between the timing of perceived shifts in the state of the bilateral relationship and shifts in China's nuclear force development. (Decisions on force development would occur within this window but might not be evident until later.)
- High: Chinese statements identify U.S. strategic intentions as the most important factor in Chinese nuclear force development. Clear connections between specific Chinese

Table A1. Expected Values of Observable Indicators for Each Model

	Secure second-strike	Nuclear shield	Great Power status	Theater deterrence (theater only)	Bureaucratic politics	Nuclear superiority
Sensitivity to U.S. Policy						
Sensitivity to U.S. strategic intentions	High	High	Medium	High	Low	High
Sensitivity to U.S. nuclear policy	Medium	High	High	Medium	Low	High
Sensitivity to U.S. BMD policy	High	High	Low	Medium	Low/Medium	Medium
Nuclear Infrastructure						
Investment intensity	Low	Medium	Medium	High	Medium	High
Warhead-handling practices	Centralized	Centralized	Centralized	Distributed	Distributed	Distributed
Doctrine and Signaling						
Force transparency	Low	High	High	High	High (domestic-oriented)	Medium
Doctrinal transparency	High	High	Medium	High	Medium	Medium
Policymaking and Process						
Bureaucratic posturing	Low	Low	Medium	High	High	Low
Leadership involvement	Low	Low	High	Low	Low	High
Nuclear narratives	Threat, Survival	Threat, Survival, Escalation control	Achievement, Status	Escalation control	Indeterminate	Escalation control, Status
Supporting Elements						
Nuclear industry	Limited	Moderate	Moderate/ Expansive	Expansive	Expansive	Expansive
Nuclear testing	None	None/ Moderate	Moderate*/ Extensive†	Extensive	Moderate	Moderate
Nuclear PME	Low/ Medium	Low/ Medium	Medium	Medium	Medium	High

*For clear number-three status.

†For parity with the United States and Russia.

nuclear force developments and perceived shifts in American strategic intentions and the state of the bilateral relationship. A high correlation between the timing of perceived shifts in the state of the bilateral relationship and shifts in China's nuclear force development. Changes may occur within a matter of a year. (Decisions on force development would occur within this window but might not be evident until later.)

***Sensitivity to U.S. Nuclear Policy*:** A measure of the responsiveness of China's nuclear policies to shifts in U.S. nuclear policy, as indicated by both authoritative sources and the timing of shifts in China's nuclear force development.

Data sources: Defense white papers, *PLA Daily* reporting, research published by PLA-affiliated and prominent civilian strategists, and secondary sources.

- Low: Chinese statements do not identify U.S. nuclear policy as an important factor in Chinese nuclear force development. Little to no temporal correlation between perceived shifts in American nuclear policy and shifts in China's nuclear force development.
- Medium: Chinese statements identify U.S. nuclear policy as an important factor in Chinese nuclear force development but not as the only or primary factor. No explicit connection between specific Chinese nuclear force developments and perceived shifts in American nuclear policy. A moderate correlation between the timing of perceived shifts in American nuclear policy and shifts in China's nuclear force development. Changes may occur within a matter of a few years. (Decisions on force development would occur within this window but might not be evident until later.)
- High: Chinese statements identify U.S. nuclear policy as the most important factor in Chinese nuclear force development. Clear connections between specific Chinese nuclear force developments and perceived shifts in American nuclear policy. A high correlation between the timing of perceived shifts in American nuclear policy and shifts in China's nuclear force development. Changes may occur within a matter of a year. (Decisions on force development would occur within this window but might not be evident until later.)

***Sensitivity to U.S. BMD Policy*:** A measure of the responsiveness of China's nuclear policies to shifts in U.S. ballistic missile defense (BMD) policy, as indicated by authoritative sources and the timing of shifts in China's nuclear force development.

Data sources: Defense white papers, *PLA Daily* reporting, research published by PLA-affiliated and prominent civilian strategists, and secondary sources.

- Low: Chinese statements do not identify U.S. BMD policy as an important factor in Chinese nuclear force development. Little to no temporal correlation between perceived shifts in American BMD policy and shifts in China's nuclear force development.
- Medium: Chinese statements identify U.S. BMD policy as an important factor in Chinese nuclear force development but not as the only or primary factor. No explicit connection between specific Chinese nuclear force developments and perceived shifts in American BMD policy. A moderate correlation between the timing of perceived shifts in American BMD policy and shifts in China's nuclear force development. Changes may occur within a matter of a few years. (Decisions on force development would occur within this window but might not be evident until later.)
- High: Chinese statements identify U.S. BMD policy as the most important factor in Chinese nuclear force development. Clear connections between specific Chinese nuclear force developments and perceived shifts in American BMD policy. A high correlation between the timing of perceived shifts in American BMD policy and shifts in China's nuclear force development. Changes may occur within a matter of a year. (Decisions on force development would occur within this window but might not be evident until later.)

***Intensity of Investment in Nuclear Forces*:** A measure of the resources dedicated to nuclear weapons systems and missions, especially relative to nonnuclear weapons and systems.

Data sources: Personnel promotions data in the Rocket Force, relative growth in conventional-versus-nuclear systems, life cycle and service times of nuclear weapons systems, and research published by PLA-affiliated and prominent civilian strategists.

- Low: Personnel affiliated with nuclear systems and missions are promoted less frequently than those affiliated with conventional systems and missions. Older nuclear systems are retained well past the introduction of newer systems. Recent growth in the number and size of conventional units surpasses that of nuclear units. Development times for nuclear systems are longer and more delayed than those of conventional systems or comparable nuclear systems of other countries.
- Medium: Personnel affiliated with nuclear systems and missions are promoted at rates comparable to those affiliated with conventional systems and missions. Older nuclear systems are phased out at a rate proportional to the introduction of new nuclear systems. Recent growth in the number and size of nuclear units is roughly equal to that of conventional units.

- High: Personnel affiliated with nuclear systems and missions are promoted more quickly than those affiliated with conventional systems and missions. Older nuclear systems are retired quickly following the introduction of newer systems. Recent growth in the number and size of nuclear units surpasses that of conventional units. Development times for nuclear systems are shorter than those of conventional systems or comparable nuclear systems of other countries.

***Warhead-Handling Practices*:** A measure of the degree of centralization in the storage and handling of nuclear warheads.

Data sources: Research published by PLA-affiliated strategists, *PLA Daily* articles, and secondary sources.

- Centralized: Warhead storage is concentrated at only a few sites. Warheads are stored at base- or brigade-level sites only sporadically, temporarily, or in crises.
- Distributed: Warhead storage is distributed both across various military organizations and at lower echelons, including at or below the base and brigade levels. Warheads are typically stored at these lower echelons in peacetime.

***Force Transparency*:** An assessment of the level of detail in descriptions of the weapons systems and equipment the armed forces use to conduct nuclear missions.

Data sources: Defense white papers; *Directory of PRC Military Personalities*, and reporting on PLA parades, tests, and demonstrations.

- Low: No discussion in authoritative sources of the weapons systems and equipment employed by the armed forces. Low and decreasing publicly available information about the structure of nuclear and missile forces. Limited and decreasing public information about the organization of nuclear and missile forces (limited largely to Rocket Force headquarters and missile bases).
- Medium: Authoritative sources contain descriptions of the primary weapons systems and equipment (for example, DF-26 missiles) employed to fulfill national security missions but do not include a comprehensive listing or table of the primary types and quantities of these systems. Moderate and consistent publicly available information about the structure of nuclear and missile forces. Moderate and consistent public information about the organization of nuclear and missile forces (with information about Rocket Force headquarters, missile bases, and attached brigades).

- High: Authoritative sources contain descriptions of the primary weapons systems and equipment and include a comprehensive listing of the primary types and quantities of these systems (for example, four brigades armed with DF-26 missiles). Extensive and increasing publicly available information about the structure of nuclear and missile forces. Extensive and growing public information about the organization of nuclear and missile forces, including specific information at and below the brigade level.

***Doctrinal Transparency*:** An assessment of the level of detail in descriptions of the approach, framework, or principles that guide nuclear policy and strategy (for example, deterring nuclear use, bolstering China's international status, or enhancing warfighting capabilities).

Data sources: Defense white papers; research published by PLA-affiliated strategists, and reporting on PLA parades, tests, and demonstrations.

- Low: No discussion of the country's nuclear doctrine in authoritative sources.
- Medium: Authoritative sources contain discussion of the country's doctrine or the principles and approaches that constitute the country's doctrine but do not specify the goals of force development or the missions to which nuclear forces are assigned.
- High: Authoritative sources contain discussion that defines and describes the country's nuclear doctrine, the goals of its nuclear forces, and the missions to which they are assigned.

***Bureaucratic Posturing*:** A measure of interservice rivalry involving nuclear weapons and missions and efforts by the military services to gain greater autonomy, prestige, and resources in the nuclear domain.

Data sources: Reporting in *PLA Daily* and service-specific media outlets (for example, *People's Navy* [人民海军报], *People's Army* [人民陆军], *Air Force News* [空军报], and *Rocket Force News* [火箭兵报]), research published by PLA-affiliated strategists, and secondary sources.

- Low: Services express little interest in or place little value on nuclear weapons systems and missions. Service-specific media outlets have little information about nuclear weapons and missions and less information than centralized media outlets such as *PLA Daily*.
- Medium: Services express some interest in or place some value on nuclear weapons systems and missions, but this interest or value does not exceed that placed on alternative nonnuclear systems and missions. Service-specific media outlets report on nuclear weapons issues at a rate comparable to that of centralized media outlets such as *PLA Daily*.

- High: Services express strong interest in and place high value on nuclear weapons systems and missions. Services emphasize the importance of their contributions to PLA nuclear missions relative to those of other services. Service-specific media outlets more frequently highlight nuclear weapons issues than centralized media outlets such as *PLA Daily*. Statements from senior military leaders within the individual services emphasize the potential contributions of their service in the nuclear domain.

***Leadership Involvement*:** A measure of the extent to which political leaders, especially Xi Jinping, as chairman of the Central Military Commission, are involved in the setting of nuclear policy and strategy.

Data sources: Reporting in *China Daily* and *PLA Daily*, leadership visits, Politburo study sessions, and research by PLA-affiliated and prominent civilian strategists.

- Low: In press and media reports, there is little association between nuclear force development and top CCP leaders, especially Xi. Statements by top leaders rarely mention nuclear weapons. The number of visits by Party leadership to nuclear- and missile-related institutes is below the number of visits to other, nonnuclear military institutes.
- Medium: In press and media reports, there is some association between nuclear force development and top CCP leaders, especially Xi, though these associations are sometimes overshadowed by others. Statements by top leaders occasionally mention nuclear weapons. The number of visits by Party leadership to nuclear- and missile-related institutes is roughly equal to the number of visits to other, nonnuclear military institutes.
- High: Most references to nuclear force development in press and academic reports mention the role of the CCP and Xi. Statements by top leaders indicate a strong focus on nuclear weapons. The number of visits by Party leadership to nuclear- and missile-related institutes surpasses the number of visits to nonnuclear military institutes.

***Nuclear Narratives*:** A qualitative measure of the ways authoritative Chinese sources discuss the country's nuclear forces. The content of the narratives used may be tightly coupled to the underlying logic of specific models.

Data sources: Reporting in *China Daily* and *PLA Daily* and research published by PLA-affiliated and prominent civilian strategists.

- Threat, Survival: China's nuclear forces are under serious threat from external sources and must be survivable. Frequent references to the capabilities of adversaries in the nuclear domain.
- Achievement, Accomplishment, Status: China's nuclear forces represent a significant symbol of the country's Great Power status and a marker of its technological achievement. Frequent references to China's technological accomplishments in the nuclear realm and the country's prestige.
- Escalation Control: China's conventional forces are described as under threat from an adversary (for example, the United States) resorting to limited nuclear use in a conflict (for example, over Taiwan). Nuclear escalation risks are portrayed as manageable, and Chinese theater/tactical nuclear capabilities are described as necessary to deter the United States from attempting limited nuclear use. (Alternatively, the current Chinese narrative that nuclear use cannot be controlled and limited nuclear war is impossible may disappear.)

***Nuclear Industry*:** A measure of the extent of the supporting nuclear industry, including research and design institutes, weapons production facilities, warhead- and missile-testing sites, and fissile material production centers.

Data sources: Open sources and U.S. Government reports.

- Limited: Little to no expansion in nuclear supporting industry as indicated by employment, construction or refurbishment of facilities, and funding.
- Moderate: Consistency or moderate growth in the overall size of nuclear industry as indicated by employment, construction or refurbishment of facilities, and funding. However, growth does not significantly outpace that of other elements of the nonnuclear defense industry.
- Expansive: Overall indication of expansion in the size of nuclear industry as indicated by efforts to increase employment, expand and refurbish facilities, and grow funding.

***Nuclear Testing*:** A measure of the frequency and breadth of testing of nuclear warheads, potentially indicating new warhead designs or new requirements for older designs.

Data sources: Open sources and U.S. Government reports.

- Low: Little to no evidence of interest in or actual resumption of nuclear weapons testing (including actual nuclear tests, cold tests of explosives packages, and simulated tests).

- Moderate: Limited evidence of resumption of nuclear weapons testing. Limited evidence of interest in possibly testing new designs or ensuring that old designs can accomplish certain missions.
- Extensive: Evidence of nuclear weapons testing and authoritative statements indicating a desire for new warhead designs, particularly low-yield, variable-yield, and miniaturized designs intended to satisfy new nuclear missions.

***Nuclear Professional Military Education*:** A measure of the faculty and students at nuclear-related programs at Rocket Force and other professional military education (PME) institutions.

Data sources: Educational appointments at the Rocket Force Command Academy, Rocket Force Engineering University, and Rocket Force NCO School.

- Low: Educational appointments, particularly those in nuclear-related fields, are lower than in previous years, indicating an expected decline in the future growth of the force.
- Medium: Educational appointments, particularly those in nuclear-related fields, are constant, indicating future force size will remain roughly constant.
- High: Educational appointments, particularly those in nuclear-related fields, are higher than in previous years, indicating an expected increase in the future size of the force.

Detailed Coding Decisions for Observable Indicators

***Sensitivity to Strategic Intentions*:** A measure of the responsiveness of China's nuclear policies to shifts in perceived U.S. strategic intentions and the state of the bilateral relationship.

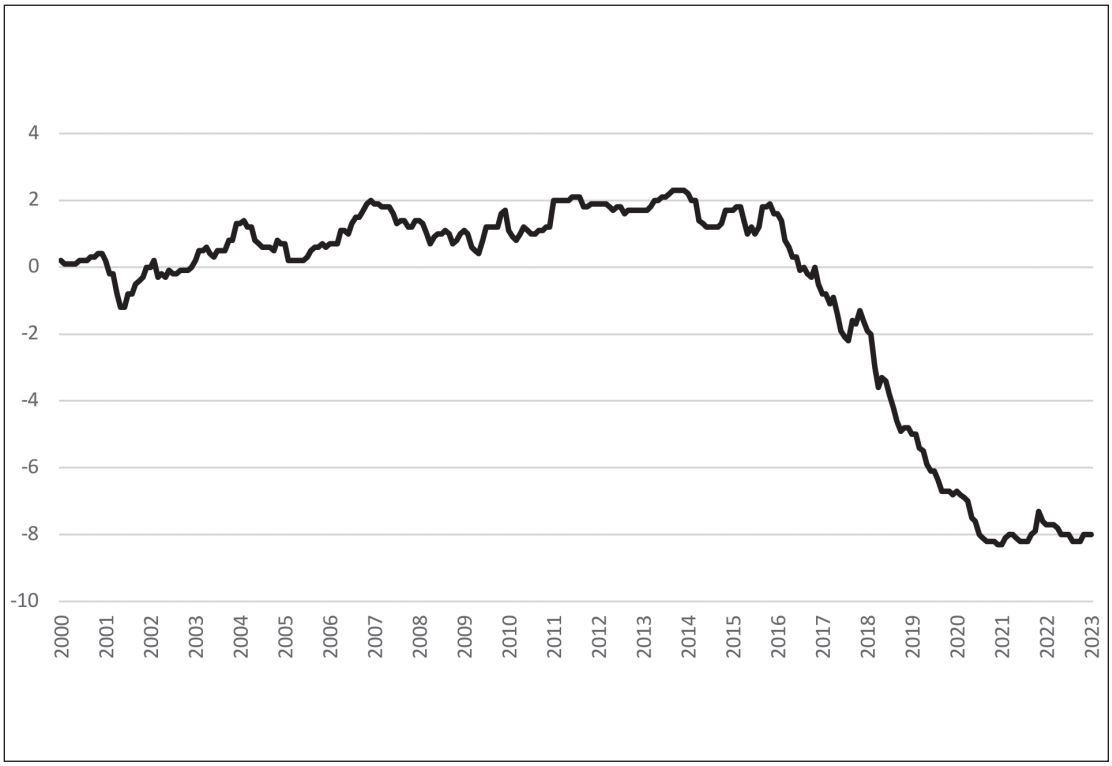
We assess that China's nuclear force development has high sensitivity to perceived U.S. strategic intentions and the state of the bilateral relationship.

Chinese experts increasingly perceive a serious downturn in the U.S.-China bilateral relationship.[1] As early as 2012, 27 percent of Chinese government officials surveyed saw the United States as an "enemy."[2] Since then, relations have significantly worsened, with Chinese officials accusing the United States of attempting to suppress China and initiating a cold war.[3] One way to capture the deteriorating relationship is through the TUIIR Database of China–Great Power Relations. This initiative, managed by Yan Xuetong, dean of the Tsinghua Institute of International Relations, attempts to quantify the state of relations between China and the world's other major powers.[4] The data since 2000, summarized in figure A1, show that U.S.-China relations have deteriorated rapidly since mid-2016.

This backdrop of worsening relations and intensified strategic competition reinforces existing Chinese concerns about the likelihood of conflict and about U.S. military capabilities, as discussed in China's defense white papers.[5] Chinese experts have also specifically highlighted the possibility that advanced conventional weapons could lower the risks of attempting counterforce strikes against China's nuclear deterrent, allowing the United States to avoid the political costs of using nuclear weapons.[6] The potential deployment to the region of U.S. systems formerly limited by the Intermediate-Range Nuclear Forces Treaty and the development by U.S. regional allies and partners of long-range conventional strike options will likely exacerbate these anxieties.[7]

Given the ongoing trends in the bilateral relationship and strong Chinese anxieties about U.S. strategic intentions, we expect this high sensitivity to remain in the future.

Figure A1. State of U.S.-China Relations, 2000–2023 (TUIIR Database)



Note: The quality of U.S.-China relations on a scale from -10 to 10, with higher values representing more positive relations and lower values representing negative relations. Figure y-axis has maximum value of 4 for presentational purposes.

***Sensitivity to Nuclear Policy*:** A measure of the responsiveness of China's nuclear policies to shifts in U.S. nuclear policy, as indicated by both authoritative sources and the timing of shifts in China's nuclear force development.

We assess that China's nuclear force development is highly sensitive to perceived shifts in U.S. nuclear policy. Official Chinese government documents, authoritative research produced by PLA-affiliated strategists, and popular media reporting all consistently highlight concerns that shifts in U.S. nuclear forces and strategy could jeopardize China's nuclear deterrent. These concerns focus on perceived U.S. willingness to resort to nuclear use, American reluctance to admit mutual vulnerability with China, and the development of new low-yield nuclear capabilities that could lower the threshold for American nuclear use.[8]

***Sensitivity to BMD Policy*:** A measure of the responsiveness of China's nuclear policies to shifts in U.S. BMD policy, as indicated by authoritative sources and the timing of shifts in China's nuclear force development.

We assess China's nuclear force development as being highly sensitive to U.S. BMD policy. Official Chinese government documents, authoritative research produced by PLA-affiliated strategists, and popular media reporting all consistently highlight BMD systems and the potential threat they pose to China's nuclear deterrent. In addition, shifts in China's nuclear force development in recent years appear to be highly correlated with perceived shifts in U.S. BMD policy. Here, we highlight three sources of evidence.

First, authoritative sources consistently and prominently identify U.S. BMD developments as a significant threat to China's nuclear deterrent. China's latest defense white paper explicitly highlights American investments in missile defense in arguing that the United States has "provoked and intensified competition among major countries . . . and undermined global strategic stability."[9] The most recent edition of *Science of Military Strategy*, published by the PLA National Defense University, argues:

> *In order to maintain its absolute nuclear superiority, the United States has been vigorously developing national and theater missile defense systems, and has begun actual combat deployment, which will break the original fragile and stable state of mutual deterrence and directly affect the effectiveness of nuclear deterrence. . . . The major nuclear powers have strengthened the construction of their nuclear defense system, which has increased the threats and challenges facing our country.*[10]

The text goes on to add:

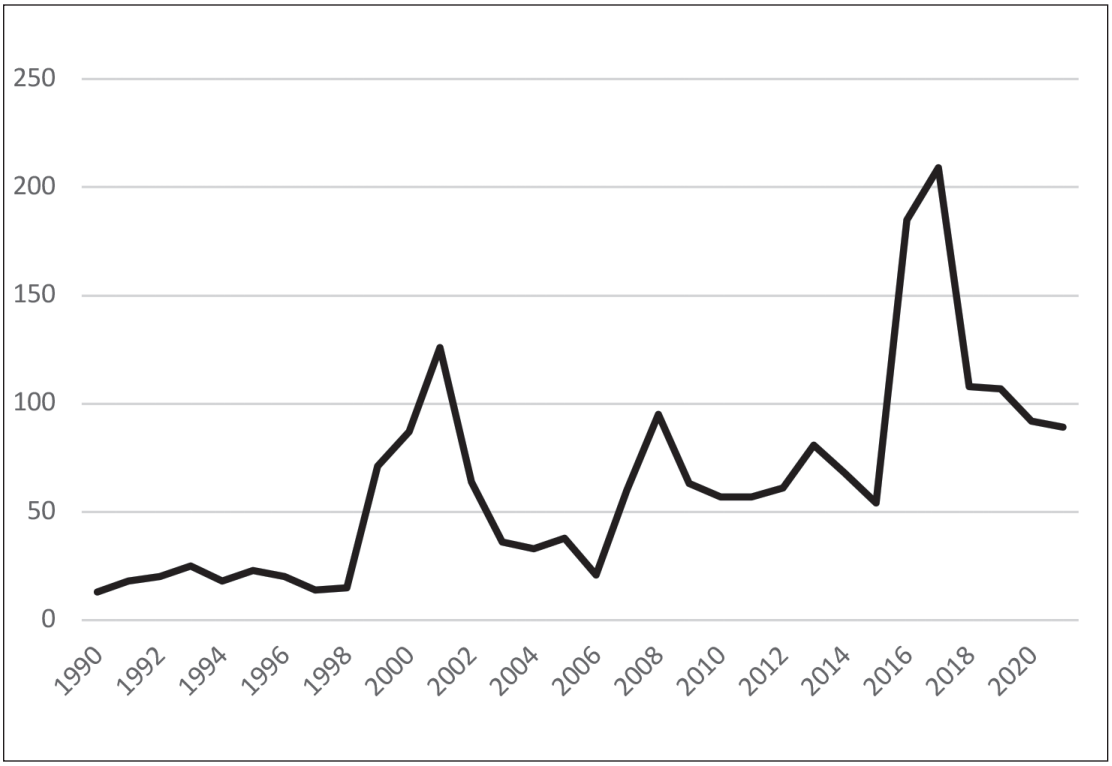
> *The system penetration capability is an important part of the counterattack capability of nuclear forces, and a strong system penetration capability is the most effective strategic deterrence. Especially when the world's military powers vigorously strengthen the construction of missile defense systems, enhancing the system penetration capability of strategic missile forces is an important measure to ensure the effectiveness of strategic deterrence.*[11]

Analysts affiliated with the PLA and other areas of the defense industry regularly point to U.S. BMD developments as undermining strategic stability and requiring counteractions to maintain China's nuclear deterrent.[12] As one prominent Chinese nuclear expert has noted, "for the foreseeable future, the biggest challenge confronting China's nuclear deterrent will be U.S. missile defense systems."[13]

Second, the *PLA Daily*, the official mouthpiece for the Chinese military, has shown a significant increase in reporting about BMD capabilities, especially corresponding with the 2016 announcement to deploy a Terminal High-Altitude Area Defense (THAAD) battery in South Korea, the 2017 announcement of joint U.S.-Japanese tests of new SM-3 Block IIA interceptors, and the 2017 announcement that Japan would purchase and deploy ground-based Aegis radar stations and interceptors. As figure A2 shows, these announcements all received significant coverage in Chinese military reporting and were consistently criticized as undermining strategic stability, threatening China, and eroding regional security.[14] This sort of increased media attention on BMD was last seen in the early 2000s, following the American announcement that it would withdraw from the Anti-Ballistic Missile (ABM) Treaty, though recent reporting has continued to surpass that of the ABM Treaty era.

Third, the recent timing of shifts in China's nuclear force development appears highly correlated with and aimed at perceived shifts in U.S. BMD policy. In the past decade, as detailed in this report, China's nuclear force development has experienced significant changes, including the introduction of new weapons systems, a growth and reorganization of the force, and the adoption of new capabilities and operational practices. However, many of these changes were initiated years, or even decades, earlier. For instance, since Xi became general secretary in 2012, the Rocket Force has incorporated several new missile systems, such as the DF-31AG, the DF-41, and the DF-26. The PLA Navy has fielded a fleet of ballistic missile submarines equipped with next-generation JL-2 submarine-launched ballistic missiles. The PLA has developed and

Figure A2. "Anti-Missile" [反导] Mentions in *PLA Daily*

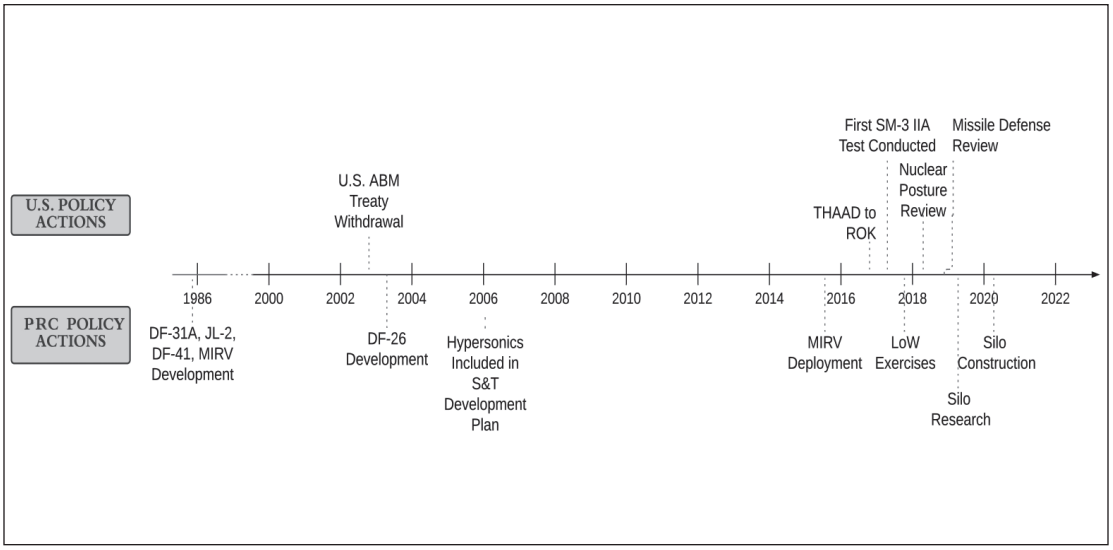


reportedly deployed hypersonic systems. However, the seeds for all these developments were planted much earlier, with development of the DF-41, DF-31AG, and JL-2 beginning in the mid-1980s, development of DF-26 beginning in 2003, and work initiated on hypersonic technologies in the early 2000s. Rather than initiating any of these changes, Xi simply oversaw their culmination.

Instead, it may be instructive to examine changes to China's nuclear force development that occurred in recent years but that were not the result of previously initiated programs and could have occurred earlier had the necessary political decisions been made. These include the deployment of multiple independently targetable reentry vehicles on some ICBMs, the possible initiation of launch-on-warning exercises, and the construction of nearly 300 new silos.[15]

As figure A3 illustrates, for much of China's recent nuclear force development, there has been a strong temporal correlation between perceived shifts in U.S. BMD policy and Chinese responses. The timeline necessarily simplifies many of these shifts and even leaves off certain important steps, such as the 2017 and 2018 National Defense Authorization Acts, which ex-

Figure A3. Timeline of China's Nuclear Force Development



panded U.S. BMD plans.[16] But the figure nonetheless helps to highlight how many of the recent changes in China's nuclear force development occurred in the context of apparently more expansive plans for U.S. BMD capabilities.

***Intensity of Investment in Nuclear Forces*:** A measure of the resources being dedicated to nuclear weapons systems and missions, especially relative to nonnuclear weapons and systems.

We assess investment in the nuclear forces as medium. China is significantly increasing its investment in its nuclear forces, but this investment remains lower than that of the leading nuclear powers and lower than China's investment in conventional missile forces. Reliable data on the level of investment in China's nuclear forces are difficult to obtain, and we must therefore seek out indirect indicators of PLA priorities and investment trends. Here, we present evidence drawing from authoritative sources for Chinese views of the relative tradeoffs between conventional and nuclear forces, personnel data, weapons deployment patterns, high-level political statements about the need to develop a strategic deterrent, future nuclear force projections, U.S. assessments of China's future nuclear expansion, and growing open-source evidence of an expanding nuclear force.

Authoritative PLA sources regularly emphasize the value and capabilities of conventional forces over nuclear ones, indicating potential limits to China's investment in its nuclear forces.[17] These materials regularly emphasize the limits and risks of exclusively relying on nuclear weapons for deterrence, coercion, or warfighting. These include inherent credibility problems

due to the nuclear taboo and the risks of nuclear retaliation, greater escalation risks, and relative lack of precision and flexibility. For example, in a section describing the concept and operation of deterrence, the 2020 edition of *Science of Military Strategy* notes:

> *With the development of the times, the limitations of nuclear deterrence are increasingly exposed, and the role of conventional deterrence is being valued again. In particular, the development of high-tech conventional weapons has not only narrowed the gap between combat effectiveness and nuclear weapons, but also has higher accuracy and greater controllability. Conventional deterrence is highly controllable and less risky, and generally does not lead to devastating disasters like nuclear war. It is convenient to achieve political goals and becomes a credible deterrence method.*[18]

The volume's section on the Rocket Force similarly emphasizes the need to develop advanced conventional weapons to satisfy mission requirements that can't be met by nuclear weapons:

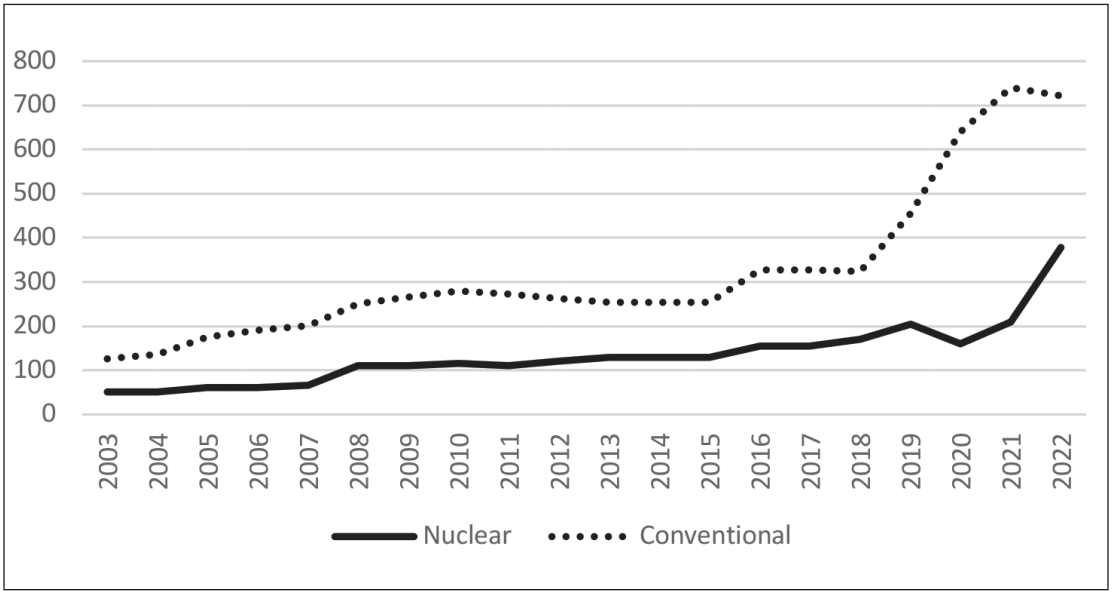
> *With the increasing demand for attacking and strengthening deep-buried targets, time-sensitive targets, moving targets, and time-and-see targets, active strategic nuclear missiles are increasingly unable to meet operational needs, and conventional strategic missiles with rapid global precision strike capabilities will become an important part of the strategic missile forces of the main military major powers.*[19]

This prioritization of conventional over nuclear capabilities is also reflected in Rocket Force personnel practices and force development, though these are admittedly lagging indicators of PLA priorities. Evidence from the promotion paths of Rocket Force officers shows that senior leaders are significantly more likely to have served at the conventionally oriented Base 61 than at any other base, including those oriented toward the strategic nuclear mission.[20] In addition to these general trends, the highest levels of the Rocket Force are filled with alumni of conventional units, with both the current commander of the Rocket Force (Li Yuchao) and his most recent predecessor (Zhou Yaning) having served at Base 61.[21]

Rocket Force deployment trends also suggest a prioritization of the conventional mission, though the construction of more than 300 additional silos may change this in the future. Be-

sides the truly dual-capable DF-26 intermediate-range ballistic missile (IRBM), which was first deployed in 2016, all Rocket Force missile brigades are believed to be exclusively either conventional or nuclear. By comparing the total number of estimated conventional and nuclear missiles deployed by the missile forces, we may infer the operational priorities of the Rocket Force and the PLA more generally.[22] As illustrated in figure A4, over nearly the past two decades, the number of both conventional and nuclear missiles deployed has increased, but the number and rate of conventional deployments have far surpassed those of nuclear deployments. In 2003, according to data from the U.S. Department of Defense (DOD) and the Federation of American Scientists, China was assessed to have deployed roughly 120 launchers for conventional systems and 60 launchers for nuclear ones.[23] In 2022, the last year for which data are available, China was estimated to have deployed 722 conventional launchers and 378 nuclear ones. If anything, this approach likely undercounts the growth in conventional missiles; many conventional systems have reload capabilities and therefore have more than one missile deployed per launcher, whereas nuclear systems are generally believed to only have a single missile assigned per launcher. Though the number of conventional launchers and missiles continues to outpace that of nuclear ones, the recent significant increase in ICBM launchers has narrowed the gap.

Figure A4. Nuclear and Conventional Missile Deployments



Sources: Department of Defense China annual reports to Congress and Chinese Nuclear Notebooks published by the Federation of American Scientists.

This prioritization of conventional forces can also be seen in the deployment of DF-21 medium-range ballistic missile (MRBM) variants. Deployment of nuclear-armed DF-21 MRBMs increased slowly from their introduction in 1991 until the early 2010s, when it plateaued at about 80 launchers. Since then, the estimated number of nuclear DF-21s deployed has fallen somewhat, while the number of conventional DF-21s has increased significantly, rising from roughly 30 in 2016 to more than 200 in 2022.[24] A similar emphasis on the conventional domain can also be seen in the deployment of dual-capable DF-26 IRBMs.[25] Despite their technical capacity for carrying either nuclear or conventional warheads, most of these systems are deployed with a conventional payload, according to public reports. One expert observes, "The majority of the [100] dual-capable DF-26s serve a conventional mission, including an anti-ship variant, and are probably not assigned nuclear warheads. But a small number of launchers, perhaps 20, might serve a regional nuclear role alongside the DF-21."[26] In addition, the Rocket Force has been somewhat slow to retire older nuclear systems, such as the DF-3A, DF-4, and DF-31, suggesting longer system service lives.[27]

Despite the PLA's historical emphasis on conventional capabilities, especially in the Rocket Force, China is investing significantly more in its nuclear capabilities than before, as indicated by several sources. First, senior leaders have called on the PLA to enhance the country's nuclear forces. Since the establishment of the Rocket Force, Xi has called on it to "improve strategic capabilities" [提升战略能力].[28] In remarks delivered as part of the 20th National Congress of the Communist Party of China, Xi called on the PLA to "build a powerful strategic deterrent force system" [打造强大战略威慑力量体系].[29] Other members of the Central Military Commission have called for "creating a high-level strategic deterrence and joint combat system."[30] U.S. analysts have highlighted how the 2020 edition of *Science of Military Strategy* removed previous references to limits on the country's nuclear force development.[31]

Second, China is likely to expand the size of its nuclear force, as indicated by unclassified U.S. Government estimates. The 2022 DOD report on the Chinese military notes, "Beijing probably accelerated its nuclear expansion, and DOD estimates this stockpile has now surpassed 400 operational nuclear warheads. By 2030, DOD estimates that the PRC will have about 1,000 operational nuclear warheads, most of which will be fielded on systems capable of ranging the continental United States."[32] As an indication that the recent expansion of China's nuclear forces is unprecedented: in the last 7 years China's nuclear warhead stockpile has grown by as much as it did in the country's first 50 years as a nuclear power.[33]

Third, these estimates of the future growth of China's nuclear forces are further substantiated by a clear expansion of nuclear-capable delivery vehicles and their associated infrastructure.

As discussed throughout this report, China is developing a robust nuclear triad, including sea and air legs. Commercial satellite imagery reveals the construction of more than 300 missile silos at three sites in the Chinese heartland.

Together, these developments indicate a significant increase in investment compared with China's past practice. However, given that PLA strategists still express reservations about the value of nuclear weapons relative to conventional ones and that China's nuclear forces still lag well behind that of the leading nuclear powers, we do not yet assess the investment as high.

***Warhead-Handling Practices*:** A measure of the degree of centralization in the storage and handling of nuclear warheads.

We assess that China maintains centralized political control over its nuclear warheads but that some warheads may be stored locally to support periodic nuclear alerts. It is unclear whether China will maintain its tradition of centralized warhead storage or whether it will increasingly opt for a distributed approach to support higher levels of alert across the force and a possible launch-on-warning posture. We have coded this indicator as centralized because of continued strong political control and lack of direct evidence about the extent of decentralized warhead storage.

Open sources indicate that China has maintained its practice of centralized political control over warhead-handling practices. China has maintained strict political control over its nuclear warhead arsenal, with warheads largely stored in a centralized location, unmated and away from delivery systems.[34] Historically, Chinese practices have largely prioritized avoiding unauthorized use or accidents over the ability to respond quickly. Although the available evidence suggests that the core features of this centralized framework remain in place, there are some hints of recent shifts in the ways China handles its nuclear warheads.

First, China periodically places a portion of its land-based nuclear forces at higher levels of alert. The most recent DOD report on the Chinese military assesses that:

> *Although the PRC almost certainly keeps most of its nuclear force on a peacetime status—with separated launchers, missiles, and warheads—nuclear and conventional* [Rocket Force] *brigades conduct "combat readiness duty" and "high alert duty." These apparently include assigning a missile battalion to be ready to launch, and rotating to standby positions, on about a monthly basis for unspecified periods of time.*[35]

Although it remains unclear from open sources precisely what operational features these higher levels of alert involve, attaching warheads to missiles would imply greater distribution in China's warhead handling practices.

At the same time, there is tentative evidence that the missile-base-level regiments responsible for warhead management may no longer be subordinate to the missile bases themselves but are now subordinate to the central warhead-handling Base 67. The evidence comes from analysis of PLA and Rocket Force organization. China's missile forces are organized under six missile bases, numbered from Base 61 to Base 66. Each base has responsibility for several missile brigades, which operate Rocket Force missile systems. Within the PLA, each unit at or above the grade of regiment leader is assigned a military unit cover designator (MUCD), a five-digit number that uniquely identifies the unit.[36] The pattern of MUCD assignments typically reflects relationships of reporting and hierarchy. For instance, units within the Rocket Force have MUCDs that begin with 96. Within the Rocket Force, MUCDs also identify unit subordination to a particular missile base. For instance, operational missile brigades have MUCDs beginning with 967, with the fourth digit representing the base to which the brigade is assigned: 9671X indicates a brigade assigned to Base 61, 9672X indicates a brigade assigned to Base 62, and so on. Similarly, supporting units assigned to bases have MUCDs beginning with 968, with the fourth digit referencing the base they are subordinated to, with 9681X referencing Base 61, 9682X referencing Base 62, and so on. Tracking changes in these MUCDs can sometimes shed light on organizational changes within the force.

China's warhead-handling infrastructure consists of a centralized base, Base 67, which is described as the "primary custodian of China's nuclear warhead stockpile," along with six regiments (or, in one instance, a brigade), known as equipment inspection regiments, one attached to each of the six missile bases. Previously, as noted, the MUCDs for these equipment inspection regiments were in the form 968X5, with the fourth digit indicating the base to which they were subordinated. This format clearly established them within the series of MUCDs for supporting units subordinate to missile bases. However, the MUCDs for equipment inspection regiments have recently changed. For instance, the MUCD of the equipment inspection regiment for Base 61 is now 96031, mirroring the MUCD of units subordinated to Base 67. This change likely reflects a shifting of authority lines for the warhead-handling units away from operational bases and toward the centralized depot.

This re-subordination suggests an effort to combine centralized political control over nuclear warheads with more decentralized warhead storage practices. Under this new organization, approval from both the missile base commander and the central warhead-handling Base

67 commander is probably necessary for the warhead handling regiment to mount a nuclear warhead on a missile. Senior Rocket Force and PLA leadership may have shifted command authority for warhead-handling regiments to offset the greater risks involved in more decentralized warhead storage and regularly placing parts of the force on higher alert status. Analysts should continue to monitor for more direct evidence of peacetime warhead mating or other changes in China's warhead-handling infrastructure and practices.

However, it appears that the core features of China's warhead management system remain unchanged. In addition to a lack of evidence that it has changed, one recent piece of evidence supporting the centralization coding comes from curricular information at the Rocket Force University of Engineering, which provides training and education in command and technical subjects for junior Rocket Force personnel. (Additional analysis of the Rocket Force University of Engineering is presented in a following section on nuclear PME.) In its 4-year bachelor's program, the university offers 16 academic majors, including 1 in nuclear engineering and technology, which specifically identifies among its competencies the handling of nuclear warheads. Interestingly, whereas many of the university's descriptions of its majors specify the role that they play in supporting the Rocket Force in particular, nuclear engineering and technology is one of only two majors, along with radiation protection and nuclear safety, that the university says aim to cultivate the relevant abilities for the entire PLA.

As China has moved toward establishing a full nuclear triad, experts have wondered how it would develop warhead management infrastructure and practices for the nuclear units of its navy and air force, including whether responsibility would be concentrated within a single PLA entity or whether each service would develop its own warhead management infrastructure and practices. There is no direct open-source evident on navy and air force warhead-handling practices. However, it appears that the Rocket Force University of Engineering also trains navy and air force nuclear personnel. The description of its nuclear engineering major states, "the nuclear engineering and nuclear technology major aims to train junior command and technical officers engaged in nuclear warhead assembly, testing, management and maintenance, combat application, manufacturing supervision, and applied research for the *entire military.*"[37] The description similarly notes, "It is the only major in our country to train nuclear warhead technology and command military talents."[38] Other PLA educational institutions do not show similar courses in their curricular materials. The Air Force Engineering University does not list any nuclear-specific subjects among its academic programs.[39] The Naval University of Engineering does offer studies in nuclear engineering and technology, whose description makes a single reference to weapons safety, but it is clearly focused on naval nuclear propulsion systems.[40]

This limited piece of evidence suggests that education and training for warhead-handling and management still resides with the Rocket Force.

***Force Transparency*:** An assessment of the level of detail in descriptions of the weapons systems and equipment the armed forces use to conduct nuclear missions.

We assess China as having very low force transparency. Compared with other nuclear-armed states, China has historically published scant information about the size and composition of its nuclear forces.[41] According to one assessment, "The least transparent of the five acknowledged nuclear weapons states, [China] has released little detailed information on its nuclear facilities, the nature of its weapon systems, and its force structure."[42] Given China's relatively small and immature nuclear forces in the past, opacity was viewed as a crucial element of force survivability.[43] Authoritative Chinese sources even encourage opacity and deception in order to complicate adversary efforts to better understand elements of the country's nuclear forces. For example, *The Science of Second Artillery Campaigns* states, "The objective is to hide the true and show the false, to create wrong enemy decisions and to impede the enemy's reconnaissance and strikes."[44] A systematic review of China's military transparency showed that China practiced the greatest transparency on issues of national security goals and general defense policy and practiced the least transparency on issues of defense posture (total personnel, force structure, and armaments) and defense management (budget trends and planned acquisitions or procurement).[45] According to that report:

> *China's white paper provides no information about specific delivery systems, modernization programs, or future nuclear force structure. Given the fact that China is upgrading and expanding its nuclear arsenal, a clearer sense of approximate future force levels would ease international concerns, even if information is provided in round numbers or discussed in terms of conditions that would affect future force levels.*[46]

The same description continues to apply to China's most recent defense white paper, which, beyond noting that the Rocket Force "comprises nuclear missile, conventional missile and support forces," provides no information about nuclear force structure or armament.[47]

***Doctrinal Transparency*:** An assessment of the level of detail in descriptions of the approach, framework, or principles that guide nuclear policy and strategy (for example, deterring nuclear use, bolstering China's international status, and enhancing warfighting capabilities).

In contrast to China's very low force transparency in the nuclear realm, we assess China's doctrinal transparency as medium. China regularly specifies the overall purpose and components of its nuclear strategy and doctrine, describing it as consisting of self-defense, limited development, counterattack, and avoidance of arms races.[48] According to an assessment by U.S. Government analysts of China's transparency on its military doctrine:

> *The* National Defense Policy *chapter* [of the 2008 defense white paper] *details elements of China's doctrine such as defensive doctrine, active defense, "winning local wars in conditions of informationization," taking "integrated joint operations as the basic approach," and China's self-defensive nuclear strategy. . . . Nuclear strategy and deterrence and integrated joint operations are detailed and connected to China's overall defense policy.*[49]

Not only are these principles repeated in official documents such as the defense white papers, but they are also consistently repeated in internal PLA materials and even materials classified as Top Secret within China, suggesting that the information in public documents largely reflects China's actual policies.[50] Observers have highlighted evidence of potential divergence between China's stated limited goals and its actual expansive nuclear force development and have raised questions about the authenticity of China's public no-first-use policy. Analysts should continue to monitor these developments.[51]

***Bureaucratic Posturing*:** A measure of interservice rivalry involving nuclear weapons and missions and efforts by the military services to gain greater autonomy, prestige, and resources in the nuclear domain.

We find little evidence of bureaucratic posturing among the military services in the nuclear domain. Our review of secondary sources and of PLA-affiliated reports and publications did not return significant evidence of the PLA services lobbying for expanded nuclear missions. As discussed elsewhere in this report, if anything we find an emphasis on conventional capabilities given the perceived limitations of nuclear ones.[52] These findings are bolstered by a review of a database of publications available through the China Aerospace Studies Institute, which showed relatively little attention to nuclear weapons issues outside of the Rocket Force and a relative decrease in attention to nuclear-related items in service newspapers.[53]

A review of key translations and summaries of PLA sources showed that military service publications give relatively little attention to nuclear issues (see table A2). From 2017 to 2020, the years for which such analysis is possible, *Rocket Force News* had 39 articles mentioning

nuclear issues in the database, but most service publications did not feature any meaningful discussion of nuclear weapons issues.[54] In the database, 18 *Air Force News* articles made mention of nuclear issues, though nearly all of these described exercises involving defense against nuclear, biological, and chemical attacks by the adversary.[55] The roughly dozen *China Space News* articles to mention nuclear issues included discussions of nuclear power, propulsion, and medicine, and very few accounts of nuclear weapons.

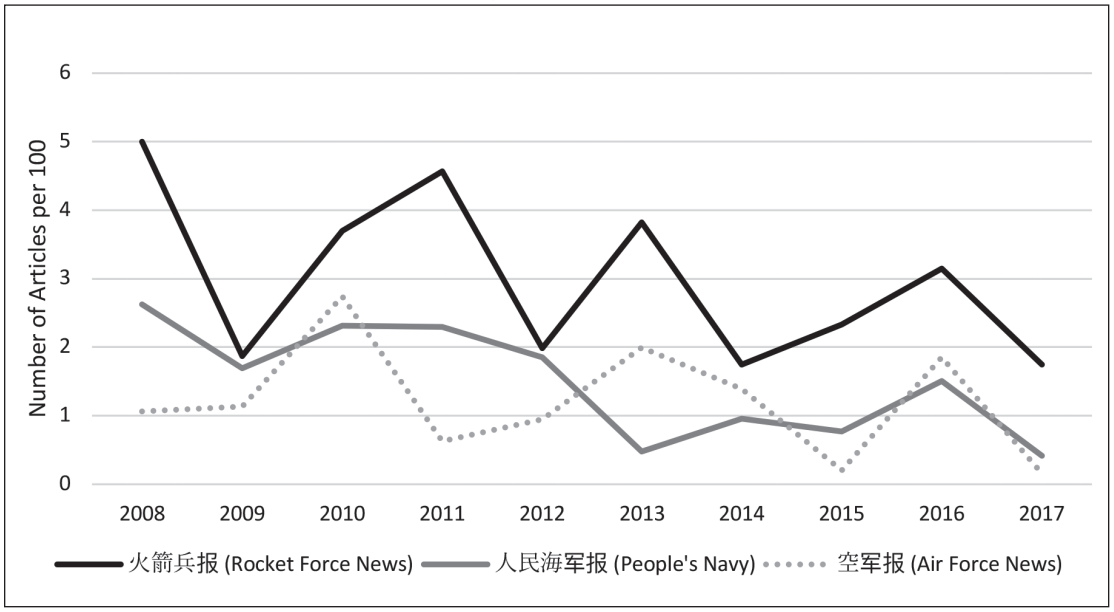
This absence of discussion of nuclear topics suggests a lack of interest in them among the other services, though analysts should continue to monitor service-level discussions for evidence of attempts to gain a greater role in nuclear missions. As China's nuclear forces continue to develop and defense spending growth continues to slow, the services might view the nuclear domain as a valuable opportunity to expand their own resources, prestige, and autonomy.[56]

We also conducted a similar longitudinal analysis of three military service newspapers in the database: *Rocket Force News* [火箭兵报], *People's Navy* [人民海军报], and *Air Force News* [空军报]. We identified the number of articles mentioning nuclear weapons by year for the period from 2008 to 2017 and normalized this figure by multiplying it by 100 and dividing it by the number of total articles published by that newspaper and contained within the database for that year (the results are shown in figure A5).[57] We found that all three newspapers appeared to publish relatively little on nuclear weapons issues, that *Rocket Force News* published the most on nuclear weapons issues (in roughly half the years, publishing more than both *People's Navy* and *Air Force News* combined), and that the overall attention to nuclear issues across all three service newspapers decreased over time.

Table A2. Nuclear-Related Articles by Military Service Publication, 2017–2020

Publication	Articles
Air Force News [空军报]	18
China Armed Forces [中国军队]	1
China Aviation News [中国航空报]	1
China Space News [中国航天报]	13
Navy Today [当代海军]	2
People's Navy [人民海军报]	0
PLA Pictorial [解放军画报]	3
Rocket Force News [火箭兵报]	39

Figure A5. Articles Mentioning "Nuclear Weapons" per 100 Articles in *Rocket Force News*, *People's Navy*, and *Air Force News*, 2008–2017



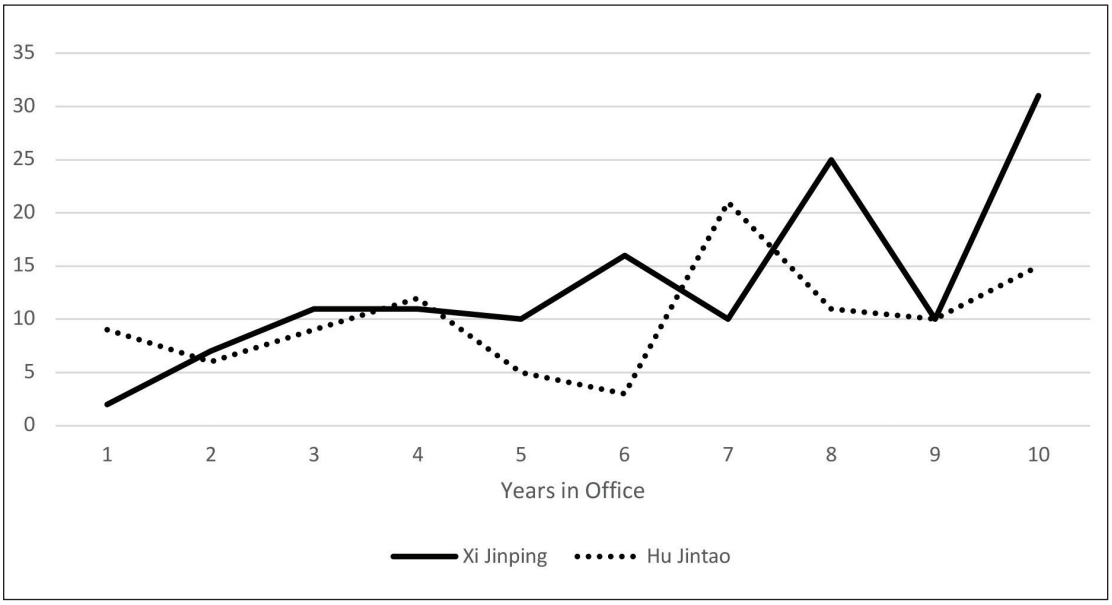
***Leadership Involvement*:** A measure of the extent to which political leaders, especially Xi Jinping as chairman of the Central Military Commission, are involved in the setting of nuclear policy and strategy.

There is little evidence of an increased interest by senior CCP officials in nuclear or missile matters. There is little to moderate evidence that senior Party officials, including Xi, have a different view of nuclear weapons and strategy than in the past.

There is no evidence of increased attention by Xi or other senior Party officials to nuclear weapons matters. If senior Party leaders were dedicating more attention to nuclear matters, we might expect to see this attention reflected in military reporting. However, reporting in the *PLA Daily* shows that Xi is not mentioned alongside nuclear weapons at a significantly different rate than Hu Jintao was during the analogous period of his time in office (see figure A6). In 2021, there was a notable increase in the frequency of military reporting associating Xi with nuclear weapons issues, though it is too early to confirm whether this represents an outlier or the start of a new trend. Analysts can use future data to continue tracking this trend.

Similarly, data on visits by Xi to PLA units indicate a relative lack of attention to the nuclear and missile forces. From late 2012 to 2021, Xi conducted at least 67 public visits to military units. Of the 26 visits that involved a single service, only one was focused on the Rocket Force.[58] The

Figure A6. *PLA Daily* Articles Mentioning "CCP General Secretary" and "Nuclear Weapons"



content of Politburo study sessions, which can indicate the public priorities of Party leadership, also does not reflect any new attention to nuclear matters. Under Xi, the Politburo has conducted 88 study sessions. Although the content of these sessions focuses on foreign affairs, military, and security matters to a greater degree than under Hu, there is no indication of a focus on nuclear matters, and none of the sessions has included any reference to nuclear weapons.[59] (Such study sessions are focused on topics where the CCP top leader wants to convey his views on a given issue to public and Party audiences, so these data are best interpreted as a lack of a desire to make a public statement on nuclear issues rather than a lack of high-level attention to them. Senior leaders may emphasize such nuclear issues in ways that are not visible in open sources.)

There is some limited evidence that senior Party leaders, including Xi, and PLA-affiliated strategists might attach more military and political value to nuclear weapons than in the past, though this evidence is less than definitive. Traditionally, Chinese leaders have reportedly attributed limited political and military utility to nuclear weapons, viewing them as useful only for deterring nuclear strikes, preventing nuclear blackmail, and launching nuclear counterattacks.[60] But recent statements suggest other roles or purposes for nuclear weapons beyond simply deterring nuclear strikes against China. For instance, shortly after being appointed general secretary in late 2012, Xi Jinping delivered a major address to a delegation of officers from the Second

Artillery Corps, the former name of the Rocket Force.[61] According to one observer, Xi characterized the value of nuclear weapons somewhat more expansively than in the past, with the observer suggesting that Chinese leaders may "be beginning to broaden the purpose of China's nuclear arsenal to include deterring conventional conflicts as well as achieving vague geopolitical objectives."[62] Similarly, PLA and other official writings have suggested the ability of nuclear weapons to deter aggression generally, safeguard the country's sovereignty, control the scope of conflict, and secure China's Great Power status.[63] However, some of the language used in these sources remains vague, and there is still strong emphasis throughout official sources on the limited role of nuclear weapons in China's national security strategy.[64] In the future, analysts can continue to watch for language suggesting a more expansive view of nuclear weapons.

***Nuclear Narratives*:** A qualitative measure of the ways authoritative Chinese sources discuss the country's nuclear forces. The content of the narratives used may be tightly coupled to the underlying logic of specific models.

A review of authoritative sources, including official government documents, PLA curricular materials, official military reporting, and research published by PLA-affiliated strategists, provides strong evidence that both threat-survival and achievement-accomplishment-status narratives accompany discussions of nuclear weapons.

Chinese sources consistently highlight threats to the survivability of China's nuclear deterrent.[65] Recent nuclear exchange modeling suggests China's nuclear deterrent would have a low chance of surviving a potential first strike by the United States.[66] As discussed in this report, Chinese experts frequently cite potential U.S. BMD advancements as the single greatest threat to China's nuclear deterrent.[67] Much of this concern stems from worries that the United States is pursuing nuclear primacy, that American BMD capabilities will continue to advance, and that advanced precision conventional weapons will provide the United States with conventional counterforce options.[68]

There is also growing discussion by Chinese strategists of a need to develop a strategic nuclear force that is not only survivable from a military-technical standpoint but also so clearly survivable that the United States would not even attempt a disarming first-strike or damage-limitation strategy against China.[69] Some Chinese strategists have recently used the term *strategic opportunism* to describe American nuclear strategy toward China.[70] According to Li Bin and Hu Gaochen, civilian scholars of China's nuclear strategy at Tsinghua University, U.S. analysts recognize that China possesses a certain level of nuclear force obviously above that of minimal nuclear-weapon states such as Israel or North Korea. However, the gap between American and

Chinese nuclear capabilities is so large that the U.S. strategic community is uncertain as to whether China's nuclear forces constitute an effective deterrent against the United States.

More significantly, according to Chinese observers, some American analysts see the gap between U.S. and Chinese capabilities as so large that it creates the possibility for the United States to eliminate China's nuclear deterrent. This belief encourages some American analysts to "[push] the U.S. Government to reduce China's nuclear retaliation capability by developing its ability to limit damage to China, which will worsen the strategic competition between China and the United States."[71] In other words, significant U.S. superiority creates windows and temptations for the United States to engage in strategic opportunism aimed at undermining China's nuclear deterrent.[72]

In fact, several prominent American analysts have reflected this logic by lobbying for the United States to maintain a significant nuclear advantage over China, to dissuade Beijing from even attempting to seek nuclear parity, to facilitate U.S. damage-limitation strategies, and to bolster U.S. extended deterrence commitments.[73] For Chinese analysts who view these dynamics at play, "In order to stabilize Sino-U.S. strategic relations and avoid U.S. opportunism, it is necessary for China to improve the effectiveness of its own strategic deterrent capability."[74] Whereas Chinese scholars typically emphasize improving the qualitative factors of China's nuclear forces, they sometimes also discuss the need to expand the force's size in order to ensure its survivability.[75] In the 2022 report to the National Congress of the Communist Party of China, Xi stated, "We will establish a strong system of strategic deterrence," perhaps suggesting greater investment in strategic nuclear capabilities.[76]

We also find evidence of a greater association between, on the one hand, China's nuclear and strategic missile forces and programs and, on the other, its status as a Great Power and nation of great achievement. Senior military and CCP officials increasingly mention China's nuclear forces, and the Rocket Force in particular, as markers of the country's Great Power status. Since the establishment of the Rocket Force in 2016, official references to the missile forces consistently include the following refrain: "The Rocket Force is the core force of our country's strategic deterrent, the strategic support for our country's great power status, and an important cornerstone for safeguarding national security" [火箭军是我国战略威慑的核心力量,是我国大国地位的战略支撑,是维护国家安全的重要基石].[77]

This position is also reflected in PLA curricular materials. For instance, the most recent edition of *Science of Military Strategy* explains, "We will strive to build a lean and effective strategic nuclear force *commensurate with China's international status* and commensurate with national security and development interests."[78] Similarly, Xi has issued public calls for the PLA

to "accelerate the creation of high-level strategic deterrence," suggesting greater attention to strategic nuclear issues.[79]

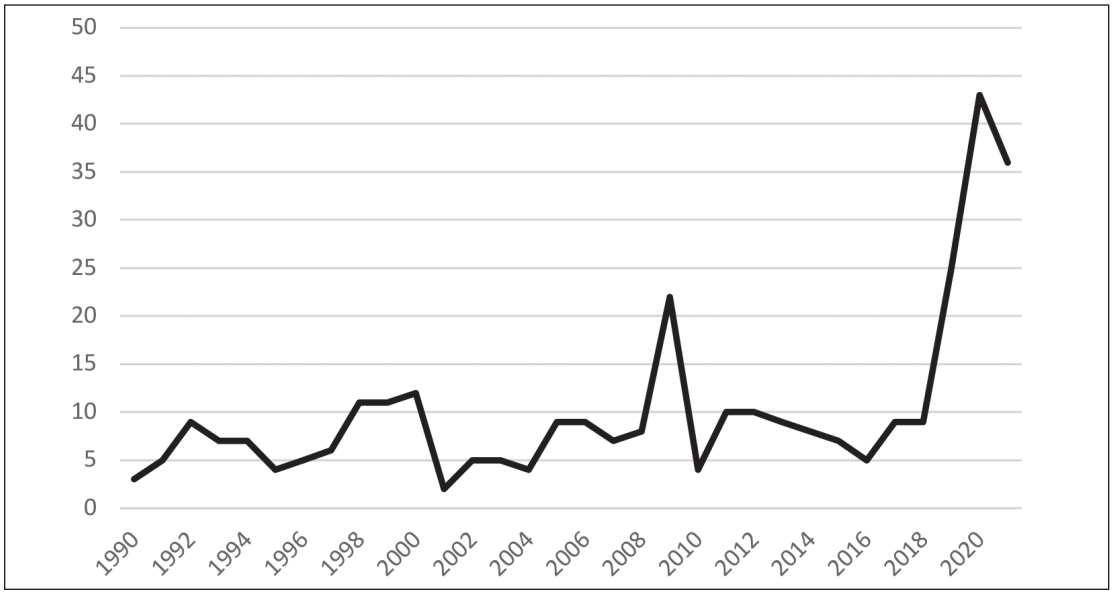
These sentiments are also reflected in military reporting trends. As illustrated in figures A7 and A8, reports in *PLA Daily* increasingly reference the country's nuclear forces alongside references to accomplishment. Similarly, reports of the country's missile forces increasingly include references to the term *great power*.

Chinese media have increasingly highlighted the technological achievements underlying the country's nuclear and strategic missile forces. There has also been an increasing effort to laud China's nuclear past by profiling prominent scientists who worked in the nuclear program and commemorating important dates in China's nuclear development.[80]

We find little evidence of escalation control narratives. As highlighted in this report, Chinese strategists frequently stress the risks and limits of nuclear weapons, including the challenges of escalation control.[81]

However, there is some evidence that Chinese strategists might increasingly view nuclear weapons as capable of not only deterring strategic nuclear attacks but also controlling escalation, deterring theater nuclear strikes, and deterring conventional military operations, though the evidence remains somewhat indirect and uncertain.[82] One recent review by an American

Figure A7. *PLA Daily* Articles Mentioning Both "Nuclear Weapons" [核武器] and "Achievement" [成就]

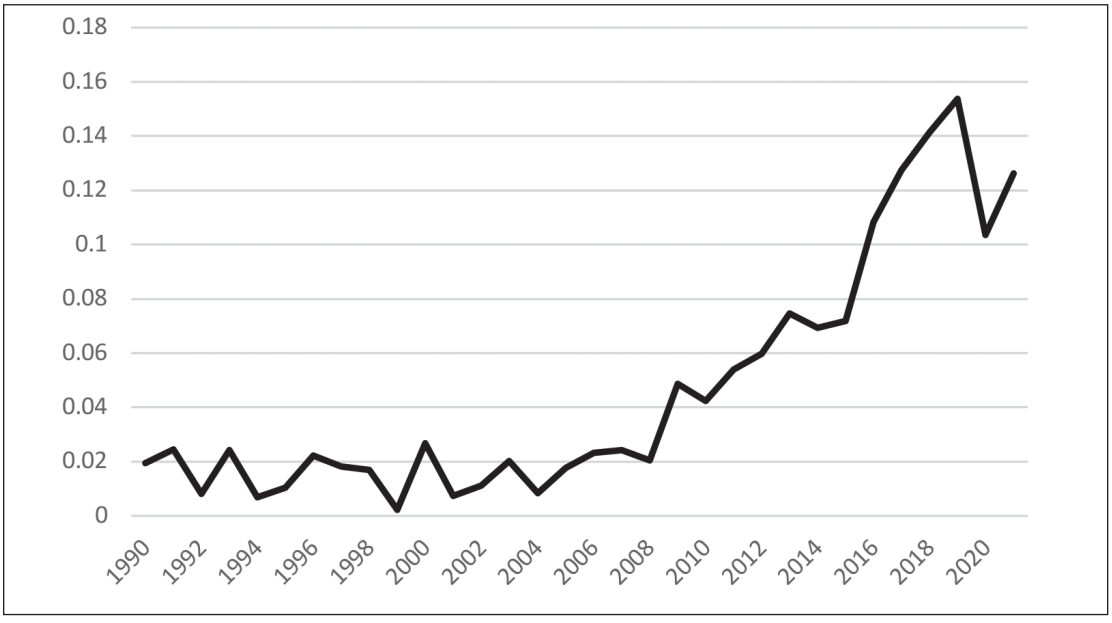


analyst concludes that "Beijing began a significant nuclear buildup by early 2016 as part of a broader effort to increase 'integrated strategic deterrence' capabilities in order to deter the United States from intervening in a regional conflict that Beijing is not confident it can win."[83]

***Nuclear Industry*:** A measure of the extent of the supporting nuclear industry, including research and design institutes, weapons production facilities, warhead and missile testing sites, and fissile material production centers.

We assess China as currently having a moderate military nuclear industry, though it is significantly expanding its civilian nuclear sector in ways that could support larger nuclear forces in the future.[84] China ceased production of highly enriched uranium in 1987 and ceased production of weapons-grade plutonium in 1990.[85] China currently possesses small to moderate fissile material stockpiles. These stockpiles, consisting of an estimated 14 tons of highly enriched uranium and 2.9 tons of weapons-grade plutonium, are significantly below those of Russia, the United States, the United Kingdom, France, and even Japan.[86] China does not currently operate a commercial-scale reprocessing plant, but it does operate a pilot enrichment plant and is developing large-scale reprocessing facilities.[87] China is expanding its civilian nuclear industry by measures including expanding uranium-enrichment capacity and constructing two large fast-breeder reactors, which could produce plutonium for use in nuclear weapons.[88] Though

Figure A8. Proportion of Rocket Force Articles in *PLA Daily* Mentioning "Great Power" [大国]



analysts report that "there is at present no evidence that China intends to divert its potential new plutonium horde to weapons use," these reactors, which are likely to come online by 2030, could produce enough weapons-grade plutonium for 100 additional nuclear bombs per year.[89] DOD reports:

> *In the past several years, China's organization traditionally associated with military uranium enrichment has expanded production capacity and likely will continue to do so. China is also working to expand and diversify its capability to produce tritium by methods such as using tritium production targets in reactors and extraction from tritiated heavy water, according to Chinese nuclear industry reporting.*[90]

In addition, the country is also investing more in its missile-production facilities. Historically, China has adopted relatively modest approaches to the development of strategic weapons programs. According to one U.S. expert, "Chinese nuclear weapons procurement practices . . . are characterized by small-batch manufacturing and modest, steady modification programs."[91] However, this situation may be changing. According to one recent assessment of China's ballistic missile industry:

> *Developments described in Chinese media, when combined with observations of known production sites using commercial satellite imagery, indicate a significant rise in capacity. In particular, the production of solid rocket motors and rocket bodies* [has] *been increased to support a rapidly expanding space launch sector, but known facilities for missile assembly and production have also expanded.*[92]

It is unclear how much of this expansion is for the construction of nuclear-capable missiles. Regardless, the available evidence indicates that China is increasing its underlying nuclear industry in ways that could better support the continued modernization and expansion of its nuclear forces.

***Nuclear Testing*:** A measure of the frequency and breadth of testing of nuclear warheads (including actual nuclear tests, cold tests of explosives packages, and simulated tests), potentially indicating new warhead designs or new requirements for older designs.

We find limited open-source evidence that China has resumed testing related to nuclear weapons development and therefore code this indicator as low. More detailed data may be avail-

able in the classified domain. The strongest evidence about a possible Chinese resumption of nuclear testing comes from U.S. Department of State reports on adherence to and compliance with arms control, nonproliferation, and disarmament agreements and commitments. The reports for 2019, 2020, and 2021 all assessed that "China's possible preparation to operate its Lop Nur test site year-round and lack of transparency on its nuclear testing activities—have raised concerns regarding its adherence to the U.S. 'zero yield' nuclear weapons testing moratorium."[93] The 2021 report cited two pieces of evidence for these concerns. The first was information about "China's possible preparation to operate its Lop Nur test site year-round,"[94] including tunnels and excavation activities and the use of explosive containment chambers.[95] The second piece of evidence was China's "lack of transparency on its nuclear testing activities," specifically its "frequently blocking the flow of data from its International Monitoring System (IMS) stations to the International Data Center operated by the Preparatory Commission for the Comprehensive Nuclear Test-Ban Treaty Organization."[96] However, despite the concerns about possible Chinese activities, these tentative statements stand in stark contrast to the more definitive language the report used to describe accusations of Russia's violation of the zero-yield testing moratorium.[97]

In addition to the State Department reports, there have been sparse reports about possible interest in China in developing new warhead designs, some of which might require resumed testing. For instance, recent DOD reports on the Chinese military point to claims in Chinese media that the PLA has already developed a low-yield nuclear warhead.[98] However, the basis for those claims appears to be statements by a retired PLA officer who was speculating about possible future low-yield warhead developments rather than reporting steps already taken.[99] The little discussion in Chinese nuclear circles about new low-yield warheads appears in opposition to these developments. Indeed, in the wake of the 2018 Nuclear Posture Review and suggestions by some Chinese commentators that China should perhaps revise its nuclear policies, several Chinese experts repudiated calls for China to consider new low-yield nuclear weapons and adopt nuclear warfighting.[100] Analysts should nonetheless continue to monitor evidence of possible Chinese interest in and activities toward resumed testing and new warhead designs.

***Nuclear PME*:** A measure of the faculty and students at nuclear-related programs at Rocket Force and other PME institutes.

We assess that there is currently a low number of nuclear-related PME appointments in Rocket Force educational institutions. However, student admissions data suggest a major expansion of Rocket Force personnel is under way, accompanied by a more modest increase in students studying nuclear-related subjects. The Rocket Force has three main educational institutions—the Rocket Force Command College, the Rocket Force University of Engineering, and

the Rocket Force NCO School—but comprehensive admissions data are publicly available only for the Rocket Force University of Engineering.[101]

Overall admissions at Rocket Force University of Engineering have more than doubled over the last decade, with sharp increases in the last 3 years.[102] Admissions data have historically been a leading indicator of future missile force expansion. In 2015, admitted students jumped to nearly 600, and for the next several years, admissions continued at this new higher level. This bump in admissions preceded a notable expansion of the Rocket Force in the period between 2017 and 2020.[103] The recent jump in admissions suggests that the size of the Rocket Force may significantly increase in the next few years.

However, while total admissions have more than doubled, the increase in admissions for nuclear-related areas of study has been much more modest, suggesting that future missile force growth might emphasize conventional units rather than nuclear ones. The university operates a 4-year bachelor's program with 16 academic majors, one of which, nuclear engineering and technology, is explicitly intended to train officers involved in the operation and support of nuclear missiles. The major is described as "aim[ing] to train junior command and technical officers engaged in nuclear warhead assembly, testing, management and maintenance, combat application, manufacturing supervision, and applied research for the entire army."[104] Figure A9 shows that admissions increases for the study of nuclear engineering and technology have not matched the dramatic increase in overall student enrollment.[105] In 2022, out of 1,177 admitted students, only 85 were for nuclear engineering and technology. This was the highest number of nuclear admissions in the last decade and a significant jump from the previous year's total of 34 students, but still constituted just over 7 percent of all admissions.[106] In 2023, the number of students admitted to the nuclear engineering major fell to 49, even as the total number of students rose to 1,301, meaning that only 3.8 percent of new students are in the nuclear engineering program. Figure A10 provides a closer look at enrollment trends in the nuclear engineering major. It is worth following future developments to determine if the recent higher number of admissions to nuclear programs is the start of a new trend or an anomaly.

Figure A9. Admissions to Rocket Force Engineering University

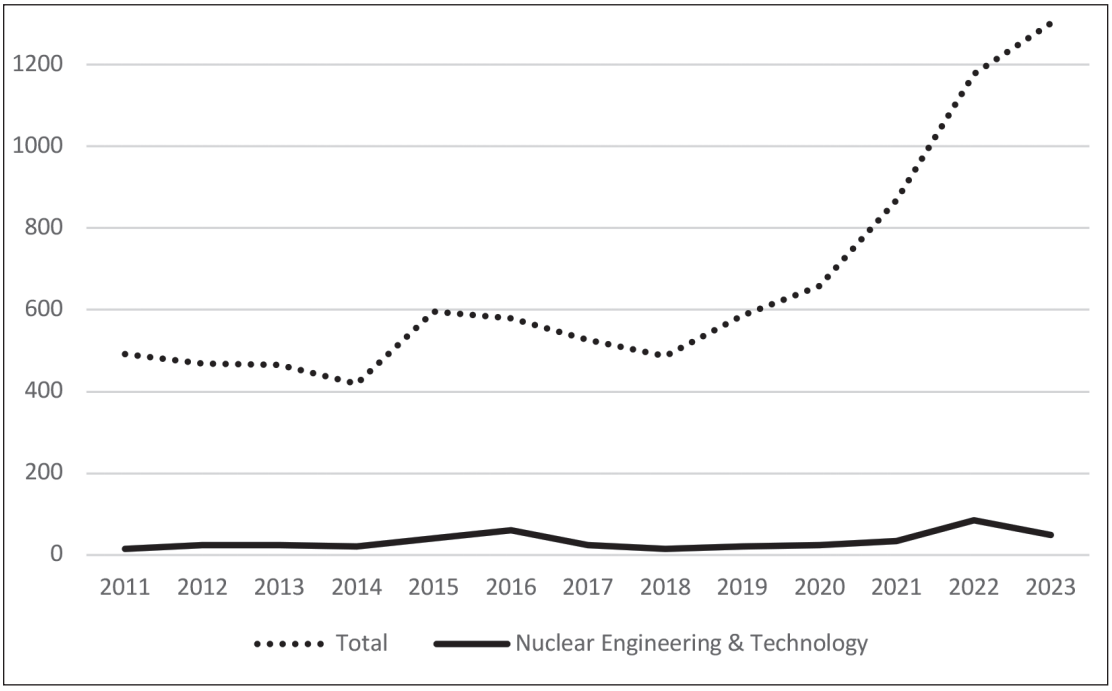
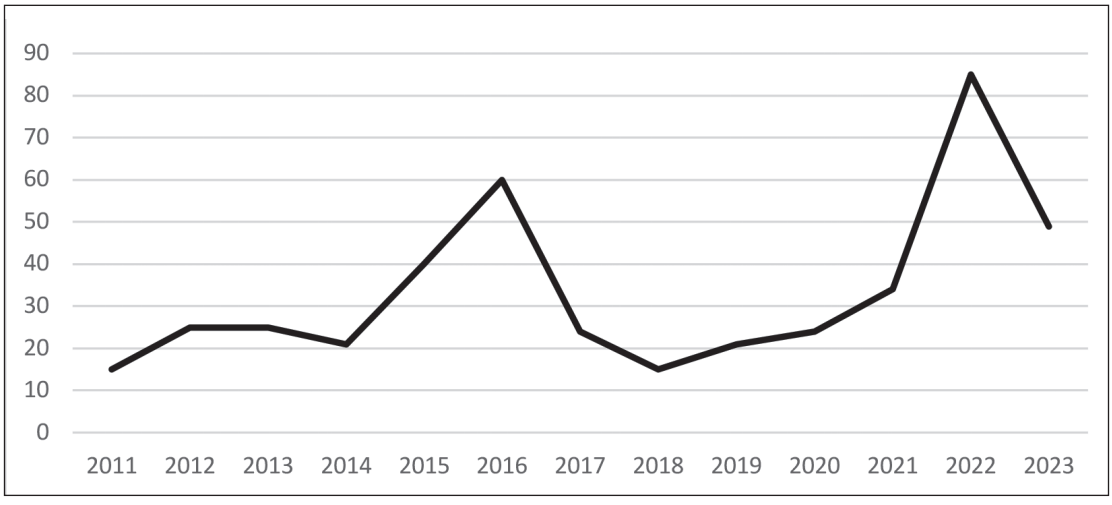


Figure A10. Admissions to Rocket Force Engineering University for Nuclear Engineering and Technology



Appendix Notes

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[17] As discussed elsewhere in this report, historically China has invested relatively little in its nuclear forces, often assigning few military roles to its nuclear weapons and being slow to deploy new nuclear capabilities. See, for example, Jonathan Ray, *Red China's "Capitalist Bomb": Inside the Chinese Neutron Bomb Program*, INSS China Strategic Perspectives, No. 8 (Washington, DC: NDU Press, 2015).

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[23] Ibid.

[24] Per open-source evidence from Hans M. Kristensen and Matt Korda, it appears that nuclear DF-21A systems are being phased out, sometimes replaced by newer nuclear DF-21E systems or by dual-capable DF-26 systems, most of which are deployed in a conventional configuration. In 2020, they assessed that "Over the past four years, the primacy of the DF-21 among China's regional nuclear forces has been overtaken by the DF-26 intermediate-range ballistic missile in significant numbers." See Hans M. Kristensen and Matt Korda, "Chinese Nuclear Forces, 2020," *Bulletin of the Atomic Scientists* 76, no. 6 (2020), 448, 451.

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[34] Mark Stokes, "China's Nuclear Warhead Storage and Handling System," Project 2049 Institute, March 12, 2010, https://project2049.net/documents/chinas_nuclear_warhead_storage_and_handling_system.pdf.

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[46] Ibid., 34.

[47] *China's National Defense in the New Era*.

[48] Fiona S. Cunningham and M. Taylor Fravel, "Assuring Assured Retaliation: China's Nuclear Posture and U.S.-China Strategic Stability," *International Security* 40, no. 2 (2015), 7–50.

[49] Kiselycznyk and Saunders, *Assessing Chinese Military Transparency*, 16.

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[52] See, for example, Xiao, *Science of Military Strategy*, 129, 382.

[53] We use two resources in the CASI databases, one providing translations and summaries of key sources, including PLA military service newspapers, and the other providing full text of primary sources, including military service publications. The translations and summaries database includes publications from 2017 to 2020, and the primary sources database includes articles published starting in 1999 (though varying slightly by publication) up to 2017. The translations and summaries database is not complete; there are gaps in collection and analysis. However, it may still provide a reasonable picture of reporting dynamics. The primary sources database is largely complete. Evaluation of completeness of databases from Logan correspondence with Roderick Lee, director of research at the China Aerospace Studies Institute.

[54] Alternatively, the PLA Navy and PLA Air Force may have tighter classification guidelines for discussion of their efforts to develop and operate nuclear forces, which would explain the low number of mentions in PLA-affiliated reports and publications.

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[64] Xu, "China's Security Environment and the Role of Nuclear Weapons"; Cunningham and Fravel, "Assuring Assured Retaliation."

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