Correspondence

The Limits of Damage Limitation

Brendan Rittenhouse Green and Austin Long

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Charles L. Glaser and Steve Fetter

To the Editors (Brendan Rittenhouse Green and Austin Long write):

Charles Glaser and Steve Fetter argue that the United States should not pursue a nuclear damage-limitation capability against China: U.S. nuclear superiority is impossible to maintain beyond the short term, and its pursuit will provide few benefits while incurring serious costs.[1] In an extended arms race, however, we argue that U.S. damage-limitation capabilities are far more technically plausible than Glaser and Fetter conclude. Further, damage limitation capabilities can make a vital contribution to U.S. strategy.

TECHNICAL ANALYSIS OF DAMAGE LIMITATION

Glaser and Fetter argue that various countermeasures can thwart U.S. surveillance systems relevant to hunting mobile intercontinental ballistic missiles (ICBMs) (pp. 68–70). They further argue that China can thwart attacks on its command and control (C2) by dispersing it to mobile platforms, pre-delegating launch authority, and adopting a launch-on-warning posture (pp. 73–74).

TRUNCATED ANALYSIS. Glaser and Fetter conclude their analysis without extending the measure-countermeasure competition very far. In so doing, they fall prey to the "fallacy of the last move," as though there were no counters to the countermeasures they propose.[2] For instance, China can employ decoy mobile missile complexes, but countering decoys is routine in long-term military competitions.[3]

In the case of surveillance of mobile missiles, U.S. space-based radar (SBR) or other

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1. Charles L. Glaser and Steve Fetter, "Should the United States Reject MAD? Damage Limitation and U.S. Nuclear Strategy toward China," *International Security*, Vol. 41, No. 1 (Summer 2016), pp. 49–98. Subsequent citations to this article appear parenthetically in the text.
2. On the fallacy of the last move, see Herbert F. York, "The Arms Race and the Fallacy of the Last Move," *Bulletin of the Atomic Scientists*, Vol. 25, No. 6 (1969), pp. 27–43.
3. See discussion in W. Coleman Hyatt, "Fleet Air Defense: Countermeasures," *John's Hopkins Applied Physics Laboratory Technical Digest*, Vol. 13, No. 1 (1992), pp. 101–109.

International Security, Vol. 42, No. 1 (Summer 2017), pp. 193–207, doi:10.1162/ISEC_c_00279

wide-area surveillance could be used to cue other sensors, such as those using multi- or hyperspectral imaging. These sensors could then detect subtle differences between a decoy missile complex and an actual missile complex. Stealth is likewise no panacea; it too is subject to countermeasures. Of course, responses on both sides can continue. But without more detailed analysis, it is difficult to say whether the United States or China will win the measure-countermeasure battle over a protracted period of time.

Likewise, Glaser and Fetter's argument that China can deploy its mobile ICBMs in mountainous areas to limit SBR line of sight ignores SBR's overhead perspective.[4] Further, the road networks in valleys between mountains that could block radar coverage are often limited and steep. This would canalize mobile ICBMs operating in these areas and impose significant operational penalties. The countermeasure in this case might cost more in an operational sense than it would benefit the mobile missile force; for example, a brake failure on a descending transporter erector launcher (TEL) would be a disaster, and a very slow climb would make a located TEL a sitting duck.

Moreover, Chinese use of underground facilities and tunnels to conceal TELs might end up being perversely helpful to U.S. planners. The United States has dedicated enormous resources to intelligence capabilities intended to detect and map underground facilities.[5] If U.S. intelligence is able to detect the entrances or exits to such facilities, then they would become highly vulnerable to attack.

Additionally, Glaser and Fetter acknowledge but do not assess two other systems that we have argued elsewhere could be used to hunt mobile missiles: stealthy penetrating unmanned aerial vehicles and unattended ground sensors.[6] Admittedly, classification makes it difficult to fully evaluate these systems; nevertheless, they could contribute greatly to tracking mobile missiles. Both of these technologies are amplified by efforts to automate and rapidly integrate the data they provide for mobile missile hunting.[7]

The difficulties in obtaining survivable C2 that bedeviled the superpowers during the Cold War belie Glaser and Fetter's somewhat blithe assessment of Chinese C2.[8] C2 problems may be even more challenging today, as mobile command posts (even those in the air) can be tracked and targeted with the same sensors that track mobile missiles. In addition, non-kinetic options for disrupting C2 have proliferated over the past four decades. Even during the Cold War, the United States had apparently devel-

4. See Keir Lieber and Daryl Press, "The New Era of Counterforce: Technological Change and the Future of Deterrence," *International Security*, Vol. 41, No. 4 (Spring 2017), pp. 9–49.

5. For an unclassified overview of some advances in underground facility monitoring, see Frank Pabian, "The New Geospatial Tools: Global Transparency Enhancing Safeguards Verification," Los Alamos National Laboratory, New Mexico, October 2010, National Security Archive Electronic Briefing Book No. 372, document 37, http://nsarchive.gwu.edu/NSAEBB/NSAEBB372/docs/Underground-Pabian.pdf.

6. Austin Long and Brendan Rittenhouse Green, "Stalking the Secure Second Strike: Intelligence, Counterforce, and Nuclear Strategy," *Journal of Strategic Studies*, Vol. 38, Nos. 1–2 (2015), pp. 38–73.

7. See Marcus Weisgerber, "The Increasingly Automated Hunt for Mobile Missile Launchers," *DefenseOne*, April 28, 2016, http://www.defenseone.com/technology/2016/04/increasingly-automated-hunt-mobile-missile-launchers/127864/.

8. On the problems of survivable command and control in the Cold War, see, among others, Ashton B. Carter, "The Command and Control of Nuclear War," *Scientific American*, Vol. 252, No. 1 (January 1985), pp. 32–39; and Leonard Wainstein et al., *The Evolution of U.S. Strategic Command and Control and Warning, 1945–1972* (Alexandria, Va.: Institute for Defense Analyses, 1975).

oped electronic warfare techniques to disable Soviet strategic C2 systems.[9] Today, the possibility for offensive cyber operations against such systems is believed to be substantially greater.[10]

OPERATIONAL AND TECHNICAL DIFFICULTIES: WARTIME ENDURANCE. Survivable second-strike forces must endure through all phases of a conflict. Yet Glaser and Fetter give short shrift to the potentially low wartime endurance of Chinese forces.

Glaser and Fetter assert that strict radio communications procedures and use of landlines will suffice to keep Chinese mobile ICBMs secure. These countermeasures are difficult to sustain over time, however, and all are subject to potential attacker responses. Mobile operations will likely impose demands for frequent communications when coordinating movement, halts, fueling, and rest breaks between the TEL and multiple support vehicles. It is also likely, given Cold War experience and current Chinese practices, that Chinese mobile ICBMs would communicate their status to higher headquarters at least sporadically.[11] Unlike ballistic missile submarines, mobile missile patrols travel in open territory. Road conditions, weather, crew health, and other factors could negatively affect such patrols, which are also potentially vulnerable to attack from special operations units or other ground forces.

In the face of these possibilities, sustained communications silence will become increasingly difficult over time. If communications are radio frequency, they are vulnerable to interception by U.S. signals intelligence sensors. Low probability of intercept transmissions will reduce but not eliminate that vulnerability for frequently communicating and difficult to duplicate TELs, which can be the target of barrage attack if imprecisely located. The use of dedicated military landlines would greatly restrict patrol areas while increasing mobile missile vulnerabilities if those lines were detected. Commercial landlines would impose fewer operational restrictions, but could be more easily penetrated. The United States was able to tap Soviet undersea naval communications in the Cold War; if motivated, it could likely tap Chinese commercial phone lines before a conflict begins.[12]

In addition, Glaser and Fetter argue that China could jam or attack SBR satellites during wartime. This is by far the most compelling of their countermeasure arguments. In wartime, though, jammers can potentially be targeted, and the fact that an area is being protected by jamming could cue other sensors to the likely mobile ICBM patrol area. Anti-satellite systems can likewise be targeted. Wartime is likely to produce first-strike advantages in the surveillance-countersurveillance competition, which will not benefit the party that has to move from a vulnerable to a less vulnerable posture.

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9. See Benjamin B. Fischer, "CANOPY WING: The U.S. War Plan That Gave the East Germans Goose Bumps," *International Journal of Intelligence and Counterintelligence*, Vol. 27, No. 3 (2014), pp. 431–464; and Fred Kaplan, *Dark Territory: The Secret History of Cyber War* (New York: Simon and Schuster, 2016), pp. 12–20.
10. Defense Science Board, "Resilient Military Systems and the Advanced Cyber Threat" (Washington, D.C.: U.S. Department of Defense, 2013), p. 42.
11. On the evidence that Soviet TEL communications were intercepted, see A. Andronov, "Amerikanskiye Sputniki Radioelektronnoy Razvedki na Geosynchronnykh Orbitakh" [American signals intelligence satellites in geosynchronous orbit], *Zarubezhnoye Voyennoye Obozreniye* [Foreign military review], No. 12, Allen Thomson, trans. (1993), p. 42; and Matthew Aid, *The Secret Sentry: The Untold History of the National Security Agency* (New York: Bloomsbury, 2009), p. 183.
12. See Sherry Sontag and Christopher Drew, with Annette Lawrence Drew, *Blind Man's Bluff: The Untold Story of American Submarine Espionage* (New York: PublicAffairs, 1998), pp. 222–229.

Furthermore, as Glaser and Fetter point out, "[F]or its DF-31As to survive, China must be able to launch them from unprepared sites." Glaser and Fetter's assumption, however, that China will be able to rely on "the Global Positioning System and other modern positioning and navigation services" is a dubious wartime proposition (p. 66). It seems more likely that Chinese mobile ICBMs will fire only from sites that have been pre-surveyed and geolocated in peacetime. Given the DF-31A's weight and maneuverability challenges, this will impose even more limitations on China's wartime operations.

POLITICAL AND ORGANIZATIONAL DIFFICULTIES. Even if the Chinese prove capable of technically demanding wartime operations, history suggests that they may face political and organizational challenges in preparing their forces during peacetime. This is especially true in the area of nuclear C2. All states face a sharp trade-off between negative control (assurances against unauthorized use) and positive control (assurances for authorized use) over their nuclear weapons. This trade-off produces strong incentives not to pursue the pre-delegation and launch-on-warning measures that Glaser and Fetter assume China will implement. These incentives may be particularly strong in authoritarian states, where the threat of internal unrest to nuclear forces, strains in civil-military relations, and worries about political succession may all bias decisions toward prioritizing negative control over survivable nuclear C2.

This pattern was demonstrated in the only other comparable case: the Cold War Soviet Union.[13] Moscow's civilian leadership abhorred pre-delegation. The Soviets also prioritized negative control in their launch procedures, which required no less than three members of the high command to authorize weapons release and two generals to generate portions of the launch code. As Glaser and Fetter themselves point out, China presently appears to favor negative control over an invulnerable posture for its mobile ICBMs in peacetime (pp. 72–73).

In sum, Glaser and Fetter omit from their analysis technical, organizational, and political factors favorable to U.S. damage-limiting capabilities. Yet damage limitation could be inadvisable even if technically plausible. We now turn to the political utility of damage limitation.

POLITICAL ANALYSIS OF DAMAGE LIMITATION

Glaser and Fetter argue that damage-limitation capabilities add little to the credibility of U.S. deterrent threats compared to alternatives. However, their analysis obscures the central character of political confrontations in the nuclear age. Following Thomas Schelling, Robert Jervis, and others, we conceive of political confrontation in the nuclear age as a competition in risk-taking.[14] That is, at every stage in an international clash—crisis initiation and each step of crisis and wartime escalation—there looms a semi-autonomous risk of a catastrophic nuclear exchange, either through unintentional spasm or tit-for-tat escalation. Political confrontations favor the state most toler-

13. See the summary in Brendan Rittenhouse Green and Austin Long, "The MAD Who Wasn't There: Soviet Reactions to the Late Cold War Strategic Balance," *Security Studies*, Vol. 26, No. 4 (Fall 2017).

14. See, among others, Thomas C. Schelling, *Arms and Influence* (New Haven, Conn.: Yale University Press, 1966); and Robert Jervis, *The Meaning of the Nuclear Revolution: Statecraft and the Prospect of Armageddon* (Ithaca, N.Y.: Cornell University Press, 1989).

ant of such risks. Cold War theories highlighted two variables as the key drivers of risk tolerance: the balance of interests at stake in a dispute and the balance of nuclear capabilities between disputants.[15]

If the second theory is true, then damage-limitation capabilities are a major source of risk tolerance in political confrontations. A state with damage-limitation capabilities will emerge from an all-out nuclear exchange as a functioning, if brutalized, society; its nuclear opponent will not. Moreover, damage-limitation capabilities need not be ironclad and certain to produce superior risk tolerance with political effects. The key feature is asymmetry between the two parties and some reasonable probability of success in limiting damage by one side. The other side need only believe that, at the moment of ultimate desperation, its adversary is more willing to gamble because it has some probability of limiting retaliation.

To be clear, we do not dismiss other sources of risk tolerance, especially those based on the political interests at stake. Decisions about U.S. force posture will influence, but may not control, U.S. and Chinese behavior. Despite such limitations, a risk-competition model provides several advantages for analyzing damage-limitation capabilities.

WARTIME COSTS AND BENEFITS. The most important scenario for the U.S. nuclear deterrent is during an ongoing conventional war with China, as poor Chinese performance in such a war is the only plausible circumstance in which Beijing might be tempted to launch nuclear attacks on the U.S. homeland. Glaser and Fetter argue that damage-limitation capabilities add little to deterrence of such outcomes compared to preexisting U.S. capabilities for limited nuclear options (LNOs). U.S. LNOs mean that any Chinese nuclear attack risks an all-out exchange and ensures unacceptable damage to China even if nuclear strikes remained limited (pp. 84–85). At the same time, damage-limitation capabilities create unnecessary risks of escalation. As Glaser and Fetter write, "The vulnerability of China's nuclear forces could create incentives for China to use them early in a crisis or conventional war" (p. 92).

There is a contradiction here. If amid a failing conventional war, China is already unlikely to employ LNOs because it is afraid of the U.S. ability to respond in kind, then why would it be driven by U.S. damage-limitation capabilities toward early escalation, which would begin an LNO exchange? Either U.S. LNOs are likely to deter Chinese LNOs, in which case U.S. damage-limitation capabilities pose little in the way of additional escalatory risk, or those capabilities will make the Chinese nervous about their nuclear vulnerability, in which case damage limitation will contribute much more to deterrence than Glaser and Fetter suggest.

An explicit theory of nuclear superiority and risk-taking helps to resolve this tension. A state that felt its regime survival was at stake might well risk an LNO exchange. As James Schlesinger put it, "In a war of nerves, with limited encounters, which side will prove the stronger—especially when we have reached the city-swapping stage?"[16] Yet a state facing an adversary with significant damage-limitation capabilities will understand that tit-for-tat LNOs will proceed only as far as its superior opponent is willing to

15. See, for example, Richard K. Betts, *Nuclear Blackmail and Nuclear Balance* (Washington, D.C.: Brookings Institution Press, 1987).
16. James R. Schlesinger, *Some Notes on Deterrence in Western Europe* (Santa Monica, Calif.: RAND Corporation, 1962) p. 10.

tolerate, which is unlikely to be very far, as Glaser and Fetter themselves acknowledge (p. 84). Concerns over damage limitation cast doubt on the ability of Chinese LNOs to successfully challenge the United States even if China faces a desperate situation. If the United States were confronted by such circumstances, U.S. LNOs by themselves are unlikely to deter Chinese escalation at the moment of decision.

CRISIS COSTS AND BENEFITS. U.S. damage-limitation capabilities could also be important in a crisis with China, potentially dissuading the Chinese from conventional military action and thereby enhancing the United States' extended deterrence of its Asian allies. Glaser and Fetter claim, however, that damage limitation can add little to extended deterrence, primarily because conventional deterrence in the region is strong. They write, "[T]he United States' key allies, in combination with the United States, have excellent prospects for deterring large Chinese conventional attacks" (p. 86).

Glaser and Fetter's focus on conventional deterrence is misleading: war in Asia is unlikely to occur because the Chinese believe that U.S. and allied conventional defenses are weak, or even because the alliances are insufficiently motivated to defend their interests. If confrontation occurs, the most likely cause will be China's concern about its vital interests, which, despite the unfavorable conventional balance, will lead Beijing to initiate a political confrontation that may result in a conventional war or even an all-out nuclear war. Beijing's crisis behavior will aim to demonstrate its greater willingness to suffer pain and risk destruction, in the hopes that its political interests will be respected. In such crises, the conventional balance will carry much less weight in influencing Chinese behavior. Clearly, if the conventional balance were dispositive, no crisis would have occurred in the first place. The United States may thus require nuclear threats, even threats of first use. If the theory of risk tolerance sketched above is correct, damage-limitation capabilities could make a major contribution to the credibility of such threats in the only scenarios likely to be relevant.

PEACETIME COSTS AND BENEFITS. Finally, damage-limitation capabilities might provide the United States with benefits during peacetime competition. Glaser and Fetter dismiss one such advantage, increased assurance of U.S. alliance partners, because the United States managed credible reassurance without damage-limitation capabilities in the much tougher Cold War case (p. 91). In contrast, the fears induced by these capabilities risk a spiral of arms racing and hard-line policies from the Chinese (p. 96).

Of all the arguments that Glaser and Fetter offer against damage limitation, this is by far the most powerful. There are empirical and theoretical reasons, however, to doubt that the United States will be able to avoid sending malign signals to the Chinese, regardless of its force posture decisions. Glaser and Fetter's analysis of U.S. theater missile defense provides a perfect example (p. 75): technically, it is clear that terminal high altitude area defense poses no threat to Chinese strategic nuclear capabilities, but that has not stopped Beijing from drawing negative inferences about U.S. intentions.[17] Compounding this problem, many surveillance assets vital to damage limitation are "indistinguishable" from those needed for other purposes. So even if the United States rejects damage limitation and embraces mutually assured destruction, it would pro-

17. See also Fiona S. Cunningham and M. Taylor Fravel, "Assuring Assured Retaliation: China's Nuclear Posture and U.S.-China Strategic Stability," *International Security*, Vol. 40, No. 2 (Fall 2015), pp. 7–50.

cure these capabilities for these other purposes and China would likely infer that the United States was seeking a damage-limiting capability regardless of U.S. declarations to the contrary.

CONCLUSION

In short, we suspect that military-technical factors can play only a minor role in putting the U.S.-Chinese relationship on a less competitive trajectory. But if the relationship does become highly competitive, damage-limitation capabilities could produce several benefits. The assurance problems that Glaser and Fetter dismiss will become much more salient in such an environment, and decisionmakers may come to remember the lessons of Cold War assurance very differently.[18] Damage-limitation capabilities will contribute to general deterrence, dissuading China from even entering crises with the United States.

Ultimately, however, the political context is the single most important variable in rendering a judgment about the optimal U.S. nuclear force posture. The best ways to avoid competition with China are to find fundamental political compromise, either through eliminating the most fraught flashpoints, such as Taiwan, or through broader grand strategic restraint.[19] We see no evidence, however, of the major changes that such strategic compromise would require. The earliest that U.S. commitments are likely to change is the moment of crisis itself; Glaser and Fetter's contrary suggestion that analysts should conduct U.S. defense planning as though the commitment to Taiwan is not valuable seems unlikely to persuade policymakers under current conditions. U.S. political leaders have adopted interests for political reasons that will be largely subject to political changes. We suspect that military-technical factors will matter only at the margins.

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—Austin Long
East Quogue, New York

To the Editors (Matthew Kroenig writes):

In "Should the United States Reject MAD?" Charles Glaser and Steve Fetter argue that the United States should forgo a damage-limitation capability against China's strategic forces.[1] To arrive at this conclusion, however, they underestimate the advantages of a

18. See, for example, Earl C. Ravenal, "Counterforce and Alliance: The Ultimate Connection," *International Security*, Vol. 6, No. 4 (Spring 1982), pp. 26–43.
19. Charles L. Glaser has suggested the former option; a great many analysts have suggested the latter, with perhaps the most thorough case in recent times offered by Barry R. Posen. We are split on this issue, with Green in favor of these suggestions and Long opposed. See Glaser, "A U.S.-China Grand Bargain? The Hard Choice between Military Competition and Accommodation," *International Security*, Vol. 39, No. 4 (Spring 2015), pp. 49–90; and Posen, *Restraint: A New Foundation for U.S. Grand Strategy* (Ithaca, N.Y.: Cornell University Press, 2014).

1. Charles L. Glaser and Steve Fetter, "Should the United States Reject MAD? Damage Limitation

damage-limitation strategy and do not even consider more feasible and desirable policy options for a strategic equilibrium with China. When these steps are corrected, it becomes clear that the United States should not forgo this capability. Rather, it should preserve its damage-limitation capability and quantitative nuclear superiority over China, while accepting the inevitability of China's possession of an assured nuclear retaliatory capability.

Glaser and Fetter begin by making the conceptual mistake of searching for an arbitrary threshold for meaningful damage limitation. In doing so, they underestimate the value of limiting damage in the event of nuclear war. Glaser and Fetter are correct that completely denying China's nuclear deterrent is increasingly difficult if not impossible as China expands and modernizes its arsenal, but this is an unnecessarily high bar. Damage limitation is better conceived of as a continuous, not a binary, variable. There is no magical threshold beyond which the ability to limit damage in a nuclear war ceases to matter. Any U.S. president would want to protect as much of the country as possible in the event of a nuclear exchange, and any damage-limitation capability (even far below the threshold set by Glaser and Fetter) would therefore be valuable. To argue otherwise, one would have to argue that saving millions of American lives is unimportant or politically irrelevant, which is an untenable position.

Glaser and Fetter's second error is to misconceive of nuclear deterrence in the wake of the nuclear revolution and overlook recent scholarly research. As a result, they underestimate how damage limitation enhances deterrence and extended deterrence. Theories of the nuclear revolution (including those Glaser helped develop) suggest that political conflicts of interest among nuclear powers are best conceived of as games of nuclear brinkmanship.[2] To deter nuclear war, therefore, a central question is: What causes states to back down in these "competitions in risk taking."[3] As recent research shows, nuclear superiority and associated degrees of vulnerability to nuclear war affect the balance of resolve, even when both sides possess an assured retaliation capability.[4] China will be less likely to challenge the United States and its allies, and to achieve coercive success against them, therefore, if the United States maintains a damage-limitation capability. In other words, a U.S. damage-limitation capability bolsters deterrence and extended deterrence.

Scholars have questioned whether this logic also applies to nuclear compellence, but recent research shows that it does.[5] A nuclear-armed state has never issued a militarized compellent threat against a nuclear superior state. In other words, nuclear superiority deters compellent threats.

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and U.S. Nuclear Strategy toward China," *International Security*, Vol. 41, No. 1 (Summer 2016), pp. 49–98.

2. Thomas C. Schelling, *Arms and Influence* (New Haven, Conn.: Yale University Press, 1966); Charles L. Glaser, *Analyzing Strategic Nuclear Policy* (Princeton, N.J: Princeton University Press, 1990); and Robert Jervis, *The Meaning of the Nuclear Revolution: Statecraft and the Prospect of Armageddon* (Ithaca, N.Y.: Cornell University Press, 1989).

3. Schelling, *Arms and Influence*, p. 94.

4. Matthew Kroenig, "Nuclear Superiority and the Balance of Resolve: Explaining Nuclear Crisis Outcomes," *International Organization*, Vol. 67, No. 1 (January 2013), pp. 141–171.

5. Todd S. Sechser and Matthew Fuhrmann, "Crisis Bargaining and Nuclear Blackmail," *International Organization*, Vol. 67, No. 1 (January 2013), pp. 173–195; and Matthew Kroenig, Miriam Krieger, and Hans Noel, "Dare to Fail: Nuclear Superiority, Threat Initiation, and Compellent Success," Georgetown University, 2016.

More broadly, order in the Asia Pacific has for decades rested on U.S. primacy. And as international relations theory suggests, rapid shifts in the balance of power, such as that which would occur if the United States abandoned nuclear advantages over China, would be destabilizing.[6] Preserving stability in Asia through the continued maintenance of U.S. predominance is a far better option.

Glaser and Fetter rightly fear the possibility of a costly arms race and deteriorating relations with China if the United States attempts the near-impossible task of seeking to deny China's nuclear deterrent altogether. There is a much better solution, however, than voluntarily shedding an important means of protecting the United States and its allies: accept that China will likely possess some minimal retaliatory capability regardless of the steps taken by Washington, while the United States continues to maintain quantitative superiority, including a damage-limitation capability. This arrangement (also advanced by former Deputy Secretary of State James Steinberg and Michael O'Hanlon) has been warmly received in my many meetings with Chinese interlocutors in track II dialogues in Beijing and in Washington over the past two years.[7] The Chinese would be comforted in knowing that their country possesses a secure, second-strike capability, which is all that its leaders desire.[8] At the same time, the United States would maintain the robust nuclear force that allows it to extend nuclear deterrence in Asia and preserve strategic stability in the region.

Indeed, such an arrangement provides the best hope for a stable strategic equilibrium between the United States and China. This outcome would certainly be much more desirable than abandoning an important source of U.S. and allied security and upending the regional balance of power.

—Matthew Kroenig
Washington, D.C.

Charles L. Glaser and Steve Fetter Reply:

We thank Matthew Kroenig and Brendan Green and Austin Long for their letters in response to our article "Should the United States Reject MAD?"[1] The letters raise a variety of conceptual, strategic, and technical issues. Length limitations allow us to deal only with those criticisms we believe are most important.[2]

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6. Robert Powell, "War as a Commitment Problem," *International Organization*, Vol. 60, No. 1 (January 2006), pp. 169–203.
7. James Steinberg and Michael E. O'Hanlon, *Strategic Reassurance and Resolve: U.S.-China Relations in the Twenty-first Century* (Princeton, N.J.: Princeton University Press, 2014); and Matthew Kroenig, "Approaching Critical Mass: Asia's Multipolar Nuclear Future" (Seattle, Wash.: National Bureau of Asian Research, June 2016).
8. Fiona S. Cunningham and M. Taylor Fravel, "Assuring Assured Retaliation: China's Nuclear Posture and U.S.-China Strategic Stability," *International Security*, Vol. 40, No. 2 (Fall 2015), pp. 7–50.

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1. Charles L. Glaser and Steve Fetter, "Should the United States Reject MAD? Damage Limitation and U.S. Nuclear Strategy toward China," *International Security*, Vol. 41, No. 1 (Summer 2016), pp. 49–98. Further references to this article appear parenthetically in the text.
2. Among the issues we do not respond to are whether an effective U.S. damage-limitation capability would fuel an arms race and increase Chinese insecurity by signaling malign U.S. motives.

Kroenig argues that we err by searching for an "arbitrary threshold for meaningful damage limitation," implies that we envision damage limitation as a binary variable instead of a continuous one, and holds that any damage-limitation capability would be valuable because "[a]ny U.S. president would want to protect as much of the country as possible." Kroenig misunderstands our discussion and exaggerates the marginal value of reducing damage when the United States would suffer such high levels of retaliatory destruction that it might never again be a functioning state. We offered three ways of conceptualizing damage limitation: (1) a threshold above which additional damage results in costs that are small compared to costs at the threshold; (2) a threshold above which the United States would be unable to recover in anything resembling its current form; and (3) a threshold above which the United States should be unwilling to risk even a small increase in the probability of nuclear war to reduce the damage of an all-out war. Although none of these variants fully captures the issues involved in judging the value of reducing the size of a nuclear attack, each offers valuable insights and the latter two are connected to key policy judgments.

Kroenig argues that any reduction in the size of a nuclear attack is worth pursuing because otherwise "saving millions of American lives is unimportant or politically irrelevant." Yet, what if those surviving millions were fated to lives of misery, famine, and disease, struggling for mere survival in a "smoking radiating ruin?"[3] Saving those lives would have value, but far less than saving lives in today's United States. If saving these lives involved no economic costs, the United States might pursue a damage-limitation capability as insurance against an even worse outcome. But if the cost of being minimally successful were hundreds of billions of dollars per decade, the insurance might not be worth the price. Moreover, because the probability of all-out nuclear war with China is very low, the expected value—that is, the probability multiplied by the value of the damage limitation—is orders of magnitude smaller. Other uses of U.S. resources to save and improve the quality of American lives would have to be compared to the expected value of damage limitation. Any such calculation would be complicated, but we expect that, above some level of nuclear destruction, additional damage limitation would not warrant the investment. Damage limitation can nevertheless be worth the investment at low levels of nuclear destruction, and we have written elsewhere about the potential value of such a capability against small nuclear arsenals.[4]

An even more telling counterargument is that a damage-limitation capability would not only be economically costly, but would also increase the probability of nuclear war. Pursuit of the highly competitive policies required to preserve a U.S. damage-limitation capability would strain the U.S.-China relationship, increasing the probability of both conventional and nuclear war. It would also create strategic incentives for both the United States and China to escalate to the use of nuclear weapons and possibly increase the probability of their accidental and unauthorized use. Given the modest benefits of damage limitation at such high levels of damage, the increased risk of nuclear war

3. See David Alan Rosenberg, "'A Smoking Radiating Ruin at the End of Two Hours': Documents on American Plans for Nuclear War with the Soviet Union, 1954–1955," *International Security*, Vol. 6, No. 3 (Winter 1981/82), pp. 3–38. Rosenberg quotes the term from a 1954 U.S. Air Force briefing of Strategic Air Command plans for attacking the Soviet Union.
4. Charles L. Glaser and Steve Fetter, "Counterforce Revisited: Assessing the Nuclear Posture Review's New Missions," *International Security*, Vol. 30, No. 2 (Fall 2005), pp. 84–126.

would more than offset the benefits, resulting in a negative expected value for U.S. pursuit of a damage limitation capability.

Kroenig also claims that we fail to understand "nuclear deterrence in the wake of the nuclear revolution," arguing that we "underestimate how damage limitation enhances deterrence and extended deterrence." There is a critical gap in Kroenig's argument. The logic of the nuclear revolution applies to two countries that possess assured-destruction capabilities; in other words, these states live in a condition of mutual assured destruction (MAD). By definition, MAD occurs when neither country has a meaningful damage-limitation capability.[5] Thus, assessing the deterrent value of a damage-limitation capability requires analysis that lies outside the central logic of the nuclear revolution.

In a related argument, Green and Long hold that we reject the nuclear deterrence and bargaining logic developed by Thomas Schelling, Robert Jervis, and others. In fact, we fully accept the core logic of these arguments: significantly different degrees of vulnerability to nuclear retaliation can influence states' relative bargaining positions. For example, we wrote that "by promising to reduce the costs of an all-out nuclear war, the U.S. damage-limitation capability increases the United States' willingness to pursue actions that raise the probability that the war would escalate to all-out war" (p. 84; see also pp. 61, 85, 88). But this bargaining advantage is likely to be small if U.S. vulnerability to retaliation remains high. As we stated when discussing a situation in which the United States suffers an asymmetry of interests, "Although a U.S. damage-limitation capability could partly offset this asymmetry, by making the possibility of all-out nuclear war less risky for the United States than for China, the modest and declining U.S. damage-limitation capability would leave the United States at a significant bargaining disadvantage" (p. 90).

Green and Long misconstrue some of our other arguments. For example, we do not see a contradiction between holding that (1) a damage-limitation capability would add little to the U.S. ability to deter a Chinese limited nuclear attack against the U.S. homeland and (2) a U.S. damage-limitation capability would create incentives for China to launch a limited nuclear attack earlier during a conventional war. Both claims could be true. In support of the first point, we argue that China would likely be deterred from starting a limited nuclear war by the combination of U.S. limited nuclear options (LNOs) and the United States' ability to destroy China with an unlimited nuclear attack. But holding that China would likely be deterred is not to say that it would be deterred in all scenarios. We allow the possibility that China could start a conventional war over an interest that is sufficiently important that it might be willing to employ LNOs to compel the United States to stop fighting. Under these conditions, a U.S. damage-limitation capability could pressure China to escalate earlier, thereby reducing the prospects for terminating the conventional war before it goes nuclear.

We agree with Green and Long that China could start a conventional war even if the United States and its allies possess highly effective conventional capabilities, if the stakes are sufficiently high. We believe, however, that this scenario is extremely

5. We should add, however, that although widely used, the term MAD did not have a single agreed-upon meaning during the Cold War. See Robert Jervis, *The Meaning of the Nuclear Revolution* (Ithaca, N.Y.: Cornell University Press, 1989), pp. 74–106. On the meaning used here, see Charles L. Glaser, *Analyzing Strategic Nuclear Policy* (Princeton, N.J.: Princeton University Press, 1990), pp. 30–32, 211–212.

unlikely, except possibly in a conflict over Taiwan. We also accept that a significant damage-limitation capability could contribute to deterring a high-stakes conventional war by reducing whatever belief Chinese leaders might have in an extreme version of the so-called stability-instability paradox.[6] We believe that the contribution to deterrence would be small, however, because even when both countries possess assured-destruction capabilities, the possibility of nuclear war via a variety of paths contributes significantly to deterrence. Moreover, we caution that the dangers of relying on the possibility of preemption to deter conventional war are likely outweighed by the risks. As we wrote, "China and the United States could become involved in a large conventional war that escalated in unforeseeable ways from a much smaller confrontation. In this type of scenario, pressures to escalate to nuclear war would do nothing to deter the original provocation; these pressures would, however, still increase the probability of escalation to nuclear war" (p. 95).

The preceding discussion makes clear that we disagree with Green and Long not so much on the logical structure of their arguments, but on the size of the deterrent and political effects of a damage-limitation capability. The size of these effects depends on, among other things, the likelihood of certain types of scenarios, leaders' perceptions of nuclear capabilities, and the relative importance of military-technical and political factors in driving conflict, which are hard to estimate. Consequently, analysts can reasonably disagree about how to weigh the different possible paths along which a damage-limitation capability could influence an adversary's decisions. For example, Green and Long argue that "damage-limitation capabilities need not be iron clad and certain. . . . The other side need only believe that . . . its adversary is more willing to gamble because it has some probability of limiting retaliation." This point is correct and lowers the bar for the damage-limitation capability the United States must acquire, but uncertainty about the U.S. damage-limitation capability should reduce its deterrent value. Green and Long also hold that "if confrontation occurs, the most likely cause will be China's concern about its vital interests that, despite the conventional balance, causes Beijing to initiate a political confrontation." By putting aside scenarios that can be deterred by conventional forces, Green and Long increase the relative value (although not the absolute value) of a damage-limitation capability. In contrast, we have chosen to emphasize different possibilities, which we believe better capture the key effects of a damage-limitation capability, and therefore find it less valuable and more dangerous.

With regard to our technical analysis of damage limitation, we agree with Green and Long on the need to avoid the fallacy of the last move. There are indeed countermeasures to the countermeasures we proposed—and countermeasures to those countermeasures, and so on. The key question is whether it is likely that the United States could prevail in this competition and sustain a damage-limitation capability against China over the long term, and, if so, whether the expected benefits of having such a capability would outweigh the costs of the competition. In making such judgments, one

6. The paradox captures the possibility that lowering the probability that a conventional war would escalate to the nuclear level, which would make conventional war less dangerous, would increase the probability of conventional war. For an early statement of this concept, see Glenn H. Snyder, "The Balance of Power and the Balance of Terror," in Paul Seabury, ed., *The Balance of Power* (San Francisco, Calif.: Chandler, 1965), pp. 184–201.

must bear in mind that China is an increasingly wealthy and technologically advanced country capable of engaging the United States in sustained, sophisticated nuclear competition. China's raw capacity to compete with the United States will exceed that of the Soviet Union during the Cold War. Counting on China not to use this capacity to do what it judges is necessary to maintain an adequate deterrent force is wishful thinking, not a sound basis for policy. China's current nuclear modernization program demonstrates that Chinese leaders take seriously the need to have a survivable retaliatory force to deter U.S. nuclear use.[7]

We agree with Green and Long that some recent and foreseeable technical advances favor damage limitation. In particular, the proliferation of small satellites will make it more difficult to conceal mobile missile movements, while also making it more difficult to deny space capabilities through antisatellite attack. We noted in our article that large constellations of imaging satellites could provide near-continuous coverage of the entire Earth. Although current commercial imaging satellites collect visible light, collection can be extended into the ultraviolet and infrared, enhancing target characterization and discrimination and degrading the usefulness of decoys and camouflage. Constellations of small satellites in low-earth orbit can also collect low-power radio-frequency emissions from objects on the ground, allowing their characterization and localization. Advances in microelectronics and signal processing are facilitating the miniaturization of synthetic-aperture radar, raising the possibility of near-continuous all-weather day-night coverage, at much lower cost than was possible just ten years ago.

Countermeasures will be available, however. Green and Long note that although jamming is a compelling countermeasure, jammers can be targeted or used to cue other sensors. Jammers are, however, cheap and easily proliferated; China could readily afford to deploy hundreds of jammers for every mobile missile, and the mobile missiles could be equipped with an identical jammer, presenting the United States with tens of thousands of potential targets. And rather than trying to make decoys appear more realistic, China could make its missiles and transporters look more like decoys by covering them with materials that will present similar signatures to overhead satellites.

Even if continuous and robust tracking becomes possible, mobile missiles can be made much more survivable by deploying them in areas where they can move in any direction, and by giving them the ability to travel at high speeds and to survive the blast from a nearby explosion. The Chinese portion of the Gobi Desert covers an area larger than Texas and is mostly bare rock, with large flat areas in which a vehicle can travel dozens of kilometers in any direction. It should be possible to build a transporter erector launcher (TEL) that could travel up to 65 kilometers per hour (40 miles per hour) over such terrain. If, in the most optimistic case for damage limitation, the location of such a TEL could be determined and U.S. ballistic missiles could be retargeted instantaneously, a single TEL could be anywhere within a 3,300-square-kilometer area by the time the attacking warheads arrive thirty minutes later. For comparison, the entire U.S. ballistic missile force under the New Strategic Arms Limitation Treaty—400 intercontinental ballistic missiles and 1,090 submarine-launched ballistic missile warheads—would have an effective lethal area of 25,000 to 60,000 square kilometers

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

against TELs hardened to 5 to 10 pounds per square inch.[8] In this best-case analysis for damage limitation, the barrage attack would be able to destroy only 8 to 20 TELs. But instantaneous retargeting is not possible, and the United States would not launch its entire missile force against Chinese mobile missiles. Using more plausible assumptions leaves the United States able to destroy a still smaller number of Chinese mobile missiles.

To achieve a more effective capability against Chinese mobile missiles, the United States would require continuous tracking of TELs and retargeting of warheads while the missiles are in flight. This would require survivable and robust surveillance and satellite communications systems, together with post-boost vehicles that can receive updated target information (or, better still, warheads that receive such information and maneuver to the new target). In-flight retargeting opens up the possibility that adversaries could employ electronic countermeasures, jamming the transmission or perhaps even diverting the warhead to a harmless area or a U.S. ally. Concern about the possibility of such countermeasures has prevented the United States from equipping its intercontinental ballistic missiles and submarine-launched ballistic missiles to receive information after launch (e.g., for improved navigation or command-destruct in the event of an errant launch).

Green and Long raise the possibility that unattended ground sensors could be used to track TEL movements. Setting aside the difficulties associated with clandestine emplacement of such devices, they would work well only if TELs are constrained to road networks, and even then they could be defeated or spoofed with noisemakers. (The Viet Cong played recordings of truck traffic to spoof U.S. air-dropped acoustic detectors.)

Green and Long cast doubt on China's ability to launch from unprepared sites, because missile crews could not rely on satellite navigation for geolocation. This is not a difficult problem to solve. First, one could pre-survey thousands of potential launch sites in advance at relatively low cost. Second, one could establish terrestrial navigation systems, such as eLoran or ground-based global positioning satellite systems, to provide robust geolocation in mobile missile deployment areas. Third, one could rely on inertial navigation systems, which would be perfectly adequate for periods of a few hours, bearing in mind that high accuracy is not needed for attacks against cities.

Finally, Green and Long suggest that stealthy penetrating unmanned aerial vehicles might be used to find and destroy mobile missiles. As they note, classification makes it difficult to fully evaluate such systems, but there are reasons to believe that this would prove difficult to implement. First, stealth technology reduces the range at which aircraft can be detected by radar and other sensors, but does not render them invisible. There are countermeasures to stealth, such as the use of low-frequency active electronically scanned array radars and passive electromagnetic and infrared sensors to cue high-frequency radars. Second, surveillance requires operation at high altitude and modest speeds, to maximize area coverage and endurance, while penetration of the adversary's airspace calls for low altitudes and high speeds. One could have swarms of high- and low-fliers that communicate with each other, but communication opens up

8. This scenario assumes 400 W87 Minuteman III warheads with a yield of 300 kilotons, 384 W88 Trident II warheads with a yield of 475 kilotons, and 706 W76 warheads with a yield of 100 kilotons; 90 percent missile reliability; and hexagonal packing.

the possibility of electronic countermeasures. Third, aircraft would have flight times of many hours to launch sites deep inside China, even if launched from the territory of regional allies or ships near the coastline. The detection of even one such aircraft would give ample time for countermeasures, such as the movement of a missile into one of several shelters.

We are aware of no technological trends that make it likely that the United States will have an enduring advantage in maintaining a damage-limitation capability against China.[9] But if technological trends do provide such an advantage, China would have the option of establishing an ability to launch on warning of a U.S. attack. The small satellite revolution will make possible robust and low-cost warning systems, able to detect missile launches anywhere on Earth and provide continuous tracking information and aimpoint prediction. This would give China warning of a U.S. counterforce attack and allow China to launch its forces under attack. There would be no easy U.S. countermeasure to such a capability. Similarly, China could pre-delegate launch authority to compensate for any shortcomings in the survivability of its command and communication capabilities. Both measures would increase risks of accidental, inadvertent, and unauthorized use of nuclear weapons, but China could reasonably judge that these risks were worth running to defeat U.S. damage-limitation programs.

CONCLUSION

In closing, the letters by Kroenig and Green and Long shed light on the complexity of the technical and strategic questions raised by damage limitation, and contribute to this important debate. Nothing in their letters, however, weakens our conclusion that the United States should forgo efforts to preserve and enhance its damage-limitation capability against China: the United States' prospects for maintaining a meaningful damage-limitation capability are too low, and the political and strategic risks are too large.

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9. Our conclusion is consistent with that of Keir A. Lieber and Daryl G. Press, "The New Era of Counterforce: Technological Change and the Future of Deterrence," *International Security*, Vol. 41, No. 4 (Spring 2017), pp. 9–49, who find that "[c]ountries that have considerable resources can buck these trends and keep their forces survivable, albeit with considerable cost and effort." See also p. 10.