Emerging technologies and strategic stability in peacetime, crisis, and war

Todd S. Sechser, Neil Narang and Caitlin Talmadge

Emerging technologies such as cyber, autonomous weapons, additive manufacturing, hypersonic vehicles, and remote sensing have been discussed in recent commentary as potential threats to strategic stability. This special issue of the Journal of Strategic Studies brings together contributions from leading experts in international relations, history, and security studies to analyze the implications of new technologies for international security. The articles in this volume explore how new technologies can have conditional and even contradictory effects on different aspects of strategic stability, and raise important questions for future research.

Technology has always played a central role in international politics. The invention of tanks, jet engines, ballistic missiles, submarines, aircraft carriers, nuclear weapons, and other technologies changed the way states competed in peacetime, maneuvered during crises, and fought during wartime. Today,
significant advancements in autonomous weapons, artificial intelligence, remote sensing, cyber technology, hypersonic vehicles, additive manufacturing, stealth, precision guidance, and other areas have contributed to a widespread sense that the world is again on the precipice of a new technological era.

There is growing consensus that emerging technologies have the potential to be ‘game-changers’ in military and strategic affairs.\textsuperscript{2} As a result, many defence experts view these coming technological disruptions with deep concern. In particular, it is widely believed that the proliferation of new technologies poses a threat to the long-term foundations of US military dominance. Weaker powers, according to this view, will be able to harness new technologies to make sudden and dramatic improvements to their capabilities, ultimately challenging US military superiority. A recent Center for Strategic and International Studies report, for example, forecasts ‘the gradual erosion of significant military advantages that the United States has long enjoyed.’\textsuperscript{3}

This pessimism is broadly shared within the US defence establishment as well. During his term as Secretary of Defense, former US Senator Chuck Hagel warned that the diffusion of new technologies posed ‘a clear and growing challenge to our military power.’\textsuperscript{4} Fears about the effects of emerging technologies have driven significant changes in US defence planning, particularly the Obama administration’s so-called Third Offset Strategy, which aimed to harness advanced technologies to gain an edge over US adversaries. More recently, the Trump administration’s 2018 National Defense Strategy pointed to rapid technological change as one of the defining challenges of the future security environment.\textsuperscript{5}

Yet the history of technological revolutions counsels against alarmism. Extrapolating from current technological trends is problematic, both because technologies often do not live up to their promise, and because technologies often have countervailing or conditional effects that can temper their negative consequences. Thus, the fear that emerging technologies will necessarily cause sudden and spectacular changes to international politics should be treated with caution. There are at least two reasons to be circumspect.

First, very few technologies fundamentally reshape the dynamics of international conflict. Historically, most technological innovations have amounted to incremental advancements, and some have disappeared into

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\textsuperscript{2}For example, Brimley, et al., \textit{Game Changers}; Haffa and Dalta, \textit{Hypersonic Weapons}.

\textsuperscript{3}Ellman et al., \textit{Assessing the Third Offset Strategy}, 1.


irrelevance despite widespread hype about their promise. For example, the introduction of chemical weapons was widely expected to immediately change the nature of warfare and deterrence after the British army first used poison gas on the battlefield during World War I. Yet chemical weapons quickly turned out to be less practical, easier to counter, and less effective than conventional high-explosives in inflicting damage and disrupting enemy operations. Other technologies have become important only after advancements in other areas allowed them to reach their full potential: until armies developed tactics for effectively employing firearms, for instance, these weapons had little effect on the balance of power. And even when technologies do have significant strategic consequences, they often take decades to emerge, as the invention of airplanes and tanks illustrates. In short, it is easy to exaggerate the strategic effects of nascent technologies.

Second, even if today’s emerging technologies are poised to drive important changes in the international system, they are likely to have variegated and even contradictory effects. Technologies may be destabilising under some conditions, but stabilising in others. Furthermore, other factors are likely to mediate the effects of new technologies on the international system, including geography, the distribution of material power, military strategy, domestic and organisational politics, and social and cultural variables, to name only a few. Consequently, the strategic effects of new technologies often defy simple classification. Indeed, more than 70 years after nuclear weapons emerged as a new technology, their consequences for stability continue to be debated.

The articles in this issue

The articles in this special issue aim to evaluate the effects of emerging technologies on the strategic dynamics of the international system. The field of international relations offers an extensive toolbox for this task, with well-developed literatures on deterrence and coercion, crisis bargaining, arms races, signalling, and the escalation and termination

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6For example, see Brodie and Brodie, From Crossbow to H-Bomb, 195–96; and Dupuy, The Evolution of Weapons and Warfare, especially chapter 23.
7See Biddle, ‘The Past as Prologue’, 1–74.
10Schelling, Arms and Influence; George and Smoke, Deterrence in American Foreign Policy.
13Jervis, The Logic of Images in International Relations; Fearon, ‘Signaling Foreign Policy Interests’, 68–90; Fuhrmann and Sechser, ‘Signaling Alliance Commitments’, pp. 919–35.
of conflict. Building on these foundations, each of the articles examines one or more of these components of strategic stability, drawing on existing theories to explore how emerging technologies might reshape peacetime, crises, and war.

**Peacetime stability: Arms races, proliferation, and arms control**

An initial set of questions addresses the arms race dynamics of new weapons technologies. Will new technologies create incentives for arms racing in peacetime? Or will they quell pressures for states to closely monitor and match the capabilities of their rivals? Ben Garfinkel and Allan Dafoe address these questions in the context of the offence-defence balance, using mathematical models to explore how increasing investments in technologies such as cyber weapons or drone swarms might shift the balance between attacker and defender.

Some new weapons may be amenable to arms control, while others may prove resistant. Which new weapons technologies will be easier to contain, and which will not? Michael Horowitz’s article in this issue argues that the speed and uncertain capabilities of lethal autonomous weapons systems could lead to arms races. By contrast, as Heather Williams argues in her article, the more quantifiable and observable nature of hypersonic glide vehicles may facilitate regimes to manage and control them.

Non-weapons technologies could affect the dynamics of arms control as well. In his article titled ‘Dual-Use Distinguishability,’ Tristan Volpe considers the impact of additive manufacturing technologies on nuclear proliferation dynamics, arguing that while such technologies may lower barriers to the spread of nuclear weapons, they also enable states to more easily reveal non-military motives, thereby dampening pressures to engage in arms racing.

**Crisis stability: Deterrence, coercion, and conflict initiation**

Because military technology shapes how states fight and win wars, it is also inextricably linked to the prevention of crises and conflict. How will emerging technologies shape the overall likelihood of military conflict in the

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15The international security literature offers multiple, sometimes competing, definitions of strategic stability. Recognising that there is no consensus on the meaning of the term, the articles in this issue adopt an expansive view of strategic stability, including both conventional and nuclear weapons and covering a wide variety of phenomena along the continuum between peace and war. For useful discussions of the varied meanings of strategic stability, see Colby and Gerson, (eds.), *Strategic Stability*; and Rubin and Stulberg, (eds.), *The End of Strategic Stability*.
16On the implications for alliances, see also Mehta, ‘Assurance in an Emerging Technology Environment’.
international system? Will new technologies enable new and different types of coercion? Which types of conflict may be more or less likely to occur in the new technological era? The articles in this issue consider several ways new technologies might alter pathways to conflict.

Emerging technologies could create first-mover incentives in crises, heightening the likelihood that crises turn into wars. Horowitz argues that the ‘machine speed’ of autonomous weapons could create first-strike instability during crises, tempting opponents to attack preemptively rather than risk suffering a rapid, disarming strike.

Technology could also reshape the nature of military vulnerabilities and incentives for conflict. Jacquelyn Schneider’s article argues that technological revolutions historically are more likely to lead to war when they introduce new vulnerabilities that opponents can exploit. If emerging technologies increase militaries’ reliance on centralised networks and digital information, Schneider argues, they will increase incentives for adversaries to target those resources with preemptive strikes.21

**Wartime stability: Conduct, escalation, and termination of wars**

A final set of questions addresses the intra-war effects of new technologies. Will new technologies make wars more intense and violent, insulating states from the costs of war and encouraging escalation, or will they encourage restraint?22 Will the conduct of war itself be different?23

In this issue, Caitlin Talmadge considers whether wars might escalate inadvertently in a world of new technologies. Will emerging technologies create new pathways for unintentional escalation by creating first-mover advantages during crises? Talmadge takes a sceptical view, arguing that technology historically has been more likely to create opportunities for intentional, not inadvertent, escalation. Drawing from several cases during the Cold War, she shows that wartime escalation is more often a conscious strategic choice than an accidental consequence of technology.24

**Conclusion**

The articles in this special issue offer a variety of new and important insights about the strategic consequences of emerging technologies. While forecasting is necessarily an uncertain business, forecasting informed by theory and history can make a significant contribution to grasping the strategic

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23Gartzke, ‘Blood and Robots’.
dynamics of tomorrow’s technologies. Understanding the lessons of previous technological revolutions can help scholars and policy makers prepare for the next one. In particular, the studies in this special issue make a convincing case that the effects of emerging technologies often are not straightforward. New technologies may strengthen strategic stability in some ways, while undermining it in others.

Yet this issue leaves a variety of questions about emerging technologies unanswered. For example, it does not investigate the signalling implications of emerging technologies. Will the versatility of new military technologies make it easier for states to communicate their willingness to defend important commitments, or will their opacity complicate the task of signalling power and resolve? A related question involves extended deterrence: How can new technologies best be harnessed to bolster commitments to allies? Finally, an important actor left out of these analyses is the public: how will emerging technologies shape public opinion about military conflict and the use of force in the coming decades? Further research can help illuminate answers to these and many other critical questions.

One clear lesson arising from this special issue is that the conclusions herein are only the beginning of a long conversation. As the contours of new technologies become increasingly clear over time, the questions explored in these articles will need to be continually revisited and reassessed in light of new developments. Moreover, this issue raises at least as many questions about strategic stability as it answers. We hope that these studies will inspire further research to help illuminate the nature of the coming technological age.

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