Technologies of Violence: Law, Markets, and Innovation for Gun Safety

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Violence in the United States is distinctive in many ways, perhaps none more visceral and fundamental than the technologies with which it is practiced. American violence disproportionately involves guns, and because guns are such an effective tool of violence, confrontations involving them are disproportionately deadly. Decades of research confirm this "instrumentality effect," and it is reflected in the broad, bipartisan agreement that the nation has a gun violence problem. The deep disagreement, of course, remains about how to address it, with most of the debate focused on regulating who can carry which guns, where, and how.

But fully understanding, let alone addressing, the problem of violence requires accounting for not only regulation but the economic and legal forces shaping the instruments that inflict and resist it—what we call the technologies of violence. Just as violence itself can be permissible and even desirable (as in cases of justified self-defense) or not (as in cases of criminal misuse), innovations in violence technology can simultaneously improve and threaten public safety. As the most prominent form of that technology, guns illustrate the point particularly clearly. Historically, innovation has made guns more lethal—a change whose overall impact on public safety is contested—but it also has the potential to make them safer, for example through better reliability, safety switches, smart gun technology, microstamping, and other technological enhancements.

In this Article, we identify and evaluate the complex and intertwined roles of markets and law in driving—and in some cases deterring—gun safety innovation. For a variety of reasons, legal efforts to incentivize certain safety

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innovations have failed, even as markets have taken off for innovations designed to cope with gun violence, such as gun detection cameras and bulletproof backpacks. At the same time, statutory and constitutional law stifle and in some cases forbid safety innovations, for example by broadly immunizing gun manufacturers from regulatory and tort liability and through Second Amendment doctrines that protect increasingly powerful weapons while limiting government's ability to enact new rules regulating them.

We hope that bringing together previously separate scholarly discourses on innovation and public law can help generate new insights into their complex interactions, as well as possible solutions to the problem of American gun violence. We conclude with some possibilities for reform that could facilitate the role of markets and innovation in providing public safety.

Introduction

Guns play a variety of roles in American life—as tools of crime and self-defense, political symbols, markers of individual identity, instruments of recreation, and more. But at the most basic level, guns are a technology designed to inflict violence, whether for good (as in justified self-defense) or for ill (as in criminal or negligent misuse). And because guns are so effective in that task, their prevalence helps account for the disproportionate

deadliness of violence in the United States.[1] In 2021, nearly 50,000 Americans died of gun shots—the highest number ever recorded by the CDC.[2] Those harms are not randomly distributed—men and people of color are especially likely to die[3]—and they come in different forms with different causes, including homicides,[4] impulsive suicides,[5] officer-involved killings,[6] school shootings,[7] and shootings by and of children (for whom gunshots are now the single leading cause of death).[8]

Americans disagree deeply about how best to address these problems, but there is broad and bipartisan agreement that the United States has a gun

1. To take just one measure: American rates of assault and violent crime are roughly similar to those in otherwise-comparable countries, but we are a stark outlier when it comes to homicides, most of which are committed with guns. FRANKLIN E. ZIMRING & GORDON HAWKINS, CRIME IS NOT THE PROBLEM: LETHAL VIOLENCE IN AMERICA 8, 37, 118 (1999); *see also* Zack Beauchamp, *America Doesn't Have More Crime than Other Rich Countries. It Just Has More Guns*, VOX (Feb. 15, 2018, 7:55 AM), https://www.vox.com/2015/8/27/9217163/america-guns-europe-homicide-rates-murder-crime [https://perma.cc/3WLN-VN5X] (collecting sources).

2. John Gramlich, *What the Data Says About Gun Deaths in the U.S.*, PEW RSCH. CTR. (Apr. 26, 2023), https://www.pewresearch.org/short-reads/2023/04/26/what-the-data-says-about-gun-deaths-in-the-u-s/ [https://perma.cc/6XAL-RKYZ] (noting that CDC data also showed 26,328 gun suicides and 20,958 gun homicides, while the remainder of gun deaths were accidental (549), involved law enforcement (537), or had undetermined circumstances (458)).

3. Lindsay J. Young & Henry Xiang, *US Racial and Sex-Based Disparities in Firearm-Related Death Trends from 1981–2020*, PLOS ONE, Dec. 14, 2022, at 3–4.

4. Sherry L. Murphy, Kenneth D. Kochanek, Jiaquan Xu & Elizabeth Arias, *Deaths: Final Data for 2021*, 73 NAT'L VITAL STAT. REP. 1, 84 (2024) (indicating that in 2021, 20,958 out of 26,031 homicides in the United States were committed with guns).

5. In the United States, handguns are the most common means of suicide, and researchers have emphasized the connection between impulsivity and guns. *See, e.g.*, E. Michael Lewiecki & Sara A. Miller, *Suicide, Guns, and Public Policy*, 103 AM. J. PUB. HEALTH 27, 27–28 (2013) (explaining how firearm restrictions could decrease suicide rates, as many suicides are impulsive); *see also* Duration of Suicidal Crises, HARV. SCH. PUB. HEALTH, https://www.hsph.harvard.edu/means-matter/means-matter/duration/#Simon [https://perma.cc/J66N-HZZ7] (reporting interviews with 153 young people who had survived a near-lethal suicide attempt; 24 percent said less than 5 minutes passed between when they decided to take their lives and when they made the attempt; 48 percent said less than 20 minutes; 71 percent said less than one hour; and 87 percent said less than eight hours).

6. *Police Shootings Database*, WASH. POST (Nov. 13, 2023), https://web.archive.org/web/20231128061835/https://www.washingtonpost.com/graphics/investigations/police-shootings-database/ [https://perma.cc/DH8D-AKJS] (reporting 1011 people shot and killed by police in the past twelve months).

7. *School Shootings Database*, WASH. POST (Oct. 6, 2023), https://web.archive.org/web/20231129071616/https://www.washingtonpost.com/education/interactive/school-shootings-database/ [https://perma.cc/BL7M-CEDY] (reporting 389 school shootings since the 1999 shooting at Columbine, and that more than 357,000 students have experienced gun violence at school in that time).

8. Bailey K. Roberts, Colleen P. Nofi, Emma Cornell, Sandeep Kapoor, Laura Harrison & Chethan Sathya, *Trends and Disparities in Firearm Deaths Among Children*, PEDIATRICS, Sept. 2023, at 2.

violence problem.[9] The growing scholarly literature on firearms has made important progress in excavating the complicated mix of legal,[10] political,[11] sociological,[12] racial,[13] and historical[14] factors that shape American gun violence and the "Great American Gun Debate."[15] Largely missing from these discussions, so far, is a focus on what shapes the instruments with which gun violence is inflicted, resisted, and controlled—what we call *the technologies of violence*.

Technologies of violence are, like all technologies, the result of applying scientific knowledge to a practical goal:[16] specifically the infliction,

9. In a 2021 Pew poll, only 6% of Americans said gun violence was *not* a problem. And 48% said gun violence was a "very big problem"—a higher percentage than said the same about the coronavirus outbreak (47%), and lower only than the affordability of health care (54%) and the federal budget deficit (49%). Katherine Schaeffer, *Key Facts about Americans and Guns*, PEW RSCH. CTR. (Sept. 13, 2021), https://web.archive.org/web/20211111144204/https://www.pewresearch.org/fact-tank/2021/09/13/key-facts-about-americans-and-guns/ [https://perma.cc/BBX5-DFLG]. In June 2024, the Surgeon General declared gun violence to be a public health crisis, invoking earlier public safety campaigns regarding smoking and traffic deaths. Ellen Barry, *Surgeon General Declares Gun Violence a Public Health Crisis*, N.Y. TIMES (June 25, 2024), https://www.nytimes.com/2024/06/25/health/gun-violence-surgeon-general.html [https://perma.cc/XL4J-7WCR].

10. As we discuss below, the law of the Second Amendment is currently in flux. *See infra* subparts III(B)–(C). For an overview of the Amendment's history and modern transformation, see generally JOSEPH BLOCHER & DARRELL A.H. MILLER, THE POSITIVE SECOND AMENDMENT: RIGHTS, REGULATION, AND THE FUTURE OF *HELLER* (2018).

11. *See, e.g.*, PATRICK J. CHARLES, VOTE GUN: HOW GUN RIGHTS BECAME POLITICIZED IN THE UNITED STATES 3, 34–35, 79–81 (2023) (tracking the rise of gun discourse and gun lobbies in American politics up until the 1980s); KRISTIN A. GOSS, DISARMED: THE MISSING MOVEMENT FOR GUN CONTROL IN AMERICA 11, 13–16 (2008) (describing the lack of a movement for gun control in the United States); MATTHEW J. LACOMBE, FIREPOWER: HOW THE NRA TURNED GUN OWNERS INTO A POLITICAL FORCE 34–35, 115, 123 (2021) (explaining the political rise of the NRA and its alignment with the GOP).

12. *See, e.g.*, JENNIFER DAWN CARLSON, CITIZEN PROTECTORS: THE EVERYDAY POLITICS OF GUNS IN AN AGE OF DECLINE 9–10 (2015) (exploring motivations for gun ownership through the lens of "social precariousness"); F. Carson Mencken & Paul Froese, *Gun Culture in Action*, 66 SOC. PROBS. 3, 5–6 (2019) (describing gun ownership as a response to economic conditions); David Yamane, *The Sociology of U.S. Gun Culture*, SOCIO. COMPASS, July 2017, at 5 (observing the development of a new gun culture centered around armed self-defense).

13. *See generally, e.g.*, CAROL ANDERSON, THE SECOND: RACE AND GUNS IN A FATALLY UNEQUAL AMERICA (2021) (arguing that both gun rights and gun regulation have operated to the disadvantage of Black Americans).

14. The literature is vast. For a recent collection of essays that respond in part to the Supreme Court's decision in *New York State Rifle and Pistol Association v. Bruen*, 142 S. Ct. 2111 (2022), see generally NEW HISTORIES OF GUN RIGHTS AND REGULATION (Joseph Blocher, Jacob D. Charles & Darrell A.H. Miller eds., 2023).

15. DON B. KATES & GARY KLECK, THE GREAT AMERICAN GUN DEBATE (1997).

16. JOHN KENNETH GALBRAITH, THE NEW INDUSTRIAL STATE 12 (2d ed. rev. 1971) ("Technology means the systematic application of scientific or other organized knowledge to practical tasks."); *see also* Alan L. Durham, *"Useful Arts" in the Information Age*, 1999 BYU L. REV. 1419, 1444–53 (discussing this and other definitions).

prevention, and control of violence.[17] Weaponry is the most obvious form, and in the United States that especially means guns. Ours is a violent society, but broadly speaking it is not more violent than other Western countries.[18] What differentiates American violence is not violence's pervasiveness but its severity—in any given violent encounter, Americans are much more likely to be killed or seriously injured, due to the prevalence of guns in those encounters.[19] Scholars refer to this as the instrumentality effect,[20] and have shown that, for example, gun robberies are three times more likely to result in death than knife robberies,[21] and ".38 caliber attacks are more than twice as deadly as .22 caliber attacks."[22] One cannot understand or address this violence without accounting for the technology that intensifies it, and accordingly much of our analysis here will focus on firearms.

But we do not argue that guns' power to inflict violence is always legally or even socially undesirable. That very power is also a means of *preventing* violence through self-defense, which is the primary reason for gun ownership in the United States today.[23] From that perspective, guns and bulletproof vests have the same purpose: They are technologies for *controlling* violence. It follows that violence technologies also encompass innovations designed to resist or mitigate the harms that weapons can inflict, such as bulletproof vests, metal detectors, and even bulletproof school desks.

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17. We focus here on the archetypal form of violence as forcible physical harm, though the analysis could theoretically apply to other forms of violence as well. For philosophical discussions about the definition of "violence," see generally HANNAH ARENDT, ON VIOLENCE (1970); C.A.J. Coady, *The Idea of Violence*, 3 J. APPLIED PHIL. 3 (1986) and Robert Paul Wolff, *On Violence*, 66 J. PHILO. 601 (1969). For legal discussions, see generally DAVID A. SKLANSKY, A PATTERN OF VIOLENCE: HOW THE LAW CLASSIFIES CRIMES AND WHAT IT MEANS FOR JUSTICE (2021); Cecelia Klingele, *Labeling Violence*, 103 MARQ. L. REV. 847 (2020); and Alice Ristroph, *The Constitution of Police Violence*, 64 UCLA L. REV. 1182 (2017).

18. Michael Tonry, *Why Americans Are a People of Exceptional Violence*, 52 CRIME & JUST. 233, 239 (2023).

19. *Id.* at 241, 258.

20. For classic studies, see generally Philip J. Cook, *Robbery Violence*, 78 J. CRIM. L. & CRIMINOLOGY 357 (1987) [hereinafter Cook, *Robbery Violence*]; Franklin E. Zimring, *The Medium Is the Message: Firearm Caliber as a Determinant of Death from Assault*, 1 J. L. STUDS. 97 (1972) [hereinafter *The Medium Is the Message*]; and Frank Zimring, *Is Gun Control Likely to Reduce Violent Killings?*, 35 U. CHI. L. REV. 721 (1968). *See also* Philip J. Cook, *The Great American Gun War: Notes from Four Decades in the Trenches*, 42 CRIME & JUST. 19, 34 (2013) ("[T]he widespread adoption of gun [sentencing] enhancements by state legislatures is a clear indication of the commonsense appeal of the instrumentality effect.").

21. Cook, *Robbery Violence*, *supra* note 20, at 374.

22. Zimring, *The Medium Is the Message*, *supra* note 20, at 105.

23. *For Most U.S. Gun Owners, Protection Is the Main Reason They Own a Gun*, PEW RSCH. CTR. (Aug. 16, 2023), https://www.pewresearch.org/politics/2023/08/16/for-most-u-s-gun-owners-protection-is-the-main-reason-they-own-a-gun/ [https://perma.cc/9UXT-L3FZ]. This is a relatively recent development. *Why Own a Gun? Protection Is Now Top Reason*, PEW RSCH. CTR. (Mar. 12, 2013), http://www.people-press.org/2013/03/12/why-own-a-gun-protection-is-now-top-reason/ [https://perma.cc/7CTY-EXJW] ("In 1999, 49% said they owned a gun mostly for hunting, while just 26% cited protection as the biggest factor.").

There are, of course, many other ways in which violence might be controlled—law and norms, for example, which themselves might be innovative—but we restrict our focus here to tangible instruments.

Our argument is that the distribution and availability of violence technologies in the United States is driven by a distinctive set of market and legal forces, and that these forces affect the pace and direction of innovation, sometimes helpfully but just as often harmfully.[24] Markets for violence technologies are meaningfully different than markets for other sorts of technologies like smart phones or automobiles. Any consideration of the problem of gun violence and its potential solutions must therefore account for how those instruments are designed and why. This is a story of industry incentives and technological innovation driven by demand and supply[25] but also by various legal doctrines, including intellectual property, torts, administrative, and constitutional law.

Centering the importance of technology and innovation in the gun debate opens up new ways of thinking not only about potential solutions but also more broadly about the respective roles of law and markets in providing public safety. The gun debate has generally focused on governmental efforts to restrict gun ownership, which raises familiar and difficult questions regarding the effectiveness,[26] political plausibility,[27] and constitutionality[28] of gun regulation. Could markets and law instead harness private demand in ways that would spur safety-enhancing innovation for guns,[29] including the prospect of innovative "upstream" solutions that do not rely on the machinery of the criminal law and carceralization?[30]

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24. Such stories are not limited to guns. Christopher Buccafusco & Samuel Weinstein, *Antisocial Innovation*, 58 GA. L. REV. 573, 581–83 (2024).

25. For recent accounts of the gun industry, see generally RYAN BUSSE, GUNFIGHT: MY BATTLE AGAINST THE INDUSTRY THAT RADICALIZED AMERICA (2021) (detailing the author's experience in the firearms industry) and JENNIFER CARLSON, MERCHANTS OF THE RIGHT: GUN SELLERS AND THE CRISIS OF AMERICAN DEMOCRACY (2023) (explaining the relationship between gun economics and gun policy).

26. The literature is voluminous and contested. For a useful review of existing research, see *Gun Policy Research Review*, RAND CORP.: GUN POL'Y IN AM., https://www.rand.org/research/gun-policy/analysis.html [https://perma.cc/48LY-KD94].

27. *See supra* note 11 and sources cited therein.

28. *See supra* note 10 and sources cited therein.

29. We are not the first to address issues like smart gun technology and tort liability. For others considering those issues, see Cody J. Jacobs, *The Second Amendment and Private Law*, 90 S. CAL. L. REV. 945, 986–89 (2017); Lars Noah, *Must Courts Recalibrate Tort Law Governing Firearms in Light of the Second Amendment?*, 92 U. CIN. L. REV. 412, 418–26 (2023); and Dru Stevenson, *Smart Guns, the Law, and the Second Amendment*, 124 PENN ST. L. REV. 691, 693 (2020). Our goal here is to provide a broader conceptual account that emphasizes the connected roles of law and markets, not the benefits of any particular technology.

30. *See, e.g.*, Brief of the Black Attorneys of Legal Aid et al. as Amici Curiae Supporting Petitioners at 5, N.Y. State Rifle & Pistol Ass'n v. Bruen, 142 S. Ct. 2111 (2022) (No. 20-843) (describing the harms of overcarceralization caused by gun laws).

There can be no doubt that the gun industry has historically been capable of great innovation. Perhaps the most obvious and consistent theme in firearm-related innovation has been ever-increasing lethality,[31] from the cannons that accompanied Columbus and other early European explorers,[32] to the arquebuses that arrived with the Puritans on the Mayflower in 1620 (one of which was used ten years later by America's first convicted murderer),[33] to the blackpowder muskets of the Revolutionary War,[34] to Samuel Colt's revolvers,[35] to the Winchester Model 73 ("The Gun that Won the West"),[36] to the Tommy Gun (designed as a "trench broom" in WWI and repurposed by gangsters),[37] to the AR-15 (pioneered by a tinkering engineer, eventually marketed to the military, and now the best-selling rifle on the market).[38]

Whether these innovations promote or threaten public safety is deeply contested, in part because the very features that make guns undesirably deadly in the wrong hands also make them attractive to those who want them for self-defense.[39] Hence the challenging symmetry of the gun debate and the centrality of the technology in understanding it: Guns' effectiveness as instruments of violence is why both criminals and self-defenders want them. Therefore, many changes in gun technology, from high-capacity magazines

31. Darrell A.H. Miller & Jennifer Tucker, *Common Use, Lineage, and Lethality*, 55 U.C. DAVIS L. REV. 2495, 2507–08 (2022); *see also* Brian DeLay, *The Myth of Continuity in American Gun Culture*, 113 CALIF. L. REV. (forthcoming 2025) (manuscript at 135–36) (emphasizing enormous differences in gun technology and culture between the Founding Era and today).

32. Linton Weeks, *The First Gun in America*, NPR (Apr. 6, 2023, 12:56 PM), https://www.npr.org/2013/04/06/176132730/the-first-gun-in-america [https://perma.cc/LB9T-BG8E].

33. Phil Klay, *How Did Guns Get So Powerful?*, NEW YORKER (June 11, 2022), https://www.newyorker.com/tech/annals-of-technology/how-did-guns-get-so-powerful [https://perma.cc/B4TW-QW4X]; *Firearms in Plymouth Colony*, PLYMOUTH ARCHAEOLOGICAL REDISCOVERY PROJECT, https://plymoutharch.tripod.com/id71.html [https://perma.cc/ZS9M-F6HR].

34. DeLay, *supra* note 31, at 201 (describing 18th-century muskets and noting "[f]irearms were the most technologically complex objects the majority of people ever encountered in the eighteenth century").

35. HERBERT G. HOUZE, SAMUEL COLT: ARMS, ART, AND INVENTION 20, 73 (2006).

36. *Winchester Rifle: A Resource Guide*, LIBR. OF CONG., https://guides.loc.gov/winchester-rifle [https://perma.cc/SU7S-X6HW].

37. Matt Fratus, *Gangsters, G-Men, and Green Berets: A Look at the Tommy Gun*, COFFEE OR DIE (Mar. 10, 2023), https://coffeeordie.com/tommy-gun#:~:text=The%20Thompson%20submachine%20gun%2C%20or,and%20notoriety%20grew%20from%20there [https://perma.cc/654Y-BBMB].

38. *See* CAMERON MCWHIRTER & ZUSHA ELINSON, AMERICAN GUN: THE TRUE STORY OF THE AR-15 36–37, 228–29 (2023) (discussing the initial development of the AR-15 and its subsequent rise in popularity).

39. *For Most U.S. Gun Owners, Protection Is the Main Reason They Own a Gun*, *supra* note 23.

to bump stocks, heighten the stakes on all sides. The result is a literal arms race.[40]

But other changes to violence technology seem to have a more unambiguously positive role in making guns safer while preserving their functionality, for example by decreasing the likelihood of accidental or criminal misuse. Safety switches were first created in the 1880s and are now ubiquitous.[41] Recent technological advances have enhanced safe storage devices (which federal law requires licensed dealers to provide with all handgun sales[42] and which some states require to be used in certain contexts[43]) and led to the creation of "smart" guns that, like modern phones, can only be operated by authorized users.[44] Perhaps they will eventually be as effective and widespread as safety switches.

The shared desire to limit gun violence has also given rise to a massive market for what we call *environmental* innovations[45]—those designed to address or respond to gun violence not by making the guns themselves safer,[46] but at a broader social level. These are innovations that attempt to minimize the effects of gun violence by changing the physical environment in which it occurs. For example, school security, which is largely focused on preventing school shootings, is now a $2.7 billion market, not including the

40. Guha Krishnamurthi & Peter N. Salib, *Small Arms Races*, U. CHI. L. REV. ONLINE, June 2022, at 1–2, 8.

41. James Forrester, *History of Gun Safety*, TENN. FIREARM SAFETY ALL., https://www.tnfirearmsafety.org/history-of-gun-safety [https://perma.cc/CM8Y-MKLS]; *see also* Stephen P. Teret, Susan Defrancesco, Stephen W. Hargarten & Krista D. Robinson, *Making Guns Safer*, ISSUES IN SCI. AND TECH., Summer 1998, at 37, 38 (noting that the safety was invented in the 1880s).

42. 18 U.S.C. § 922(z)(1) (providing, with some limited exceptions, that "it shall be unlawful for any licensed importer, licensed manufacturer, or licensed dealer to sell, deliver, or transfer any handgun to any person other than any person licensed under this chapter, unless the transferee is provided with a secure gun storage or safety device . . . for that handgun").

43. Everytown Research and Policy, *Which States Have Child-Access and/or Secure Storage Laws?*, EVERYTOWN FOR GUN SAFETY (Jan. 4, 2024), https://everytownresearch.org/rankings/law/secure-storage-or-child-access-prevention-required/ [https://perma.cc/D4BN-9NUM] (counting 26 states).

44. As President Barack Obama put it in a 2017 *Harvard Law Review* article, "As long as we've got technology to prevent a criminal from stealing and using your smartphone, then we should be able to prevent the wrong person—including kids—from pulling the trigger on a gun." Barack Obama, *The President's Role in Advancing Criminal Justice Reform*, 130 HARV. L. REV. 811, 857–58 (2017).

45. *See* Christopher Buccafusco, *Disability and Design*, 95 N.Y.U. L. REV. 952, 958 (2020) (explaining the difference between individual-level innovations and environmental-level innovations in the disability context).

46. *See, e.g.*, Sarah Holder & Fola Akinnibi, *Gunshot Detection Technology Spurs Debate Over Policing and Surveillance*, CITYLAB (Oct. 27, 2022, 12:37 PM), https://www.bloomberg.com/news/articles/2022-10-27/cities-weigh-value-of-ai-powered-gunshot-detection-tech [https://perma.cc/8CKA-ZW2Z] ("Overall, the market for gunshot detection in the US reached $650 million in 2020 and is expected to be worth more than $1 billion by 2026.").

billions more spent on armed guards.[47] It includes technological innovations like bulletproof backpacks,[48] $4,000 bullet-resistant doors developed by companies with expertise in bomb-resistant vehicles,[49] and security firms adapting principles of prison design for school buildings so as to make them harder targets for would-be shooters.[50]

Importantly, none of these innovations just happen to exist. Contrary to the views of some participants, there is no pure "market" that decides which technologies succeed and which fail. As we will show, all the violence technologies that society gets (and does not get) are at least partially the product of decisions by legislators, courts, and policymakers about what to promote and what to deter. The basic project of this Article is to identify and evaluate the forces affecting the pace and direction of innovation in violence technology, with a particular focus on guns and technological responses to them.[51] By bringing together scholarship on innovation and public law, we unearth hard questions and important lessons about the relationship between markets, law, and public safety more broadly.

To some extent, the issues raised by firearm safety are similar to situations that society has faced in the past. They are not wholly different from the challenges of encouraging safer automobiles, pharmaceuticals, and tobacco products. Yet guns are also different. One reason is, of course, the Second Amendment. Perhaps relatedly, Americans' feelings about guns may run deeper than their feelings about cars and drugs. Guns may be a more politically divisive issue than these other technologies, though recent disputes about vaccines and even gas stoves suggest that the polarization of the gun debate is not unique. In any event, the strength of the analogies we draw from other technologies and the validity of the lessons our story generates for other fields of course depend on whether and how guns are relevantly similar.

The Article proceeds in three parts. Part I describes the conditions in which markets can be expected to deliver safety-enhancing innovation, even

47. John Woodrow Cox & Steven Rich, *Armored School Doors, Bulletproof Whiteboards and Secret Snipers*, WASH. POST (Nov. 13, 2018), https://www.washingtonpost.com/graphics/2018/local/school-shootings-and-campus-safety-industry/ [https://perma.cc/Z53A-XYK9].

48. David Yaffe-Bellany, *Bulletproof Backpacks in Demand for Back-to-School Shopping*, N.Y. TIMES (Aug. 6, 2019), https://www.nytimes.com/2019/08/06/business/bulletproof-backpack.html [https://perma.cc/8BM4-DYQK].

49. Paul Bowers, *Bullet-Resistant Doors Coming Soon to Three Charleston County Schools*, POST & COURIER (Sept. 14, 2020), https://www.postandcourier.com/news/bullet-resistant-doors-coming-soon-to-three-charleston-county-schools/article_051ade5e-7a49-11e8-8579-ff174799a51e.html [https://perma.cc/VS5L-H523].

50. Henry Grabar, *The Mad Rush to Bulletproof American Schools*, SLATE (Aug. 27, 2019, 5:54 PM), https://slate.com/business/2019/08/school-shootings-design-architecture-sandy-hook-columbine.html [https://perma.cc/B3NC-ARNN].

51. We focus on the civilian market, though the public demand for military weapons has historically been a major driver of innovation in the private market.

for products that are inherently dangerous. Some of those conditions are present for guns, which suggests that markets should be able to generate safety-promoting innovations while preserving guns' basic functionality. But in other ways, violence technology confounds the basic logic of safety-enhancing innovation both because of standard market failure characteristics like externalities and irrationality and because of fundamental disagreement about whether and how the capacity for violence enhances safety.

Part II explores the market for gun safety innovation, including various ways in which it appears to be succeeding and failing. We start by briefly recounting the gun industry's astonishing and successful history of innovation—primarily but not exclusively in the direction of ever-increasing lethality and, more recently, in regulation-avoiding technologies like "ghost guns."[52] We contrast that innovation with the story of "smart guns," for which there seems to be demand[53] and potential supply,[54] but no meaningful market.[55] This apparent failure arises at least in part from certain curious features of this market. We also show how one prominent effort to incentivize gun safety innovation—a smart gun requirement in New Jersey—generated such backlash that it likely hindered smart gun adoption rather than promoting it. At the same time, markets have delivered astonishing development in environmental innovations like those designed to harden schools against school shootings—a multibillion dollar market almost as big as that for guns themselves.

Part III shows that innovation is a function of public law as well as market forces. We highlight two ways in which law has shaped (generally by stunting) incentives to innovate gun safety. First, statutory immunities against tort liability and consumer product safety regulation insulate guns from the kinds of incentives that have driven safety innovation in other

52. Ghost guns are unserialized and untraceable guns that can be acquired without a background check—most commonly those made from kits. As this Article was being finalized, the Supreme Court confirmed that such kits can be subject to regulation as firearms. Bondi v. VanDerStok, No. 23-852, 2025 WL 906503, at *1 (U.S. Mar. 26, 2025). *See generally* Brandon Waldon, Cleo Condoravdi, James Pustejovsky, Nathan Schneider & Kevin Tobia, *Reading Law with Linguistics: The Statutory Interpretation of Artifact Nouns*, 62 HARV. J. LEG. (forthcoming 2025) (manuscript at 11, 22, 26–27) (arguing, based on linguistic theory, language usage, and a survey study, that gun parts kits fit within the statutory meaning of "firearm").

53. *See infra* notes 167–173 and accompanying text.

54. *See infra* notes 190–193 and accompanying text.

55. Stevenson, *supra* note 29, at 695 ("The promise these devices have for reducing firearm injuries and fatalities makes their deficiencies and unmarketability all the more frustrating."); Chris Kaczor, *Guide to Smart Gun Safety Technologies: Legislation, Innovation & More*, CAMCODE (Sept. 30, 2024), https://www.camcode.com/blog/guide-to-smart-gun-safety-technologies-legislation-innovation-more/ [https://perma.cc/32JQ-AL37] ("Smart gun technology has been on the public's radar for more than two decades, but, due to a long list of political, financial, and technical factors, its evolution has gone slower than once projected.").

industries like automobiles[56] and toxins.[57] Second, the Second Amendment—and in particular, the Supreme Court's heavily historical approach to its application—can be read to place limits on laws mandating potential safety-promoting technologies like microstamping, serial numbers, and safe storage. At the same time, some courts have been quick to extend constitutional protection to new and more-powerful forms of "Arms," thus providing an asymmetric incentive to innovate new firearms while denying new means to regulate them.

Our story is largely one of frustration and failure, but we hope that there are some positive lessons to be gleaned from it. The Conclusion offers a variety of policy levers that are still available to address some aspects of gun violence. There are important roles for policymakers and innovators to play in the future development of violence technologies.

I. Innovating for Safety

Virtually everyone believes that innovation is essential to human progress, but markets, left to their own devices, are liable to underproduce it.[58] Accordingly, policymakers have developed an array of tools to ensure that society gets as much desirable innovation as possible.[59] Here, we explore the role of markets in providing innovation, as well as the policy tools available to encourage it, such as providing innovation incentives to suppliers of new technologies, boosting consumer demand for them, and using regulation and tort liability as incentives. We conclude by noting some ways in which violence technologies like guns can confound the usual incentives and tools for safety-promoting innovation—a theme that Parts II and III explore and illustrate in more detail.

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56. *See, e.g.*, JERRY MASHAW & DAVID L. HARFST, THE STRUGGLE FOR AUTO SAFETY 10–14 (1990) (reviewing the National Highway and Traffic Safety Administration's regulatory behavior and its effect on automotive safety); John F. Saylor, *The Road to Transportation Justice: Reframing Auto Safety in the SUV Age*, 170 U. PA. L. REV. 487, 498, 503 (2022) (detailing the expansion of regulatory toolkit for addressing automotive safety); Gregory H. Shill, *Should Law Subsidize Driving?*, 95 N.Y.U. L. REV. 498, 563, 573 (2020) (canvassing various considerations informing vehicle safety regulation and the structural subsidies provided by tort law).

57. *See, e.g.*, PETER H. SCHUCK, AGENT ORANGE ON TRIAL: MASS TOXIC DISASTERS IN THE COURTS 286–93 (1986) (describing the deterrence effect of the Agent Orange tort litigation); Carrie Menkel-Meadow, *Ethics and the Settlements of Mass Torts: When the Rules Meet the Road*, 80 CORNELL L. REV. 1159, 1174–77 (1995) (exploring how claimants, legislatures, and administrative agencies shape chemical mass tort litigation); Robert L. Rabin, *Tort System on Trial: The Burden of Mass Toxics Litigation*, 98 YALE L.J. 813, 819 (1989) (explaining how "compensation and deterrence are two sides of the same coin" with respect to toxins).

58. Buccafusco & Weinstein, *supra* note 24, at 612–13.

59. *See generally* SUZANNE SCOTCHMER, INNOVATION AND INCENTIVES (2006) (detailing various policy and legal tools used to promote innovation).

A. The Basic Economic Model of Safety Innovation

People want the products they use to be as safe as possible in light of their functions. This gives firms an incentive to innovate products that are safer, satisfying consumer demand and increasing market share. Soda bottles used to explode at surprisingly high rates, and then manufacturers began to make them stronger.[60] Cars that were once "unsafe at any speed"[61] were made safer through seat belts and other technological innovations, and motor vehicle-linked deaths have plummeted.[62]

Consider table saws. In order to work properly, saws must be sharp. This makes them dangerous, and many people are injured annually through table saw use. If people could use safer table saws, they would be better off. Recognizing the issue, Steve Gass, a patent attorney and amateur woodworker, conceived the idea of running an electrical signal through the saw blade which is interrupted when the blade comes into contact with a human finger.[63] Gass patented the technology, and his company, SawStop, successfully markets injury-reducing products.[64] People who want safer saws can now purchase them, albeit at higher prices than less safe, unpatented saws.

This is the simple story of product safety innovation. Consumers desire safer products, and innovators create new solutions to make them so. The market helps coordinate consumers' preferences with innovators' activities, and law facilitates that coordination, for example through intellectual

60. An exploding Coke bottle is the centerpiece of the well-known torts case, *Escola v. Coca Cola Bottling Co. of Fresno*, 150 P. 2d 436, 459 (Cal. 1944). *See also The Explosive Problem of Defective Pop Bottles*, CBC ARCHIVES (May 23, 2023), https://www.cbc.ca/archives/the-explosive-problem-of-defective-pop-bottles-1.5127714 [https://perma.cc/U78Y-5KZX] (concluding that "the bottle was in some manner defective at the time defendant relinquished control, because sound and properly prepared bottles of carbonated liquids do not ordinarily explode when carefully handled").

61. *See generally* RALPH NADER, UNSAFE AT ANY SPEED: THE DESIGNED-IN DANGERS OF THE AMERICAN AUTOMOBILE (1965) (discussing the unsafe design of automobiles). Many of Nader's specific claims have been contested, but by virtually any measure, cars *have* become safer in the sixty years since he wrote his book.

62. *Car Crash Deaths and Rates*, NAT'L SAFETY COUNCIL, https://injuryfacts.nsc.org/motor-vehicle/historical-fatality-trends/deaths-and-rates/ [https://perma.cc/F6GC-359R] (showing steady decline in motor vehicle deaths per mile driven and noting that "[b]y all measures, motor-vehicle safety has vastly improved since the early 1900s. Driver attitudes and behaviors have changed substantially, as has vehicle safety technology, which makes car travel safer").

63. Robert Ferris, *Man Sticks Finger into Table Saw to Test Incredible Safety Invention*, BUS. INSIDER (May 14, 2013), https://www.businessinsider.com/steve-gass-sawstop-demonstration-2013-5 [https://perma.cc/VLG2-M4VM].

64. Nick Fountain & Chris Arnold, *'Planet Money': What Does It Take to Make Table Saws Safer?*, NPR (Oct. 11, 2024, 3:50 AM), https://www.wrur.org/2024-10-11/planet-money-what-does-it-take-to-make-table-saws-safer [https://perma.cc/76GP-XLHC].

property rights allowing innovative firms to recoup their investments via exclusive rights.[65]

Often, though, markets do not work perfectly. This can happen when consumer preferences aren't good proxies for social welfare. In the table saw example, consumers want safer saws and are willing to purchase them, even at higher prices. Their welfare is improved by having access to safer table saws. But sometimes consumers have imperfect information about their own welfare. They might be deceived into thinking that a particular drug or medical practice is good for them, for example, in which case even the staunchest defenders of market logic tend to accept the desirability of legal intervention.[66]

In many environments, people have mistaken views about product safety simply because they have no experience with the ways in which products could be made safer.[67] Consider rearview cameras on cars and trucks.[68] Rearview cameras make vehicles safer by enabling drivers to more easily see the people, pets, or other objects that are behind the vehicle.[69] But how much safer are they? According to research by the National Highway and Traffic Safety Administration (NHTSA), people who did not have previous experience with rearview cameras dramatically undervalued them compared to people who had used them.[70] Because people's own preferences for rearview cameras might have been insufficient to make them widely available, NHTSA chose to mandate them on new cars and trucks.[71]

Innovations are, by definition, new. Predicting their value is difficult. Before people use a new piece of technology, they often struggle to anticipate

65. Katherine J. Strandburg, *What Does the Public Get? Experimental Use and the Patent Bargain*, 2004 WIS. L. REV. 81, 90–91 (2004).

66. *Compare* W. Kip Viscusi, *Regulating the Regulators*, 63 U. CHI. L. REV. 1423, 1423 (1996) (discussing how government regulation can overstep bounds), *with* W. Kip Viscusi, *Constructive Cigarette Regulation*, 47 DUKE L.J. 1095, 1128 (1998) [hereinafter Viscusi, *Constructive Cigarette Regulation*] (arguing that the FDA should take "a constructive role in fostering technological innovations to promote cigarette safety").

67. Barker v. Lull Eng'g Co., 573 P. 2d 443, 454 (1978) ("[T]he expectations of the ordinary consumer cannot be viewed as the exclusive yardstick for evaluating design defectiveness because '[i]n many situations . . . the consumer would not know what to expect, because he would have no idea how safe the product could be made.'" (quoting John W. Wade, *On the Nature of Strict Tort Liability for Products*, 44 MISS. L.J. 825, 829 (1973))).

68. *See generally* Cass R. Sunstein, *Rear Visibility and Some Unresolved Problems for Economic Analysis (with Notes on Experience Goods)*, 10 J. BENEFIT COST ANALYSIS 317 (2019) (discussing the NHTSA's rear visibility standard).

69. *Id.* at 318.

70. *Id.* at 320 (describing a 2019 survey finding that individuals who least valued rearview cameras were less likely to have experience with them).

71. *Id.* at 318, 327–28.

how much better it might be.[72] In such cases, regulations can guide society towards optimal levels of product safety when policymakers have good information about product safety.[73] Then, regulators can influence the design of products by mandating product features, taxing unsafe products, or providing incentives to firms or consumers to make and purchase safer products.[74]

Other times, consumers' decisionmaking does not take into account how their choices will affect others. Economists refer to this problem as one of *externalities*, because the effects of the decision are borne by others.[75] If a product creates positive externalities, then the market will under-produce it because the decisionmakers will bear all the costs without all of the benefits.[76] If externalities are negative, then the market will over-produce it, because benefits are fully priced but costs are not.[77] Again, even the most devoted free market advocates tend to recognize the legitimacy of governmental intervention in those conditions[78]—products that threaten others' safety might be regulated; those that promote others' safety might be subsidized.

Another challenge is that many innovations are expensive to produce but cheap to copy. This is what economists call the public goods problem for information.[79] Consider a firm deciding whether to invest in developing a new carbon monoxide detection system for which it believes there is strong market demand. Developing and testing the device might cost millions of dollars and years of effort. But once the device is released to the market, the firm's competitors will quickly figure out how it works and copy it. The competitors will undercut the firm's price, because they did not spend money

72. Daniel J. Walters & Hal E. Hershfield, *Consumers Make Different Inferences and Choices When Product Uncertainty Is Attributed to Forgetting Rather than Ignorance*, 47 J. CONSUMER RSCH. 56, 75–76 (2020).

73. *See, e.g.*, Michael Guihot, Anne F. Matthew & Nicolas P. Suzor, *Nudging Robots: Innovative Solutions to Regulate Artificial Intelligence*, 20 VAND. J. ENT. & TECH. L. 385, 391 (2017) (discussing the role regulators can play in influencing beneficial development of new technologies).

74. *See, e.g.*, *How FDA Regulates Vapes*, U.S. FOOD & DRUG ADMIN., https://www.fda.gov/media/159412/download [https://perma.cc/8XJX-H5SG] (discussing the FDA's various regulatory strategies for electronic nicotine delivery systems).

75. Thomas Helbling, *What Are Externalities?*, FIN. & DEV., Dec. 2010, at 48, 48.

76. Ian Ayres & Steven D. Levitt, *Measuring Positive Externalities from Unobservable Victim Precaution: An Empirical Analysis of Lojack*, 113 Q.J. ECON. 43, 44–45 (1998) (providing "the first thorough empirical examination of the externalities associated with self-protective efforts" and concluding that Lojack technology has massive positive externalities).

77. Peter Lee, *Patent Law's Externality Asymmetry*, 43 CARDOZO L. REV. 1923, 1926 (2022).

78. *See, e.g.*, Viscusi, *Constructive Cigarette Regulation*, *supra* note 66, at 1096 (recognizing the need for FDA regulation of the cigarette industry).

79. Mark A. Lemley, *IP in a World Without Scarcity*, 90 N.Y.U. L. REV. 460, 482 (2015) ("IP is designed to solve a public goods problem that arises because it is cheaper to be an imitator than an inventor.").

on research and development (R&D). Anticipating this, the firm will likely choose not to invest in innovation, and society will be worse off.

Much has been written about the promise and limits of markets for innovation.[80] Our purpose here is simply to highlight a few of the essential conditions in which markets might be expected to generate it, including the kinds of public safety-enhancing innovation that are our focus here. These elements will reappear throughout the story of violence technology, from consumer demand to firm incentives to externalities and the public goods problem.

B. The Policymaker's Arsenal

Because markets alone are likely to underproduce desirable innovation, policymakers use a variety of tools to incentivize it. Some of those tools have shaped violence technology innovation in significant ways. Others could be deployed more effectively to incentivize gun safety innovation in particular.

1. Supply Side Tools.—Policymakers have various mechanisms to ensure that innovators can recoup their R&D expenses. Most directly, governments can give money to innovators in the form of research grants or prizes.[81] The federal government spends billions of dollars annually supporting research in virtually every sector of human endeavor—health, communication, transportation, defense, and more.[82] These grants help ensure investments in innovation, even if those efforts do not result in market-based returns (which, if they are public goods, they likely will not). Similarly, policymakers could establish a monetary prize for achieving a particular technological result, thereby offsetting costly R&D.[83] More generally, governments often offer substantial tax incentives for innovation, allowing firms to take tax credits for innovation-related expenses.[84]

Patent law provides the most obvious solution to the problem of competitors copying innovations and undermining market returns. Patents give inventors the exclusive right to make, use, or sell their inventions for

80. *E.g.*, Lee, *supra* note 77, at 1926.

81. *E.g.*, *Funding Innovation*, U.S. DEP'T OF HOMELAND SEC., https://www.dhs.gov/science-and-technology/funding-innovation [https://perma.cc/3QKQ-5QVU]; *Programs for Small Businesses*, U.S. NAT'L SCI. FOUND., https://www.nsf.gov/funding/smallbusiness.jsp [https://perma.cc/45LT-3XAB]; *Development Innovation Ventures*, U.S. AGENCY FOR INT'L DEV., https://www.usaid.gov/div [https://perma.cc/3V24-RFS4].

82. Daniel J. Hemel & Lisa Larrimore Ouellette, *Beyond the Patents–Prizes Debate*, 92 TEXAS L. REV. 303, 317 (2013).

83. Michael J. Burstein & Fiona E. Murray, *Innovation Prizes in Practice and Theory*, 29 HARV. J.L. & TECH. 401, 422–23, 447 (2015).

84. Hemel & Ouellette, *supra* note 82, at 321–22.

twenty years.[85] Exclusivity means that the patentee can charge supracompetitive prices for the innovation during that period.[86] In the example above, copying and competition would drive the price of the carbon monoxide detection device down to the costs of production. But if the firm has a patent on the device and is the only one who can sell it, the firm can charge more than its production costs, thus recouping its investments in development and testing.

A vast scholarly literature compares the relative benefits and drawbacks of these different supply side innovation incentives, and we will not rehash it here,[87] except to emphasize a few key themes. With some approaches, government picks the winners (prizes), while with others, markets do (patents). For some approaches, financial support occurs early in the process (grants), while in others, it arises later (tax incentives). Who pays for the incentive also varies. Taxpayers are generally responsible for grants, prizes, and tax incentives, while consumers and competitors bear the costs of patent incentives.

2. Demand Side Incentives.—Motivating the suppliers of innovation isn't the only option for encouraging the production and distribution of new technologies. Policymakers can also influence demand for innovation. Generally speaking, consumers want new and safer technologies, which gives firms incentive to create and supply them. But, as on the supply side, there are reasons why demand for innovation can be suboptimal. As noted above, this will happen when consumers are biased, have imperfect information, or their actions generate externalities.[88] It will also happen for the simple reason that innovative technologies are often expensive, especially when they are covered by patents that increase their prices.[89] Thus, supply side incentives like patents will induce innovation in directions where relatively wealthy people can afford the new technology, even if the prime safety beneficiaries would be the poor.[90] But many valuable innovations are for poorer communities. When that is the case, what people can pay for an innovation is not a good measure of its social value.[91]

85. Adam Mossoff, *Exclusion and Exclusive Use in Patent Law*, 22 HARV. J.L. & TECH. 321, 327–28 (2009); 35 U.S.C. § 154(a).

86. Jeremy N. Sheff, *Self-Replicating Technologies*, 16 STAN. TECH. L. REV. 229, 241 (2013).

87. Much of that literature is cited and discussed in Hemel & Ouellette, *supra* note 82.

88. *See supra* notes 72–78.

89. *See supra* note 65.

90. *See* Amy Kapczynski, *The Cost of Price: Why and How to Get Beyond Intellectual Property Internalism*, 59 UCLA L. REV. 970, 978 (2012) (arguing that the distribution of resources for innovation is unjust).

91. *See id.* at 996 ("Copyright and patent law both disadvantage the virtuous poor because they make price a ticket for entry.").

In these cases, the government can subsidize innovations, increasing people's willingness and ability to pay for them. For example, many wounded veterans returning from World War II required expensive modifications to automobiles so they could return to the workforce, but their disabilities often meant that they could not get the jobs they needed to pay for the modifications in the first place.[92] A federal program was created to provide financial support for these purchases, which in turn motivated carmakers to produce them.[93] Government expenditures can increase the size of the market for innovation when there is reason to think that willingness and ability to pay are not good proxies for social welfare.[94]

Or consider how the Americans with Disabilities Act (ADA) has required public pools to have wheelchair lifts.[95] Although pool owners themselves might not have had much desire for chairlifts in the absence of the ADA, the idea behind the ADA was that it is important for people with disabilities to have equal access to public accommodations. The chairlift requirement increased pool owners' willingness to pay for this technology, because the alternative was expensive litigation and penalties. Accordingly, once firms knew that there was a market for chairlifts, they innovated new (often less expensive) options to satisfy the demand.

Demand side innovation incentives have received less scholarly attention than supply side incentives.[96] They raise many of the same sorts of questions about who decides on the incentive and who pays for it. In both the subsidy and the mandate examples, governments are deciding to institute an incentive. Notice, though, that with subsidies, taxpayers foot the bill, while private parties pay for the incentives associated with mandates.

3. Tort Law and Regulation.—Tort rules like negligence and products liability exist in part to ensure that manufacturers make and develop appropriately safe products.[97] While consumers desire safe products, they might not know how safely products can be made. And as Judge Learned Hand explained, "a whole calling may have unduly lagged in the adoption of

92. Buccafusco, *supra* note 45, at 968–69.

93. *Id.* at 969.

94. *E.g.*, Karen Tumulty, *'Obama Phones' Subsidy Program Draws New Scrutiny on The Hill*, WASH. POST (Apr. 10, 2013, 9:00 PM), https://www.washingtonpost.com/politics/obama-phones-subsidy-program-draws-new-scrutiny-on-the-hill/2013/04/09/50699d04-a061-11e2-be47-b44febada3a8_story.html [https://perma.cc/K623-C5CK] (discussing the "ObamaPhones" subsidy program).

95. Buccafusco, *supra* note 45, at 999.

96. *See* Ian Ayres & Amy Kapczynski, *Innovation Sticks: The Limited Case for Penalizing Failures to Innovate*, 82 U. CHI. L. REV. 1781, 1783 (2015) (focusing on using "sticks" instead of "carrots" to encourage supply side innovation).

97. Gideon Parchomovsky & Alex Stein, *Torts and Innovation*, 107 MICH. L. REV. 285, 286 (2008).

new and available [safety] devices."[98] Thus, tort law empowers private plaintiffs (and their contingency fee attorneys) to bring lawsuits against the makers of unsafe products. The threat of legal liability can encourage firms to invest in improving their products' safety.[99]

Federal and state regulation can have a similar effect on product safety. Regulatory authorities like the NHTSA, Food and Drug Administration, Environmental Protection Agency, and Occupational Safety and Health Administration regulate the kinds of products that can be sold and the features they must have. Regulation can be an especially valuable innovation incentive when negative externalities loom: Private purchasers might not care enough about how the products they buy could harm others, so regulation can compel them to internalize others' experiences.[100]

Automobile safety innovation provides an excellent example of the ways in which tort law and regulation operate. We have already noted the NHTSA's recent requirement that new cars and trucks have rearview cameras. Automobiles are also covered by dozens of crashworthiness performance standards covering matters like deceleration of the driver's head upon impact. With performance standards, manufacturers are free to meet the standard in any manner they see fit, leaving open the possibility of innovative solutions to the problem.[101] Sometimes, regulators can create standards that cannot be met by current products. These are technology-forcing, like NHTSA's 1990s side-impact standards, which effectively required the automative industry to find new ways to keep passengers safe.[102]

As with the other innovation incentives discussed above, tort law and regulation have both benefits and drawbacks. In these legal frames, juries and government bureaucrats set incentives for safety innovation, while firms and their customers pay for it. These variations can be good or bad, depending on the circumstances. The point here is simply to identify some of the tools with which policymakers can try to promote useful innovation.

C. Innovation, Safety, and Violence

Sometimes the safety benefits of innovation will eventually be widely recognized and shared, as with the polio vaccine, seatbelts, and smoke detectors. While the desirability of any new product will always be

98. The T.J. Hooper, 60 F.2d 737, 740 (2d Cir. 1932).

99. Parchomovsky & Stein, *supra* note 97, at 307 n.100.

100. Timur Kuran & Cass R. Sunstein, *Availability Cascades and Risk Regulation*, 51 STAN. L. REV. 683, 751 (1999).

101. Cary Coglianese, Jennifer Nash & Todd Olmstead, *Performance-Based Regulation: Prospects and Limitations in Health, Safety, and Environmental Protection*, 55 ADMIN. L. REV. 705, 706 (2003); Lee Jared Vinsel, *Designing to the Test: Performance Standards and Technological Change in the U.S. Automobile After 1966*, 56 TECH. & CULTURE 868, 871 (2015).

102. Vinsel, *supra* note 101, at 885.

contested—Covid vaccines are an obvious recent example—debates usually boil down to whether the innovative product actually improves public safety in the way it promises (for example by preventing or lessening the symptoms of Covid) or whether and how it should be legally mandated.[103]

Technologies of violence confound the usual story. People generally agree that society is better off with less disease and will tend to welcome innovative medicines that combat it, even if they disagree about which innovations achieve that goal. But for many people and in many contexts, the threat or infliction of violence is a *solution* to public safety problems, including violence itself. This same complication extends to violence technologies, because the power of an instrument to inflict violence has a deeply contested and fundamentally ambiguous relationship to public safety.[104] Nearly all the features that make guns safety-enhancing from the perspective of some (for example as tools of self-defense) also make them dangerous (for example, as instruments of criminal, impulsive, or accidental violence). It follows that "gun safety" is a complicated and perhaps counterintuitive concept precisely because guns are designed to be dangerous. Guns' dangerousness is the very reason why many Americans think they *promote* public safety. In the words of the former CEO of the National Rifle Association Wayne LaPierre: "The only thing that stops a bad guy with a gun, is a good guy with a gun."[105]

In many contexts involving innovations, one might conceptualize the underlying tension as being between desirable primary functions and undesirable side effects. New pharmaceuticals might treat one disease while simultaneously causing other health problems. But with firearms, it is harder to separate the primary function from the side effects since—as far as the instrument is concerned—the point is to threaten or inflict violence either way. The context, not the technology, determines whether the effect is good or bad, like a mis-prescribed drug rather than one with bad side effects. The

103. Christopher Buccafusco & Daniel J. Hemel, *Framing Vaccine Mandates: Messenger and Message Effects*, J.L. & BIOSCIENCES, Jan.–June 2022, at 4, 19 (showing experimentally how small changes in the framing of a policy can alter its acceptability).

104. *Cf.* McDonald v. City of Chicago, 561 U.S. 742, 891 (2010) (Stevens, J., dissenting) ("*Your* interest in keeping and bearing a certain firearm may diminish *my* interest in being and feeling safe from armed violence."). The particular symmetry we describe here is easiest to illustrate with weapons but pervades violence technology more broadly. A person who sees gun violence as inevitable and unregulable—that bad guys will always get their guns—will be more inclined to support what we call environmental solutions like "hardening" schools against shooters.

105. Peter Overby, *NRA: 'Only Thing That Stops a Bad Guy with a Gun Is a Good Guy with a Gun,'* NPR (Dec. 21, 2012, 3:00 PM), http://www.npr.org/2012/12/21/167824766/nra-only-thing-that-stops-a-bad-guy-with-a-gun-is-a-good-guy-with-a-gun [https://perma.cc/43KA-9JDW].

primary question for firearms, then, is not whether the technology "works" but the relative prevalence of their misuse.[106]

The challenge is unlocking the fact that private demand drives the very innovations that others seek to regulate. This is the awful symmetry at the heart of the gun debate. Both sides generally begin with some shared premises: that unjustified gun violence is bad and public safety is good. But they have fundamentally contradictory prescriptions about how to get less of the bad and more of the good, since the product one side sees as the problem, the other side sees as the solution.[107] That makes the debate difficult but not necessarily intractable. Guns have their own political and legal baggage, to be sure, but they fit within a broader category of products that are inherently dangerous—where some degree of danger is part of the function—and nonetheless should be made as safely as possible. The same is true of table saws, meat slicers, and even chemotherapy drugs. Just as chemotherapy should kill cancerous cells while harming as few healthy cells as possible, guns should be dangerous (in the sense of being powerful and effective) when appropriately used in justified self-defense, and safe (ineffective) when in the hands of an unsupervised toddler.

And indeed, it is not hard to imagine various forms of safety-promoting gun innovation that should be embraced by all sides of the gun debate—that are, in that sense, akin to a disease-ending medicine, or one that serves its purpose without side effects. Nobody benefits from guns that fire accidentally,[108] jam when needed,[109] or are prone to misuse by children, criminals, or other unauthorized users. While guns' basic function requires them to be dangerous, there is no particular benefit to their being unusually, unpredictably, or overwhelmingly so.[110] Most gun owners today report that

106. In any event, if one were to characterize the high toll of American gun death as an undesirable side effect of guns' desirable primary functions, the attractiveness of technological solutions is even more apparent. After all, the point of nearly every safety-promoting invention is to limit undesirable side effects while preserving desirable functions.

107. *See, e.g.*, Donald Braman & Dan M. Kahan, *Overcoming the Fear of Guns, the Fear of Gun Control, and the Fear of Cultural Politics: Constructing a Better Gun Debate*, 55 EMORY L.J 569, 570–71 (2006) (arguing that "competing cultural visions" of the good society, rather than empirical questions of safety, "are what drive the gun control debate").

108. *E.g.*, Champe Barton & Tom Jackman, *Popular Handgun Fires Without Anyone Pulling the Trigger, Victims Say*, WASH. POST (Apr. 11, 2023, 7:00 AM), https://www.washingtonpost.com/dc-md-va/2023/04/11/sig-sauer-p320-fires-on-own/ [https://perma.cc/CC85-CV73].

109. Alex Yablon, *New Jersey Attorney General Says Gunmaker Sold Defective Guns to Police*, TRACE (May 17, 2017), https://www.thetrace.org/2017/05/gunmaker-sig-sauer-sold-defective-guns-police/ [https://perma.cc/QEN4-MFME].

110. Strains of this reasoning come through in Second Amendment doctrine, which denies constitutional protection to "dangerous and unusual" weapons. *See infra* notes 310–315 and accompanying text.

self-defense is their primary reason for owning a gun,[111] but few would claim a legitimate interest in owning land mines, which are surely effective as an area-denial self-defense weapon but also present massive safety concerns.[112]

Which innovations could serve that function—preserving violent features while limiting violent bugs—is, as with any new technology, deeply contested, and it is not our goal here to endorse one or another. It could be better trigger locks, or smart gun technology that renders guns responsive only to a registered owner, or a variety of other technological features designed to decrease the likelihood of a gun being misused in ways that harm either its owner or others. Our more fundamental interest is whether innovations in violence technology, whatever they might be, are likely to emerge in the current economic and legal environment. Such innovations are not "gun control"; they do not deprive anyone of a weapon, and in that sense are entirely consistent with the desire of some Americans to have and use guns for self-defense, while enhancing public safety overall. To return to LaPierre's aphorism: Wouldn't it be even better if the good guy is armed with a functional smart gun, while the bad guy's stolen smart gun is locked because he is not an authorized user?

It is easy enough to dismiss the "good guy with a gun" trope. But it does usefully capture a deep market logic regarding the relationship between public safety and the technology of violence that deserves to be taken seriously. Consider the "marketplace of ideas" metaphor that has fundamentally shaped First Amendment law and scholarship.[113] The underlying supposition of that metaphor is that, as Justice Louis Brandeis put it, the proper remedy for bad ideas is not legal intervention but "more

111. Kate Masters, *Fear of Other People Is Now the Primary Motivation for American Gun Ownership, a Landmark Survey Finds*, TRACE (Sept. 19, 2016), https://www.thetrace.org/2016/09/harvard-gun-ownership-study-self-defense/ [https://perma.cc/TGD8-CHFY].

112. Indeed, if a non-lethal weapon could effectively provide self-defense—the stun-gun phaser of science fiction, for example—it would be harder to articulate a legitimate self-defense reason for traditional firearms. *See* Joseph Blocher & Darrell A.H. Miller, *Lethality, Public Carry, and Adequate Alternatives*, 53 HARV. J. LEGIS. 279, 297–98 (2016) ("A person is only permitted to use force when necessary to prevent a harm, and then only proportional force . . . ."); *see also* Craig S. Lerner & Nelson Lund, Heller *and Nonlethal Weapons*, 60 HASTINGS L.J. 1387, 1404 (2009) (considering the phasers example); Eugene Volokh, *Nonlethal Self-Defense, (Almost Entirely) Nonlethal Weapons, and the Rights to Keep and Bear Arms and Defend Life*, 62 STAN. L. REV. 199, 237 (2009) ("Yet the crime control arguments for gun bans do not apply with anywhere near the same force to stun guns and to irritant sprays.").

113. Abrams v. United States, 250 U.S. 616, 630 (1919) (Holmes, J., dissenting) ("[T]he best test of truth is the power of the thought to get itself accepted in the competition of the market, and . . . truth is the only ground upon which [people's] wishes safely can be carried out."); William P. Marshall, *In Defense of the Search for Truth as a First Amendment Justification*, 30 GA. L. REV. 1, 12 (1995) ("[T]raditional Speech Clause jurisprudence asserts that freedom of expression promotes truth by fostering a 'marketplace of ideas' which allows truth to ultimately prevail over falsity.").

speech."[114] Though expressed more like a bumper sticker, LaPierre's statement essentially picks up the same logic. In this marketplace of violence, desirable gun use will ultimately win out over gun misuse, in much the same way that good ideas are thought to beat out bad ideas in the marketplace of ideas.[115]

There are many reasons to contest the analogy, of course. Even speech "markets" permit regulation to prevent immediate physical harm, after all, and the brutal logic of the arms race casts plenty of doubt on whether unmediated individual choice would lead to a desirable equilibrium as opposed to a Hobbesian war of all against all. For our purposes here, though, what stands out is the suggestion that government should stay out of the field and that decisions about which guns are made and which innovations take place should be made "by the market."[116]

But there has never been a "market" for violence technology free of government intervention. For example, Samuel Colt's early repeater rifle succeeded in part because he convinced Congress to grant him a seven-year patent extension.[117] All of the major current players—Colt, Smith & Wesson, Winchester, and Remington—have received massive government support for their creations.[118] And all manufacturers are insulated, statutorily and constitutionally, from the kinds of tort liability and regulation that have incentivized safety-promoting innovations in other fields.[119] In short, the good guys and the bad guys have the guns they have not just because of individual choice, but because of markets that themselves are shaped by law.

To put the point in innovation policy terms, the question is whether society is getting the optimal amount of gun safety in light of a complex and sometimes conflicting set of preferences. Are guns being made as safe as they can be in light of their intrinsic dangerousness? In the next two Parts, we identify and evaluate some of the economic and legal forces at work.

II. Innovation, Markets, and Incentives for Firearms

Firearms technology is the product of centuries of innovation that has consistently increased guns' reliability, accuracy, rate of fire, and overall

114. Whitney v. California, 274 U.S. 357, 377 (Brandeis, J., concurring).

115. Joseph Blocher & Darrell A.H. Miller, *What Is Gun Control? Direct Burdens, Incidental Burdens, and the Boundaries of the Second Amendment*, 83 U. CHI. L. REV. 295, 352–54 (2016).

116. Anthony Davies & James R. Harrigan, *Let Markets Solve the Gun Problem*, U.S. NEWS (Mar. 1, 2018, 3:00 PM), https://www.usnews.com/opinion/economic-intelligence/articles/2018-03-01/how-markets-can-solve-americas-gun-problem [https://perma.cc/7B3A-GQ82].

117. Colt v. Young, 6 F. Cas 171, 171–72 (S.D.N.Y. 1852).

118. PAMELA HAAG, THE GUNNING OF AMERICA: BUSINESS AND THE MAKING OF AMERICAN GUN CULTURE 16–18 (2016) (detailing the subsidies that gun manufacturers received throughout the nineteenth century).

119. *See infra* subpart III(A).

capacity to inflict violence. Such innovations have come both from government grants, especially via military spending, and the private market, bolstered by patent protection.[120] We begin this Part by describing the historical role of innovation in the gun industry, and then show in recent years how the industry—faced with the prospect of selling durable goods in a largely saturated and shrinking market—has emphasized innovations in cosmetic design and regulation-avoidance.

Drawing on the market-based and policy factors laid out in Part I, we then turn to the puzzling story of smart guns—those designed to be fired only by an authorized user. Despite plausible supply and demand, no viable market for these guns has yet to emerge. We first identify some economic explanations, then show how one particular governmental effort to incentivize the market had the opposite effect, triggering a market-smothering backlash.

We then contrast the stunted growth of smart guns with an area where innovation incentives have been remarkably successful at establishing a new market for violence technology—the market for products that "harden" schools against active shooters. Here, federal, state, and local governments have spent billions on innovations like gun-detecting cameras, bulletproof whiteboards, and metal detectors in an effort to curtail school shootings. While we do not endorse one form of technology or another, we do highlight a variety of reasons to doubt that these markets are delivering socially optimal results.

A. The Past and Present of Firearms Innovation

It is far beyond the scope of this Article to summarize the history of gun-related innovation—a tale ably told by other scholars.[121] Our more limited goal is to emphasize that the production of firearms in many ways fits a familiar model of incentives and technological breakthroughs.

The history of firearms is full of striking innovations, such that one can essentially track the lineage of modern weapons. Some examples include the evolution from John Browning's mastery of self-loading mechanisms[122] to John Garand's creation of the M1 rifle[123] to the M1's eventual replacement

120. HAAG, *supra* note 118, at 16–18, 22, 26.

121. For broader histories, see generally *id.*; IAN V. HOGG, STORY OF THE GUN (1996); PRIYA SATIA, EMPIRE OF GUNS: THE VIOLENT MAKING OF THE INDUSTRIAL REVOLUTION (2018); DAVID J. SILVERMAN, THUNDERSTICKS: FIREARMS AND THE VIOLENT TRANSFORMATION OF NATIVE AMERICA (2016); and DeLay, *supra* note 31.

122. John Keilers, *Arming the Army, John M. Browning*, U.S. ARMY (Jan. 12, 2009), https://www.army.mil/article/15705/arming_the_army_john_m_browning [https://perma.cc/23P8-CACS].

123. *John Garand*, NAT. PARK SERV. (Mar. 25, 2023), https://www.nps.gov/spar/learn/historyculture/john-c-garand.htm [https://perma.cc/7NSK-ZLX8].

by the M16 (the military version of the AR-15[124]), and Mikhail Kalashnikov's adaptation of the M1 and other technologies for increased reliability and cheaper production, resulting in the AK-47, which some say "ranks as the deadliest, most prevalent and most game-changing individually wielded weapon in the history of military armament."[125]

A huge proportion of gun-related innovation has been in response to military demand (a prime form of the kinds of demand side incentive discussed above[126])—though, as with other innovations, many such technologies eventually find their way into the civilian market.[127] The AR-15, for example, was largely the result of engineer Eugene Stoner's private tinkering while an employee at Armalite.[128] Colt later purchased the patents and developed the gun (named the M-16 for military use) with major support from the U.S. Air Force and Army in the leadup to the Vietnam War.[129] Today, the AR-15 is the most popular rifle on the American civilian market.[130]

It would be an understatement to say that there is deep disagreement about whether new firearms technologies have been a net social good, but there can be no reasonable disagreement that modern firearms are drastically different and more lethal than their forebears. Founding-Era muskets were capable of firing perhaps a few times per minute, with a muzzle velocity of 1,000 feet per second and an effective range of 50 meters.[131] A modern AR-15 can fire 45 rounds per minute at 3,260 feet per second with an effective

124. Daniel T. McElrath, *The ArmaLite Story*, AM. RIFLEMAN (July 29, 2021), https://www.americanrifleman.org/content/the-armalite-story/ [https://perma.cc/68PP-8V6K].

125. Stephan Wilkinson, *How the AK-47 Became the 'Weapon of the Century'*, MIL. TIMES (Dec. 12, 2017), https://www.militarytimes.com/off-duty/gearscout/2017/12/12/how-the-ak-47-became-the-weapon-of-the-century/ [https://perma.cc/L3KA-7C7U].

126. *See supra* section I(B)(2).

127. The space program is another institution that has created enormous civilian technological spillovers. *Technology*, NASA, https://www.nasa.gov/specials/60counting/tech.html [https://perma.cc/ZNT4-VUXB].

128. Christopher R. Bartocci, *AR-15/M16: The Rifle That Was Never Supposed to Be*, GUN DIGEST (July 16, 2012), https://gundigest.com/gun-reviews/the-ar-16m16-the-rifle-that-was-never-supposed-to-be [https://perma.cc/P55V-HALU].

129. *Id.*

130. Terry Gross, *How the AR-15 Became the Bestselling Rifle in the U.S.*, NPR (Apr. 20, 2023, 1:45 PM), https://www.npr.org/2023/04/20/1171027638/how-the-ar-15-became-the-bestselling-rifle-in-the-u-s [https://perma.cc/2HF4-23U8].

131. Christopher Ingraham, *What 'Arms' Looked Like When the 2nd Amendment Was Written*, WASH. POST (June 13, 2016, 4:01 PM), https://www.washingtonpost.com/news/wonk/wp/2016/06/13/the-men-who-wrote-the-2nd-amendment-would-never-recognize-an-ar-15/ [https://perma.cc/L8DG-LCBJ].

range of 550 feet.[132] Some downplay the scale of change[133] and embrace what historian Brian DeLay calls "the myth of continuity."[134] But most gun owners probably celebrate these innovations as characteristic American ingenuity,[135] and few would accept the suggestion that the Second Amendment only protects muskets. Understandably, gun owners want the benefits of technological innovation, even if they also want to analogize AR-15s to muskets in terms of being "Arms" protected by the Second Amendment.

Whatever one thinks of such analogies at a conceptual level—we address the constitutional arguments below[136]—current economic realities provide ample incentive for further gun-related innovation. This is because the gun industry faces the challenge of selling a durable good to a relatively concentrated and saturated market. A well-maintained gun can last for decades or more, and the percentage of Americans who own them is declining.[137] Like many other consumer markets, the gun market is quite top-heavy, in the sense that most people own no guns, but some gun owners own a great many.[138]

One response for sellers in such markets is to focus on design innovations, in the hopes of selling variations on the same basic theme. It therefore makes sense that many recent gun-related innovations seem largely aesthetic. Now, more than 250 companies make a version of the AR-15,

132. *Id.*

133. *E.g.*, Clayton E. Cramer & Joseph Edward Olson, *Pistols, Crime, and Public: Safety in Early America*, 44 WILLAMETTE L. REV. 699, 716 (2008) ("[I]t is certainly true that firearms technology has advanced since 1791—*but not as much as some would like to think*.").

134. DeLay, *supra* note 31.

135. *See, e.g.*, Brian C. Sheetz, *The Rifleman Report: Innovation in the Firearm Industry*, AM. RIFLEMAN (Dec. 24, 2021), https://www.americanrifleman.org/content/the-rifleman-report-innovation-in-the-firearm-industry/ [https://perma.cc/K436-ZYQ4] ("Technological innovation has been the driver of the American experience—and the American firearm industry—since the days of the frontier longrifle. And . . . it continues to result in products that stand as examples of hope that the American spirit is alive and well."); *How Gun Innovation Supports Our Freedoms* WWW.LICENSETOCARRY.COM (Aug. 25, 2018), https://www.licensetocarry.com/how-gun-innovation-supports-our-freedoms/ [https://perma.cc/2K9A-GL8D] ("Our father's fathers fought to defend the principals [sic] and values we hold dearly. The success they found in battle is directly related to true grit and determination to defend this Country and our Constitution. It is also a reflection of the innovative capacity of the people in this land.").

136. *See infra* subpart III(C).

137. VIOLENCE POL'Y CTR., GUN OWNERSHIP IN AMERICA: 1973 TO 2021, at 3 (2022) ("From 1973 to 2021, the percentage of American households that reported having any guns in the home dropped by 28 percent."); Jennifer Mascia & Chip Brownlee, *How Many Guns Are Circulating in the U.S.?*, TRACE (July 22, 2024), https://www.thetrace.org/2023/03/guns-america-data-atf-total/ [https://perma.cc/6YUT-M6H9].

138. Philip J. Cook, *Gun Markets*, 1 ANN. REV. CRIMINOLOGY 359, 365 (2018) ("[G]un ownership is quite concentrated, and individuals who own at least one gun averaged 4.9 guns in 2015. That average is indeed higher than in a previous survey of this sort conducted in 1994." (internal citations omitted)).

which has been called "a Barbie doll for men"[139] and "Legos for adults."[140] In fact, some defenders of assault weapons (or at least critics of assault weapons bans) argue—not without reason—that the differences between them and other semiautomatic guns are largely cosmetic.[141]

Other innovations have emerged in response to legal change. The current popularity of assault weapons, for example, is only possible because the federal assault weapons law lapsed in 2004.[142] As we discuss in more detail below, the same federal law also restricted large-capacity magazines, which are also popular now.[143] Broad statutory (and, more recently, constitutional) deregulation of public carry has similarly unleashed demand for handguns. As recently as 1980, most states either outlawed concealed carry altogether or had relatively stringent "may issue" licensing requirements.[144] By the time the Supreme Court struck down the latter in 2022,[145] *all* states allowed some form of concealed carry.[146] And Professor Dru Stevenson reports that his "twelve-month review of manufacturers' catalogs or websites and gun enthusiast blogs that review new gun models suggests that manufacturers are innovating to meet intense consumer demand for firearms optimized for concealed carrying, now that all states permit the practice."[147]

Other innovations are nominally designed to comply with existing regulations, but do so in ways that seem to frustrate the purpose of those regulations and thus likely undermine legislative judgments about social

139. Bernd Debusmann Jr., *AR-15: The Lethal Weapon at Heart of US Gun Debate*, BBC (Apr. 14, 2023), https://www.bbc.com/news/world-us-canada-65242244 [https://perma.cc/C4B6-K8DN].

140. *AR-15 Parts List: What Do You Really Need?*, U.S. LAWSHIELD (Mar. 2, 2022), https://www.uslawshield.com/ar-15-parts-list-what-do-you-really-need/ [https://perma.cc/NER7-JHFJ].

141. *Protecting America from Assault Weapons: Hearing Before the Subcomm. on Crime, Terrorism, and Homeland Security of the H. Comm. on the Judiciary*, 116th Cong. 23 (2019) (statement of Amy Swearer, Heritage Foundation) ("'[A]ssault weapons' are universally categorized based on cosmetic features alone."); Allen Rostron, *Style, Substance, and the Right to Keep and Bear Assault Weapons*, 40 CAMPBELL L. REV. 301, 303 (2018) ("Critics of assault weapon bans complain that these laws irrationally draw distinctions among firearms based on cosmetic features . . . .").

142. Glenn Thrush, *Democrats Failed to Extend Assault Weapons Ban in 2004. They Regret It.*, N.Y. TIMES (June 9, 2022, 7:20 PM), https://www.nytimes.com/2022/06/09/us/politics/democrats-assault-weapons-ban.html [https://perma.cc/4XK8-YP2F].

143. *See infra* notes 316–330 and accompanying text.

144. Jacob D. Charles, *Securing Gun Rights by Statute: The Right to Keep and Bear Arms Outside the Constitution*, 120 MICH. L. REV. 581, 596 (2022).

145. N.Y. State Rifle & Pistol Ass'n, Inc. v. Bruen, 142 S. Ct. 2111, 2156 (2022).

146. Adam Weinstein, *Meet the Gun Rights Absolutists Bringing 'Constitutional Carry' to a State Near You*, TRACE (Feb. 8, 2017), https://www.thetrace.org/2017/02/constitutional-carry-gun-rights-absolutists [https://perma.cc/VAB2-G7FW].

147. Stevenson, *supra* note 29, at 698.

welfare or public safety.[148] For example, federal law requires licensed firearm dealers to perform background checks on prospective purchasers—a requirement designed to make it harder for prohibited purchasers like convicted felons and fugitives from justice to acquire guns.[149] But sellers of so-called 80% or unfinished receivers, which are essentially gun kits that can be completed at home, have argued that their products are not subject to firearm-specific rules like the background check requirement.[150] As this Article was being finalized, the Supreme Court rejected this argument, finding that at least some of those weapons kits are "firearms" within the meaning of the statute.[151]

Or consider the bump stock, an innovation that helps avoid restrictions on civilian ownership of automatic weapons—those that fire multiple rounds with every trigger pull.[152] A standard civilian AR-15 requires the user to pull the trigger each time they want the weapon to fire a round. But a bump stock harnesses the gun's recoil to reset the trigger and fire continuously.[153] After the Las Vegas shooter used weapons outfitted with bump stocks to kill sixty people in 2017, the ATF classified them as automatic weapons subject to heavy restriction[154]—a classification that the Supreme Court recently struck down as beyond the agency's statutory authority.[155]

Whether and in what ways any of these innovations enhance public safety is at the heart of the gun debate, and our goal here is not to identify the right balance so much as to emphasize that the industry can innovate when it has incentives to do so. And that in turn sets up the matter of smart gun technology, which is perhaps the most prominent—and some think promising—form of gun safety innovation in recent years.

148. *Cf.* Buccafusco & Weinstein, *supra* note 24, at 581 (arguing that bump stocks are an almost purely antisocial innovation).

149. 18 U.S.C. § 922(t)(1).

150. *Are "80%" or "Unfinished" Receivers Illegal?*, BUREAU OF ALCOHOL, TOBACCO, FIREARMS & EXPLOSIVES (Apr. 6, 2020), https://www.atf.gov/firearms/qa/are-%E2%80%9C80%E2%80%9D-or-%E2%80%9Cunfinished%E2%80%9D-receivers-illegal [https://perma.cc/ZEZ5-B8FG]. As if to illustrate how fine the line is between receivers and arms, one leading company selling unfinished receivers calls itself "80 Percent Arms." *See* 80% ARMS, https://www.80percentarms.com/ [https://perma.cc/RZ2K-5DH4]; *see also* Waldon et al., *supra* note 52, at 27 (showing evidence that sellers and buyers of kits refer to them as guns).

151. Bondi v. VanDerStok, No. 23-852, 2025 WL 906503 (U.S. Mar. 26, 2025).

152. 18 U.S.C. § 922(o) (prohibiting the possession of machineguns); 26 U.S.C. § 5845(b) (defining "machinegun" as "any weapon which shoots . . . automatically more than one shot, without manual reloading, by a single function of the trigger").

153. *Bump Stocks*, BUREAU OF ALCOHOL, TOBACCO, FIREARMS & EXPLOSIVES (Sept. 23, 2022), https://www.atf.gov/rules-and-regulations/bump-stocks [https://perma.cc/PZ8U-54US].

154. *Id.*

155. Garland v. Cargill, 144 S. Ct. 1613, 1624 (2024).

B. The Failure of Smart Gun Incentives

A substantial portion of gun violence is inflicted by people who are not authorized users of the firearm. Police officers are shot by their own guns.[156] Children are killed and injured when they get access to adults' guns.[157] Upwards of a quarter million guns are stolen every year, and many end up being used for other criminal ends.[158] If these guns were capable of being fired only by their owners, the reduction in fatalities and injuries could be dramatic.

Enter "smart guns"—those that incorporate authentication technologies that limit who can access them, in similar ways to now-standard features of cell phones. The demand for smart guns appears sufficient, supply seems feasible in that potential technologies have existed for decades, and governments have tried to further incentivize innovation. But a market for the technology has largely failed to emerge. Why?

As with any new technology, many potential consumers have concerns about cost and reliability.[159] Because they incorporate new, patented technologies, smart guns are more expensive than traditional counterparts. For example, BioFire's recently released smart gun costs between two and three times as much as a standard handgun.[160] And just as consumers were anxious about whether airbags would work properly, so too are some consumers worried about smart guns' reliability. As small arms researcher Matt Schroeder explains, "There are fears that adverse physical conditions, battery failure, electromagnetic interference, or sabotage could render the devices inoperable during an armed engagement."[161] Perhaps a smart gun's

156. Rachel Tucker, Beth Rousseau & Dylan Abad, *Winter Haven Man Shoots Police Officer With His Own Gun*, WFLA (July 18, 2022, 4:37 PM), https://www.wfla.com/news/polk-county/haines-city-police-officer-shot-by-his-own-gun/ [https://perma.cc/HSR4-WLHR]; WISN/CNN Newsource, *Body Cam Video Reveals Clues After Officer Shot With His Own Gun*, FOX11NEWS (May 4, 2023, 10:03 PM), https://fox11online.com/news/local/officer-sam-schroeder-shot-own-gun-accidentally-hobart-lawrence-police-highway-29-chase-sig-sauer-body-cam-video-chief-michael-renkas [https://perma.cc/YGS7-GAWK].

157. Arti Vaishnav, Gary A. Smith, Jaahnavi Badeti & Nichole L. Michaels, *An Epidemiological Study of Unintentional Pediatric Firearm Fatalities in the USA, 2009–2018*, INJURY EPIDEMIOLOGY, June 26, 2023, at 1, 7.

158. David Hemenway, Deborah Azrael & Matthew Miller, *Whose Guns Are Stolen? The Epidemiology of Gun Theft Victims*, INJURY EPIDEMIOLOGY, Apr. 10, 2017, at 1, 3 (estimating 250,000 gun theft incidents per year, with about 380,000 guns stolen).

159. Adam Crepelle, *Concealed Carry to Reduce Sexual Violence Against American Indian Women*, 26 KAN. J. L. & PUB. POL'Y 236, 254–55 (2017).

160. Patrick Linehan, Mola Lenghi, Jeffrey Cook & Josh Margolin, *Colorado Company Introduces 'Smart Gun' It Hopes Will Lower the Number of Firearm Deaths*, ABC (May 22, 2023, 1:02 PM), https://abcnews.go.com/US/colorado-company-introduces-smart-gun-hopes-lower-number/story?id=98538759 [https://perma.cc/KJL5-UPDE].

161. Matt Schroeder, *New Technologies and Small Arms Control: Preventing Unauthorized Acquisition and Use*, *in* BEHIND THE CURVE: NEW TECHNOLOGIES, NEW CONTROL CHALLENGES

unlocking mechanism will malfunction when wet.[162] Perhaps it will be too difficult to open a trigger lock in an emergency.[163]

Other gun owners might discount the need for safe storage, perhaps believing themselves not to need it. One mantra among many gun owners is that safety is "between the ears." In other words, gun safety is primarily a matter of personal responsibility and individual choice. Similar arguments have been made in other areas, including automobile safety, and they tend to downplay the need for technological change.[164] (Of course, as with automobiles, there might also be legitimate concerns that gun owners are systematically misperceiving costs and benefits—including whether they actually store guns safely.[165])

For any of these reasons, many gun owners might be skeptical about the desirability of owning a smart gun. Some research suggests that they are. A 2013 survey by the National Shooting Sports Foundation (NSSF) found that only 14% of Americans would be willing to buy a smart gun, and that 74% are concerned about the reliability of battery powered biometric or radio frequency activation systems.[166]

But the question is not whether all, most, or even many people would buy smart guns. Most Americans own *no* guns, after all,[167] and yet the industry thrives. The relevant issue is whether firms can make a profit, and

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75, 82–88 (Benjamin King & Glenn McDonald eds., Small Arms Survey 2015); *accord* Caitlin Hoffman, *Survey: Most Gun Owners Support Sale of 'Smart' Guns But Aren't Likely to Buy Them*, JOHNS HOPKINS UNIV.: HUB (June 10, 2019), https://hub.jhu.edu/2019/06/10/smart-guns-personalized-firearms-unlikely-to-boost-gun-safety/ [https://perma.cc/RBB8-4LKT] (finding that 56% of respondents were concerned with cost and 70% were concerned about the technology working).

162. Andres Paciuc, *Smart Guns: An Effective Solution or a Waste of Resources?*, SECOND THOUGHTS BLOG (June 5, 2020), https://firearmslaw.duke.edu/2020/06/smart-guns-an-effective-solution-or-a-waste-of-resources/ [https://perma.cc/9B6M-R5EL].

163. Transcript of Oral Argument at 83–84, District of Columbia v. Heller, 554 U.S. 570 (2008) (No. 07-290). The Court went on to strike down the District's safe storage requirement, finding that it did not contain a self-defense exception and thus required guns to remain locked even in a moment of immediate self-defense need. *Heller*, 554 U.S. at 635. Most courts after *Heller* instead read such laws—like most generally applicable laws—to allow acts of justifiable self-defense, and upheld them on that basis. *See* Joseph Blocher, *Safe Storage from* Heller *to* Bruen, N.C. L. REV. 1353, 1373 (2024) (criticizing *Heller*'s approach on this point).

164. *See* MASHAW & HARFST, *supra* note 56, at 65–68 (1990) (discussing the work of epidemiologists and other scientists to convince regulators that cars needed to be made safer in response to unsafe behaviors of drivers).

165. *E.g.*, Michael D. Anestis, Allison E. Bond, Jayna Moceri-Brooks, Shelby L. Bandel & Daniel Semenza, *Perceptions of the Utility of Secure Firearm Storage Methods as a Suicide Prevention Tool Among Firearm Owners Who Currently Store Their Firearms Loaded and Unlocked*, 54 SUICIDE & LIFE THREATENING BEHAVIOR 122, 127 (2023).

166. *Americans Skeptical of 'Smart Guns'; Oppose Their Legislative Mandate, National Poll Finds*, NAT'L SHOOTING SPORTS FOUND. (Nov. 12, 2013), https://web.archive.org/web/20140209042037/http:/www.nssf.org/newsroom/releases/show.cfm?PR=111213_americans-skeptical-of-wont-buy-smart-guns.cfm&path=2013 [https://perma.cc/V79V-6WNP].

167. Schaeffer, *supra* note 9.

considering that firearms as a whole are a $10 billion-dollar-a-year industry,[168] even a small slice of that market could be significant. And in contrast to the NSSF findings, a 2016 survey by the Johns Hopkins Bloomberg School of Public Health found that 59% of Americans would be willing to buy a smart gun, including 56% of political conservatives and four in ten gun owners.[169] Each group discounts the others' results, with the NSSF saying that Hopkins "makes no effort to hide the authors' gun control agenda"[170] and the Hopkins team describing the NSSF report as "funded by the gun manufacturers' trade association."[171] Whichever may have been the case when these studies were conducted, it is also worth noting that people's views of technology change over time. Only 31% of Americans were interested in buying an electric vehicle in 2015,[172] but by 2020, 71% were.[173]

Even faced with the prospect of demand for smart guns, bringing a new smart gun innovation to the market is nonetheless an uphill battle for start-up technology firms for at least two important reasons. First, many would-be investors seem unwilling to put their money into supporting any sort of firearms-related firm. For these investors, the firearms industry falls into the

168. *Gun & Ammunition Manufacturing Industry Profile*, FIRST RSCH. (Oct. 21, 2024), https://www.firstresearch.com/Industry-Research/Gun-and-Ammunition-Manufacturing.html [https://perma.cc/U9ZQ-9X4E].

169. *Survey: Most Americans Support Smart Guns*, JOHNS HOPKINS BLOOMBERG SCH. PUB. HEALTH (Jan. 21, 2016), https://publichealth.jhu.edu/2016/survey-most-americans-support-smart-guns [https://perma.cc/7JKB-NSMA]; Julia A. Wolfson, Stephen P. Teret, Shannon Frattoaoli, Matthew Miller & Deborah Azrael, *The US Public's Preference for Safer Guns*, 106 AM. J. PUB. HEALTH 411, 412 (Mar. 1, 2016) ("Overall, we found that 59% of Americans, if they were to purchase a new handgun, were willing to buy a childproof gun, 23% were undecided, and 18% were unwilling to buy a childproof gun.").

170. Elizabeth McGuigan, *New Smart Gun Survey Confirms NSSF Findings*, NAT'L SHOOTING SPORTS FOUND. (June 13, 2019), https://www.nssf.org/articles/new-smart-gun-survey-confirms-nssf-findings/ [https://perma.cc/VST8-KCY6].

171. *Survey: Most Americans Prefer Smart Guns*, *supra* note 169.

172. *New Data Shows Consumer Interest in Electric Vehicles Is Growing*, CONSUMER FED'N AM. (Sept. 19, 2016), https://consumerfed.org/press_release/new-data-shows-consumer-interest-electric-vehicles-growing/ [https://perma.cc/XQQ7-PCDD].

173. Julian Spector & Maria Virginia Olano, *Chart: Most Americans Are Interested in EVs, But Very Few Are Actually Buying Them*, CANARY MEDIA (Dec. 17, 2021), https://www.canarymedia.com/articles/electric-vehicles/chart-most-americans-are-interested-in-evs-but-very-few-are-actually-buying-them [https://perma.cc/24G2-ZVTU]. Interestingly, that number has probably dropped in the last several years, as people's experiences with charging stations has made them less enthused about electric vehicles. Alison Spencer, Stephanie Ross & Alec Tyson, *How Americans View Electric Vehicles*, PEW RSCH. CTR. (July 13, 2023), https://www.pewresearch.org/short-reads/2023/07/13/how-americans-view-electric-vehicles/ [https://perma.cc/76QY-G68R] (noting that public interest in buying EVs dropped approximately four percentage points between 2022 and 2023, and that availability of public charging stations is one potential obstacle to broader EV adoption).

same category as fossil fuels and tobacco.[174] According to a recent report by the Sustainable Investment Forum, "Institutional investor policies that restrict or exclude weapons-related investments applied to more than $1.5 trillion in assets under management as of 2018, a more than 20-fold increase from the $74 billion identified in 2012."[175] And while liberals have been donating to gun-control and anti-violence groups, they have shied away from giving money to smart gun manufacturers. As one San Francisco philanthropist explained, "At the end of the day, it's still investing in a weapon and I suspect conceptually that might have been a hurdle for people."[176]

These investment preferences are likely exacerbating another challenge to firearm safety technology, which is that venture capitalists and other investors who might fund start-up firearms firms are typically anxious about hardware innovations compared to software innovations.[177] Many of the most promising user authentication technologies are being developed by start-up firms rather than by established manufacturers.[178] Like disruptive start-ups in any industry, though, firearms start-ups require substantial infusions of capital to commercialize their innovations.[179] Proceeding from concept to prototype and then to testing and ultimately manufacturing is enormously expensive. Typically, start-ups rely on venture capital and other early-stage investors to support them through these periods.

It is now accepted wisdom, however, that venture capitalists strongly prefer to back software innovations over hardware innovations, because the former tend to be much easier to scale. This is the reality behind Peter Thiel's quip, "We wanted flying cars, and instead we got 140 characters."[180] Software innovations like Twitter, Facebook, and Uber do not require firms to build very much. The code is the product, and scaling the innovation is

174. *See* Kimberly D. Krawiec & Andrew Jennings, *Vice Capital*, 15 U.C. IRVINE L. REV. (forthcoming 2025) (manuscript at 17 n.101, 18) (noting that alcohol, tobacco, weapons, gambling, and more recently fossil fuels constitute vice industries).

175. Lisa Woll, *What ESG-Conscious Investors Can Do About Guns*, U.S. SUSTAINABLE INV. F. (Dec. 20, 2018), https://www.ussif.org/article_content.asp?edition=1&section=3&article=19 [https://perma.cc/2N3K-RAUJ].

176. Zusha Elinson & Joe Palazzolo, *Why No One Wants to Back the Gun of the Future*, WALL ST. J. (Apr. 17, 2018, 12:36 AM), https://www.wsj.com/articles/why-no-one-wants-to-back-the-gun-of-the-future-1523707203 [https://perma.cc/N3HR-CKE3].

177. *Id.* ("Ian Sobieski, chairman of the Band of Angels, said the group of angel investors turned down investment opportunities not because of politics, but because hardware deals carry more risk. Unlike developing software, building and testing physical things is more expensive, he said.").

178. *Id.*

179. Pavithra Mohan, *Why Smart Gun Tech Isn't Getting More Funding*, FAST CO. (Mar. 22, 2018), https://www.fastcompany.com/40544983/why-smart-gun-tech-isnt-getting-more-funding [https://perma.cc/YRK3-V5X6].

180. Shane Hickey, *Modern Tech Entrepreneur Decries Old Way of Learning and Thinking*, GUARDIAN (Jan. 4, 2015, 8:22 AM), https://www.theguardian.com/business/2015/jan/04/the-innovators-peter-thiel [https://perma.cc/UWW2-CGXB].

only a matter of increasing adoptions. These features make it less risky for venture capital firms to realize their investments through acquisitions or initial public offerings during the short windows of their existence.[181]

Most firearm user-authentication technologies are hardware intensive. Firms must build prototypes that can be tested, and then the prototypes need to be redesigned, often several times. These steps cost money, take time, and carry risk. Ultimately, as with other hardware innovations, investors are less enthused about embracing the additional risk.[182] In fact, acquiring venture funding for smart gun technology is likely even harder than for other hardware innovations, because the options for acquisition are starkly limited. Although some start-up firms go public or remain private as they reach maturity, many others seek to be acquired by larger, established firms. But for reasons we discuss below,[183] established gun manufacturers seemingly want nothing to do with smart guns.[184] Accordingly, one venture capitalist went so far as to call smart gun technology "uninvestable," claiming that it would take "multiple miracles" to bring a product to market.[185]

In light of these challenges, policymakers who support the development of smart gun technology might look for mechanisms to incentivize innovation. One such mechanism, as discussed in Part I, is public support in the form of prizes or grants. Between 1997 and 2014, the U.S. Department of Justice awarded more than $12 million in grants to develop smart gun technologies.[186] Some of this money went to established firearms manufacturers like Colt and Smith & Wesson, some to start-ups, and some to universities.[187] On the back of this support, a number of firms demonstrated meaningful progress towards a marketable smart gun. A 2013 report by the federal government's National Institute of Justice (NIJ) cataloged the technological advances already made by several firms to develop reliable user authentication.[188]

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181. Sabrina T. Howell, *Reducing Information Frictions in Venture Capital: The Role of New Venture Competitions*, 136 J. FIN. ECON. 676, 677 (2020).

182. Ellinson & Palazzolo, *supra* note 176.

183. *See infra* notes 196–213 and accompanying text.

184. Mohan, *supra* note 179 (quoting Smith & Wesson's statement "We are a manufacturing company, not a technology company").

185. BioFire, *Founders Fund Leads Biofire's $14 Million Series A to Bring Smart Gun to Market*, PR NEWSWIRE (Nov. 7, 2022, 11:17 AM), https://www.prnewswire.com/news-releases/founders-fund-leads-biofires-14-million-series-a-to-bring-smart-gun-to-market-301670454.html [https://perma.cc/42S5-TUYM]. This isn't to say that firearms firms can never obtain venture funding. Recently, BioFire, a start-up out of Colorado, received $14 million in Series A funding to develop its smart gun technology. *Id.*

186. U.S. DEP'TS OF JUST., HOMELAND SEC. & DEF., REPORT TO THE PRESIDENT OUTLINING A STRATEGY TO EXPEDITE DEPLOYMENT OF GUN SAFETY TECHNOLOGY 5–6 (2016).

187. *Id.* at 5–6; MARK GREENE, A REVIEW OF GUN SAFETY TECHNOLOGIES 15–16 (2013).

188. GREENE, *supra* note 187, at 15–17.

In the 1990s, Colt spent more than half a million dollars of federal funding on a smart gun prototype using radio frequency identification (RFID) on a .40 caliber pistol.[189] While the technology was not perfect, Colt had established proof-of-concept, according to NIJ.[190] NIJ planned to purchase twenty prototypes for testing at police academies, but Colt eliminated its smart gun R&D in 2000 and has not reentered the field.[191] In the first decade of the twenty-first century, NIJ provided several million dollars in research funding to Smith & Wesson to spur its smart gun innovations.[192] Like Colt, Smith & Wesson developed several prototypes of its authentication technology. Smith & Wesson used a biometric skin identification system developed in partnership with Lumidigm, Inc.[193] And, like its competitor, Smith & Wesson suddenly withdrew from smart gun research in 2000.[194]

These accounts of grant-backed R&D by established players are mirrored by the experiences of startup firms that also received federal funding. iGun Technology Corporation used a small grant to develop an RFID shotgun by 1998 that passed all relevant reliability tests,[195] but they shelved the technology by 2002. With more than $2 million in federal funding, the Belgian firm FN Manufacturing produced a 9 mm handgun with an RFID ring that fired hundreds of times without authentication errors or other malfunctions.[196] When grant funding ended in 2006, the firm discontinued further development.

Why did all these promising starts fizzle out? One important factor, ironically, is that another attempted innovation incentive undermined the field. In 2002, New Jersey passed the Childproof Handgun Act (CHA) in an attempt to encourage smart gun development.[197] The law required that once a "personalized handgun" had been available on the market for three years, no new unpersonalized handguns would be allowed to be sold.[198] The statute described itself as a "bold and innovative step of fostering the development of personalized handguns by firearms manufacturers."[199] According to the

189. *Id.* at 37. RFID is the technology that allows identification badges to communicate with security gates and that allows pets to be identified by implanted microchips.

190. *Id.* at 39 ("The prototypes demonstrated that it was possible to integrate the transmitter technology into a watch-size wristband and the wireless receiver and actuator into the handgun grip.").

191. *Id.*

192. *Id.* at 43.

193. *Id.* at 44.

194. Alex Yablon, *Obama Counts on Law Enforcement to Popularize Smart Guns*, TRACE (Apr. 29, 2016), https://www.thetrace.org/2016/04/obama-smart-guns-plan-law-enforcement/ [https://perma.cc/B6LQ-YG47].

195. GREENE, *supra* note 187, at 4, 42.

196. *Id.* at 45, 49.

197. Childproof Handgun Law of 2002, ch. 130, 2002 N.J. Laws 1130.

198. Childproof Handgun Law of 2002, ch. 130(1)(b), 2002 N.J. Laws 1130, 1131.

199. *Id.*

bill's chief sponsor, "By passing the bill, we have helped spawn the technology . . . . We're going to help it exist. The whole idea is to take a very deadly consumer product and make it safer."[200]

The statute was clearly designed as an innovation incentive. Just as the ADA increased demand for poolside wheelchair lifts and FDA fuel-economy standards boost demand for gas-saving technologies,[201] the CHA promised to dramatically increase demand for smart guns. Three years after the introduction of a smart gun on the market, all new guns would have to be smart. That would mean that the leading firm would stand to gain an enormous share of the market, because its (presumably patented) technology would be the only one available until competitors caught up or paid for licenses. The statute was meant to turbocharge the patent race, at least in New Jersey.

That did not happen. The law's passage generated a massive backlash against both manufacturers and retailers of smart guns. Established gun manufacturers faced enormous criticism from their customer bases and the NRA for their willingness to invest in smart gun technology. According to the NRA, when Smith & Wesson entered an agreement with the Clinton administration to develop smart guns, it "had run the white flag of surrender" to the government.[202] Colt's efforts faired similarly, with both companies experiencing huge sales losses because of their purported complicity in government overreach. In fact, the losses were so staggering that both companies faced bankruptcy and were sold off.[203]

Some retailers experienced similar boycotts. The Oak Tree Gun Club in California agreed to sell a smart gun manufactured by the German company Armatix, but gun rights advocates flooded social media with calls to boycott the company and doxed its owner.[204] Oak Tree quickly removed all references to Armatix and denies ever selling the gun.[205] An owner of a

200. Jeremy Pearce, *Smart Guns, A Clever Bit of Legislating*, N.Y. TIMES (Jan. 12, 2003), https://www.nytimes.com/2003/01/12/nyregion/smart-guns-a-clever-bit-of-legislating.html [https://perma.cc/TW9U-HBUD].

201. Hemel & Oullette, *supra* note 82, at 316, 316 n.40; *see, e.g.*, Buccafusco, *supra* note 45, at 978 (discussing the innovations that have occurred as a response to the ADA's enforcement).

202. John Rudolf, *Smith & Wesson Broke Clinton-Era Gun Safety Pledge to Boost Profits*, HUFFPOST (Dec. 23, 2012, 6:52 PM), https://www.huffpost.com/entry/smith-wesson-clinton-bush-nra_n_2348503 [https://perma.cc/FEF5-A3TR].

203. *See* Stevenson, *supra* note 29, at 705–07 (discussing Smith & Wesson's failure); Sophia Agathis, *Private Equity's Overleveraging of Portfolio Companies*, 21 FORDHAM J. CORP. & FIN. L. 607, 629–30 (2016) (discussing Colt's financial troubles following its smart gun project).

204. Jeremy W. Peters, *'Smart' Firearm Draws Wrath of the Gun Lobby*, N.Y. TIMES (Apr. 28, 2014), https://www.nytimes.com/2014/04/28/us/politics/smart-firearm-draws-wrath-of-the-gun-lobby.html [https://perma.cc/CF5U-M2H7].

205. *Id.*

Maryland store that planned to stock the gun was subject to death threats.[206] Other retailers, fearful of similar responses, have been unwilling to stock smart guns.[207]

The NRA claims that it does not object to smart guns, saying that decisions should be left to the market.[208] But it also asserts that the push for smart guns "mesh[es] with the anti-gunner's agenda, opening the door to a ban on all guns that do not possess the government-required technology."[209] The New Jersey law looked like just such an attempt. By mandating new technology, the law would increase the price of new weapons, making them prohibitively expensive for some buyers.[210] An inevitable feature of patented products—supracompetitive prices—was thus recast as a restriction on ownership.

Ultimately, the New Jersey law has been a catastrophic failure as an incentive mechanism, and it has been modified to only require that retailers carry a single smart gun once they are available.[211] Even so, BioFire, the company that recently released a smart gun using facial and fingerprint recognition, refuses to register the weapon with New Jersey,[212] apparently concluding that the potential for increased in-state sales are not worth the risk of backlash.

The market that the NRA trusts to develop the right mix of safety innovations is itself a product of law. Firms were making strides to develop smart gun technologies leading up to the passage of the New Jersey law, but the backlash from a segment of consumers was so strong that it scared the established manufacturers out of the business. Not only would Smith & Wesson and Colt not be contributing their substantial R&D expertise to smart gun development, they also were no longer in the market to acquire startup firms with new technology. Startups' exit options were thus radically curtailed, because they would have to take their technology all the way from development and testing to manufacture. And because retailers would not stock their products, they would have to retail them as well, as BioFire does.

206. Adrianne Jeffries, *Gun Control: The NRA Wants to Take America's Smart Guns Away*, VERGE (May 5, 2014, 1:30 PM), https://www.theverge.com/2014/5/5/5683504/gun-control-the-nra-wants-to-take-smart-guns-away [https://perma.cc/M5PD-FYGP].

207. *Id.*

208. Frank Miniter, *The Smart-Gun Maker Who Told Holder Off*, NAT. REV. (Aug. 11, 2014, 8:00 AM), https://www.nationalreview.com/2014/08/smart-gun-maker-who-told-holder-frank-miniter [https://perma.cc/D94X-QRN2].

209. Peters, *supra* note 204.

210. Miniter, *supra* note 208.

211. 2019 N.J. Laws 1238, 1242.

212. Champe Barton, *New Jersey's Effort to Pave the Way for Smart Guns Hits Another Bump*, TRACE (May 31, 2023), https://www.thetrace.org/2023/05/new-jersey-childproof-smart-handgun-law [https://perma.cc/RP8X-6Z8C].

To be fair, it is hard to know how much of this was caused by the New Jersey law. Certainly, retailers in California and Maryland were not directly subject to it. Just as likely, the incredibly slow pace of development for smart guns is due to the concerted effort of a small cohort of buyers to prevent these weapons from emerging.

C. The "Success" of School Safety Incentives

Even as the market for smart guns has stalled, a parallel market for a different kind of violence technology has taken off, now rivalling in size the market for guns themselves: the multibillion dollar industry devoted to curbing active shooters, especially in schools. Innovations in this area are distinctive because many of them operate at the social or community level—they are what we call *environmental* innovations.[213]

Environmental innovations have unique characteristics from a market perspective, including the potential to be public goods with non-excludable and non-rivalrous benefits. A stair-climbing wheelchair works only for the person using the wheelchair, but a properly designed ramp benefits wheelchair users as well as people pushing carts or strollers.[214] Environmental responses to gun violence include ShotSpotter, a gunshot detection system that uses microphones to detect the location of gunshots, thus theoretically improving law enforcement's ability to police gun violence and increase public safety.[215] The benefits and costs of this technology are broadly shared. ShotSpotter is paid for by taxpayers, after all, and may also generate negative side effects by reducing privacy and increasing the burdens of policing on communities already suffering over-carceralization.[216] As with smart guns, our goal here is not to evaluate any particular innovation but to identify the market and legal forces at work in bringing it about.

Of these environmental innovations, none has been more significant than the massive bipartisan effort to motivate the development and implementation of school security technology. Prior to the 1999 shooting at Columbine High School, most schools had relatively little formal security.

213. Buccafusco, *supra* note 45, at 958.

214. *Id.* at 999–1000.

215. Erica Goode, *Shots Fired, Pinpointed and Argued Over*, N.Y. TIMES (May 28, 2012), https://www.nytimes.com/2012/05/29/us/shots-heard-pinpointed-and-argued-over.html [https://perma.cc/58PT-MZK7].

216. *See* Justin Agrelo, *Chicago Trades One Controversial Gun Surveillance Technology for Another*, TRACE (Oct. 10, 2024), https://www.thetrace.org/2024/10/chicago-transit-zeroeyes-gun-shotspotter/ [https://perma.cc/P7TY-CZAB] ("As Chicago's ShotSpotter microphones shut down following years of controversy about the gunshot detection device, the Chicago Transit Authority is trying out a new tool designed to detect the presence of firearms—this time, through video surveillance [provided by ZeroEyes].").

Few required staff to wear ID badges, and even fewer had security cameras.[217]

In the subsequent quarter century, school security has become a $3 billion industry.[218] Many schools have adopted older technologies like metal detectors, but firms also offer more sophisticated options.[219] At a recent industry convention, firms touted the value of "surveillance cameras with facial recognition capability, automated door locks, gunshot detection sensors, and software that scans social media platforms in search of the next shooter."[220] Other firms sell bulletproof glass, doors, and even dry erase boards that children can hide behind or under if a shooter enters the building. For $5000 per month, a high school can purchase the services of ZeroEyes, which uses 200 cameras and machine learning to identify assault rifles on video feeds.[221] Former military and law enforcement personnel review images the system detects and notify school administrators if there is a weapon on campus.[222]

Architects and builders have, at great cost, designed school campuses that are meant to prevent access by shooters and to minimize harm if they enter. The new Sandy Hook Elementary School building, which replaced the site of the 2012 shooting of twenty students and six staff members, cost $50 million and was built according to principles of "crime prevention through environmental design," which focus on detecting and deterring shooters through the layout of the building and other spaces, the materials used in construction, and the implementation of surveillance technologies throughout.[223] According to one of the school's designers, "All the

217. *See* Alex Yablon, *We Already Turned Schools into Fortresses: Kids Are Dying Anyway*, CURBED (May 27, 2022), https://www.curbed.com/2022/05/school-hardening-industry-fails-texas-uvalde.html [https://perma.cc/WG83-9S4C] ("Before Columbine, school security focused more on preventing petty vandalism and drug use.").

218. Charlotte Morabito, *The School Security Industry Is Valued at $3.1 Billion. Here's Why That May Not Be Enough*, CNBC (July 6, 2022, 12:46 PM), https://www.cnbc.com/2022/07/06/the-school-security-industry-was-valued-at-3point1-billion-in-2021.html [https://perma.cc/RWW3-ER3E].

219. *See* Emily Baumgaertner & Alex Kalman, *Bulletproofing America's Classrooms*, N.Y. TIMES (Sept. 18, 2024), https://www.nytimes.com/interactive/2024/09/18/science/bulletproofing-schools.html [https://perma.cc/MC8J-XTL9] (describing bulletproof hoodies, clipboards, backpack inserts, binders, and more).

220. Mark Keierleber, *School-Security Companies Are Thriving in the Era of Mass Shootings*, ATLANTIC (Aug. 9, 2018), https://www.theatlantic.com/education/archive/2018/08/school-security-mass-shootings/567080/ [https://perma.cc/99N9-VASP].

221. Natasha Singer, *Schools Are Spending Billions on High-Tech Defense for Mass Shootings*, N.Y. TIMES (June 22, 2023), https://www.nytimes.com/2022/06/26/business/school-safety-technology.html [https://perma.cc/5P64-P77J].

222. *Id.*

223. Tim Newcomb, *After Sandy Hook Massacre, Designing Schools for Safety*, 74 MILLION (Nov. 6, 2017), https://www.the74million.org/article/after-sandy-hook-massacre-designing-

components of the school, from parking, walking, playing, now we have to think about how to make those things safer than you would if you didn't have the societal issues we have."[224]

School violence is enormously salient, and efforts to harden schools appeal to voters across the political spectrum,[225] so it is perhaps unsurprising that federal, state, and local governments have provided more than $1 billion in tax dollars for these innovations.[226] For example, between 2021 and 2022, Florida approved more than $60 million for its School Hardening Program, with eligible expenditures including bullet-resistant glass, metal detectors, security cameras, and steel doors.[227] In 2023, Georgia allocated a total of $115 million for $50,000 school safety grants for every K-12 school in the state.[228] Georgia's school safety law directs the government to provide funding for school safety improvements and initiatives, including "the installation of safety equipment, including, but not limited to, video surveillance cameras, metal detectors, alarms, communications systems, building access controls, and other similar security devices."[229] New York and Massachusetts have also allocated funding for video surveillance and other high-tech security features.[230]

The STOP School Violence Act of 2018 made $350 million available for new school security measures, including the kinds of innovations discussed above.[231] It also redirected the entire $75 million budget of the Comprehensive School Safety Initiative, a federal grant program that was

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schools-for-safety/ [https://perma.cc/W442-FZH9]; *Crime Prevention Through Environmental Design (CPTED) School Assessment*, U.S. DEP'T OF HEALTH & HUM. SERVS., https://www.schoolsafety.gov/resource/crime-prevention-through-environmental-design-cpted-school-assessment [https://perma.cc/BWW7-5KWW].

224. Newcomb, *supra* note 223.

225. Gabriel R. Sanchez & Carly Bennett, *Voters Want Congress to Address Gun Violence and Mass Shootings*, BROOKINGS (Jan. 23, 2023), https://www.brookings.edu/articles/voters-want-congress-to-address-gun-violence-and-mass-shootings/ [https://perma.cc/EA2P-MD3Y].

226. Mark Keierleber, *Inside the $3 Billion School Security Industry: Companies Market Sophisticated Technology to 'Harden' Campuses, But Will It Make Us Safe?*, 74 MILLION (Aug. 9, 2018), https://www.the74million.org/article/inside-the-3-billion-school-security-industry-companies-market-sophisticated-technology-to-harden-campuses-but-will-it-make-us-safe/ [https://perma.cc/KG8K-LYK4].

227. 2022 FLA. LAWS 1055, 1088; *see also* Memorandum from Timothy Hay, Fla. Dep't of Educ. on School Hardening Grant 2 (Oct. 15, 2022), https://info.fldoe.org/docushare/dsweb/Get/Document-9341/dps-2021-108.pdf [https://perma.cc/XL5S-J2EN] (describing the 2021 school hardening budget and eligible expenditures).

228. 2023 Ga. Laws 40.

229. GA. CODE ANN. § 20-2-1185(b) (2023).

230. N.Y. EDUC. LAW § 3641(16)(a)(8) (McKinney 2024); *Healey-Driscoll Administration Awards Nearly $3 Million to Improve Public School Security*, MASS.GOV (July 11, 2023), https://www.mass.gov/news/healey-driscoll-administration-awards-nearly-3-million-to-improve-public-school-security [https://perma.cc/SZB8-8SUN].

231. Student, Teachers, and Officers Preventing School Violence Act of 2018, 34 U.S.C. §§ 10551–10556.

created after the Sandy Hook massacre, to this cause.[232] While the earlier program funded a wide variety of programs related to school safety, including those dedicated to school police, bullying prevention, and comprehensive safety plans, the new legislation does not emphasize research and evaluation and has a narrower list of acceptable funding priorities.[233] Research-based programs have now been replaced with commitments to spend tax dollars on school hardening technology, most of which has no empirical support.

Government spending on school safety technologies is a demand side incentive for innovation—it affects consumers' willingness and ability to pay.[234] However much schools would have been willing to pay for surveillance cameras with facial recognition or gunshot detection sensors, in the absence of the subsidy, many likely could not have afforded them, especially given the many other demands on their limited funding. Once the school system has the money, though, it can purchase new school security innovations. Moreover, some school safety laws *require* schools to implement various safety measures,[235] generating demand for new safety technology.

Firms, seeing massive increases in ability and willingness to pay, now enter the market. Some of those firms will seek to develop new technology for which there was previously insufficient demand, such as gunshot detection sensors. Other firms may instead seek innovations like bulletproof doors that lower the cost of safety technology, because schools will try to comply with their obligations as cheaply as possible. In either case, the existence of the government subsidy increases demand for safety innovations, which thereby increases their supply.

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232. Evie Blad, *Federal School Safety Research Eliminated to Fund New School Security Measures*, ED WEEK (Mar. 27, 2018), https://www.edweek.org/leadership/federal-school-safety-research-eliminated-to-fund-new-school-security-measures/2018/03 [https://perma.cc/R2Q3-PABG].

233. *Id.*

234. *See* Buccafusco, *supra* note 45, at 954–55 (discussing the difference between demand side and supply side innovation incentives); *see also* Rebecca S. Eisenberg & W. Nicholson Price II, *Promoting Healthcare Innovation on the Demand Side*, 4 J. L. & BIOSCIENCES 3, 5 (2017) (describing the demand side benefits of health innovation); Rachel E. Sachs, *Prizing Insurance: Prescription Drug Insurance as Innovation Incentive*, 30 HARV. J.L. & TECH. 153, 169 (2016) (discussing how perception of risk affects individual valuation of medical innovations); Mark A. Lemley, Lisa Larrimore Ouellette & Rachel E. Sachs, *The Medicare Innovation Subsidy*, 95 N.Y.U. L. Rev. 75, 78 (2020) (describing the effect of the Medicare innovation incentive on the pharmaceutical market).

235. *See, e.g.*, Alyssa's Law, 2019 N.J. Laws 153 (requiring schools in New Jersey to implement silent panic alarm systems). Similar legislation mandating silent alarm systems in schools has been enacted in Florida, New York, Texas, Tennessee, Utah, and Oklahoma. ALYSSA'S LAW, https://alyssas-law.com/#:~:text=Alyssa's%20Law%20is%20legislation%20to,that%20directly%20notify%20law%20enforcement [https://perma.cc/QM92-4BNY].

The effectiveness of these innovations in improving the physical safety of students—or for that matter even their sense of safety—is deeply contested. Clearly they are popular with many relevant decisionmakers, and seem to have been effective in some well-reported incidents.[236] And yet one recent study of metal detectors, surveillance cameras, and security officers "found no evidence that any pattern of visible security measure utilization was consistently associated with reduced exposure to crime or violence at school."[237] School hardening might in fact undermine important relationships between students and faculty, thereby increasing the risk of violence. According to scholars, "A hardened environment frames children and youth not as learners but as potential threats to be policed, controlled, and, in some sense, feared."[238]

Our goal is not to endorse any particular form of environmental safety technology but to highlight the market and legal forces that shape their adoption and how those forces differ from those at play with regard to the gun-level innovations described above. There, patents, government mandates, and federal grants played the leading roles in setting incentives. For example, smart gun technologies are covered by patents, and those products are likely to cost more simply because the patent allows charging supracompetitive prices. If microstamping were required,[239] gun manufacturers would have to redesign firearms to accommodate the technology, increasing their cost. Of course, these are precisely the reasons why some gun owners and lobbyists object to gun-level safety requirements.[240]

By contrast, the market for environmental safety innovations like those in schools is driven by different decisionmakers and a different cost-benefit analysis. Unlike patents, where the size and direction of the incentive are determined by consumers and markets, the value of demand side incentives depends on whether the government is making good decisions about its spending. And just as the former might not lead to optimal public safety, so too with the latter. In other innovation contexts, research has shown that

236. Melissa Chan, *New Panic Alarm System at Georgia H.S. Saved Lives During Shooting, Officials Say. Advocates Want It Nationwide.*, NBC NEWS (Sept. 5, 2024, 2:31 PM), https://www.nbcnews.com/news/us-news/new-panic-alarm-system-georgia-high-school-saved-lives-shooting-offici-rcna169754 [https://perma.cc/4EYU-VK77].

237. Emily E. Tanner-Smith, Benjamin W. Fisher, Lynn A. Addington & Joseph H. Gardelia, *Adding Security, but Subtracting Safety? Exploring Schools' Use of Multiple Visible Security Measures*, 43 AM. J. CRIM. JUST. 102, 113 (2017).

238. Bryan R. Warnick & Ryan Kapa, *Protecting Students from Gun Violence*, 19 EDUC. NEXT 23, 26 (2019).

239. *See infra* notes 288–291 and accompanying text.

240. Miniter, *supra* note 208 (quoting a gun industry lobbyist as saying "most firearms manufacturers have been reluctant to invest R&D dollars in smart-gun technology because gun-control advocates want to make the technology mandatory. If that happens, new guns will become prohibitively expensive, which is part of what these groups want").

intermediaries can distort innovation incentives in inefficient directions. In the pharmaceutical context, doctors and insurance companies make decisions about which drugs patients take and how much they pay for them,[241] and their goals may not be well-aligned with patient welfare.

It is also worth considering who pays for school security innovations. In many innovation contexts, where patents play the primary incentive role, consumers of new technology pay for the incentive via higher prices for patented goods.[242] Patents act as a shadow tax on *consumers* of new innovations.[243] In other contexts, such as those supported by grants or tax incentives, the public foots the bill.[244] That is what is happening with school security. Legislative requirements spend taxpayer money on ballistic doors, facial recognition cameras, and gunshot detection systems.

The desirability of any particular safety innovation comes down in large part to considerations of effectiveness that are beyond the scope of our project here. Maybe smart guns improve public safety by limiting unauthorized use; maybe they threaten it by failing in times of need. Maybe ZeroEyes improves public safety by quickly identifying active shooters; maybe it represents a waste of money better spent on counseling. The point is that these technologies of violence are contingent, and the markets which produce them are potentially subject to a variety of distortions, whether it be over-reliance on private choice when externalities and other market failures make it an unreliable guide to social welfare, or over-reliance on government decision-making when doing so leads to inefficient and inequitable spending.

Markets for innovation have contributed immeasurably to Americans' health, wealth, and overall well-being. The possibility of market-based solutions to gun violence has obvious appeal not only because of its potential for success but because it could do so without the standard tools of criminal law, which have so long been at the forefront of gun violence prevention and which—for whatever good they have done—have contributed to the crisis of police violence and over-carceralization. And yet, we have shown here there are reasons to doubt that the market for gun safety innovation is functioning efficiently. In the next Part, we highlight some ways in which the market is not "free" but subject to a variety of legal restrictions.

III. Public Law and Gun Safety Innovation

Part II focused on the demand and supply factors shaping the market for gun safety innovation. But as the New Jersey mandate shows, fully

241. Christopher Buccafusco & Jonathan S. Masur, *Drugs, Patents, and Well-Being*, 98 WASH. U. L. REV. 1403, 1414 (2021).

242. Hemel & Ouellette, *supra* note 82, at 312.

243. *Id.*

244. *Id.*

understanding the incentives for gun safety innovation means accounting for the ways in which statutory and constitutional law shape them. Broadly speaking, public law has operated to statutorily disincentivize and even constitutionally forbid a variety of gun safety innovations. The result is that even if one were to trust the logic of the "marketplace of violence,"[245] it is also important to recognize how that market is already subject to a variety of legal limitations.

A. Statutory (Dis)Incentives for Gun Safety Innovation

The prospect of regulation or tort liability for unsafe products can be a significant driver of safety-promoting innovation. But gun manufacturers, sellers, and owners are broadly insulated from the kinds of regulatory and tort liability that other industries face, thus reducing the incentive to innovate safer products.

Most consumer products in the United States are subject to oversight by the Consumer Product Safety Commission (CPSC), whose charge is to "to save lives and keep families safe by reducing the unreasonable risk of injuries and deaths associated with consumer products."[246] In carrying out that goal, CPSC typically does not forbid broad classes of products, but rather requires that they be made reasonably safe in light of their legitimate purposes. Misuses of medicines by children, for example, led not to prohibitions on medicine but rather child-resistant pill bottles, which are now mandated by federal law.[247] Thousands of people have been seriously burned using dangerous portable gasoline containers. In response, a recent federal regulation requires that all new containers be sold with flame arrestors that protect against fires.[248]

Guns are, among other things, a consumer good, and some of the safety issues that they raise are risks to the consumer. A recent investigation of the Sig Sauer P320—a popular handgun—found that "[m]ore than 100 people allege that their P320 pistols discharged when they did not pull the

245. *See supra* notes 113–119 and accompanying text.

246. *About Us*, U.S. CONSUMER PROD. SAFETY COMM'N, https://www.cpsc.gov/About-CPSC [https://perma.cc/3CLW-5YY4]; *see* Sabrina K. Presnell, *Federal Regulation of BB Guns: Aiming to Protect Our Children*, 80 N.C. L. REV. 975, 1002–07 (2002) (elaborating CPSC's authority).

247. *See* GUIDE TO CHILD RESISTANT AND SENIOR-FRIENDLY PACKAGES, U.S. CONSUMER PROD. SAFETY COMM'N, https://www.cpsc.gov/Regulations-Laws--Standards/Statutes/Poison-Prevention-Packaging-Act/Child-Resistant-and-Senior-Friendly-Packages-packaging-guide [https://perma.cc/35HQ-VUU7] (describing child-resistant packaging requirements).

248. Portable Fuel Container Safety Act, 88 Fed. Reg. 74342, 74343 (Oct. 31, 2023) (to be codified at 15 C.F.R. pt. 1461). Flame arrestors were first invented in 1815 for use in coal mines, so the regulation in this case did not compel the creation of an entirely new innovation. Rather, the regulation compelled further research on the appropriate technology for this particular use. *See* Glen Stevick, Joseph Zicherman, David Rondinone & Allan Sagle, *Failure Analysis and Prevention of Fires and Explosions with Plastic Gasoline Containers*, 11 J. FAILURE ANALYSIS & PREVENTION 455, 462–64 (2011) (discussing the history of flame arrestors).

trigger . . . . At least 80 people were wounded in the shootings, which date to 2016."[249] That kind of product failure seems squarely within CPSC's remit as to other products. And broadly speaking, one might expect to see it require guns to have the same kind of safety requirements that apply to other products: not a prohibition on ownership, but the equivalent of child-resistant pill bottles.

But a federal statute specifically carves firearms and ammunition out of the "consumer products" over which the Commission has authority.[250] The natural effect is to dampen the industry's incentive to make a safer product, since it is insulated from the costs that its faulty products impose on consumers. CPSC's limited ability to regulate firearms was on ironic display recently when the Commission mandated the recall of biometrically opened gun safes after a 12-year old died when he opened a safe and fired the gun he found inside.[251] CPSC reported thirty-nine incidents of unauthorized openings of these safes, which triggered a recall of more than 60,000 products.[252] And yet, CPSC is powerless to regulate the guns stored within them.

The second major way in which federal law dampens industry incentives for gun safety regulation is by altering the backdrop of possible tort liability. A fundamental goal of tort law is to deter parties, including product manufacturers, from engaging in unsafe activities.[253] Mass tort litigation is often identified as among the main drivers getting products like Agent Orange, Dalkon Shield, and asbestos either taken off the market entirely, made safer, or replaced by safer alternatives.[254] When producers of

249. Barton & Jackman, *supra* note 108.

250. 15 U.S.C. § 2052(a)(5)(E). This carve-out is not quite as striking as the tort liability discussed below, because there are other products similarly carved out: automobiles, drugs, and food, for example. 15 U.S.C. § 2052(a)(5). But those are subject to regulation by specific federal bodies like the Department of Transportation and Food and Drug Administration (FDA). *See* Benjamin N. Cavataro, *Regulating Guns as Products*, 92 GEO. WASH. L. REV. 87, 91 (2024) (arguing that Congress should authorize the Consumer Product Safety Commission to regulate the safety of firearms as products). For a creative argument that the FDA might regulate guns as a "device," see Lars Noah, *Time to Bite the Bullet? How an Emboldened FDA Could Take Aim at the Firearms Industry*, 53 CONN. L. REV. 787, 832–33 (2022).

251. *Fortress Safe Announces Recall of Biometric Gun Safes Due to Serious Injury Hazard and Risk of Death; One Death Reported*, U.S. CONSUMER PROD. SAFETY COMM'N, https://www.cpsc.gov/Recalls/2024/Fortress-Safe-Announces-Recall-of-Biometric-Gun-Safes-Due-to-Serious-Injury-Hazard-and-Risk-of-Death-One-Death-Reported [https://perma.cc/FA2N-86GU].

252. *Id.*

253. *See supra* notes 97–102.

254. *See*, *e.g.*, Benjamin H. Barton, *Tort Reform, Innovation, and Playground Design*, 58 FLA. L. REV. 265, 270 (2006) ("[T]ort reformers have gotten at least one of their justifications for reform wrong: The law of product liability does not retard innovation. To the contrary, in some markets it actually has led to a spectacular rise in innovation."); Robert E. Litan, *The Safety and Innovation*

flammable pajamas and tampons that increased the risk of toxic shock syndrome began to face tort liability, for example, they responded by improving their products.[255]

In the same way, it seems plausible that "litigation against firearms manufacturers may also add to the pressure to personalize guns"[256] or otherwise make them safer. Indeed, throughout the 1990s and early 2000s, the gun industry was subject to a wave of cases,[257] many of them arguing that manufacturers were under a legal duty to make guns with improved safety features.[258]

Now, though, most such lawsuits are prohibited by the Protection of Lawful Commerce in Arms Act (PLCAA), which immunizes gun manufacturers from most suits relating to the "criminal or unlawful misuse" of their products.[259] PLCAA prohibits litigation:

> brought by any person against a manufacturer or seller of a qualified product [i.e., guns, ammunition, or parts], or a trade association, for damages, punitive damages, injunctive or declaratory relief, abatement, restitution, fines, or penalties, or other relief, resulting from the criminal or unlawful misuse of a qualified product by the person or a third party.[260]

In practice, this means that firearms manufacturers and sellers have generally been able to evade the mass tort lawsuits that arguably helped change other industries.[261]

Effects of U.S. Liability Law: The Evidence, 81 AM. ECON. REV. 59, 63 (1991) (suggesting judges and legislators should consider allowing manufacturers more space to experiment with safety innovations).

255. *See* Kehm v. Procter & Gamble, 580 F. Supp. 913, 925 (N.D. Iowa 1983) (suing Procter & Gamble for product liability); RALPH NADER & WESLEY J. SMITH, NO CONTEST: CORPORATE LAWYERS AND THE PERVERSION OF JUSTICE IN AMERICA 315–17 (1996) (noting safety improvements resulting from litigation involving tampons and flammable pajamas); SHARRA L. VOSTRAL, TOXIC SHOCK: A SOCIAL HISTORY 111–12 (2018) (describing *Kehm* litigation and its aftermath).

256. Teret et al., *supra* note 41, at 38–39.

257. Timothy D. Lytton, *Introduction* to SUING THE GUN INDUSTRY 1, 3 (Timothy D. Lytton ed., 2005).

258. Stevenson, *supra* note 29, at 707 n.99 (collecting cases).

259. Jacobs, *supra* note 29, at 986.

260. 15 U.S.C. § 7903(5)(A). A separate set of tort doctrines largely shield individual gun owners from liability when their guns are stolen, which lessens incentives for gun safety at the individual level as well. *See* Andrew Jay McClurg, *The Second Amendment Right to Be Negligent*, 68 FLA. L. REV. 1, 24–31 (2016) (outlining the harms of negligent gun ownership protected by these tort principles).

261. *See, e.g.*, City of New York v. Beretta U.S.A. Corp., 524 F.3d 384, 390 (2d Cir. 2008) (dismissing public nuisance claims based on New York statute); Ileto v. Glock, Inc., 565 F.3d 1126, 1130, 1138 (9th Cir. 2009) (dismissing claims brought under California common law tort statutes for foreseeably and proximately causing injury, emotional distress, and death through knowing,

But PLCAA is not an insurmountable barrier, and some recent litigation may be increasing pressure on manufacturers to make their products safe. For example, PLCAA specifically creates an exception for "action[s] for . . . damage resulting directly from a defect in design or manufacture of the product."[262] Thus, lawsuits against a gun manufacturer whose weapons spontaneously misfire are still allowed, and such suits might well have the effect of incentivizing safer (in the sense of more reliable) weapons, even if courts generally do not permit claims that a lack of safety features is a design defect.[263] Other courts have permitted suits alleging a "wrongful marketing theory of liability" for gun manufacturers who "have sought to grow the AR-15 market by extolling the militaristic and assaultive qualities of their AR-15 rifles and, specifically, the weapon's suitability for offensive combat missions."[264] For example, the lawsuit by families of the victims of the Sandy Hook massacre against Remington for wrongfully marketing its Bushmaster AR-15 style rifle settled for $73 million after the U.S. Supreme Court declined to review a decision by the Connecticut Supreme Court allowing the case to go to trial.[265]

Seeking to take advantage of PLCAA's "predicate exception," in 2021, New York passed a law requiring gun industry actors who sell firearms, ammunition, or accessories in the state to "establish and utilize reasonable controls and procedures to prevent its qualified products from being possessed, used, marketed or sold unlawfully in New York state."[266] The law also prohibits gun industry actors from knowingly or recklessly creating, maintaining, or contributing to a condition in New York that endangers public health and safety "by conduct either unlawful in itself or unreasonable under all the circumstances."[267] In a lawsuit seeking to invalidate the law, the NSSF and various gun manufacturers argued that "New York is now trying to accomplish through legislation what it was unable to accomplish through litigation"[268]—reversing the usual criticism of tort liability that, as expressed in PLCAA itself, tort suits impermissibly "attempt to use the judicial branch

intentional, reckless, and negligent conduct); *see also* Dru Stevenson & Jenna R. Shorter, *Revisiting Gun Control and Tort Liability*, 54 IND. L. REV. 365, 393–95 (2021) (discussing the PLCAA and recent efforts to get around it).

262. 15 U.S.C. § 7903(5)(A)(v).

263. Travieso v. Glock, 526 F. Supp. 3d 533, 545 (D. Ariz. 2021).

264. Soto v. Bushmaster Firearms Int'l, LLC, 202 A.3d 262, 277–78 (Conn. 2019), *cert. denied sub nom.* Remington Arms Co., LLC v. Soto, 140 S. Ct. 513 (2019) (mem.).

265. Rick Rojas, Karen Zraick & Troy Closson, *Sandy Hook Families Settle with Gunmaker for $73 Million Over Massacre*, N.Y. TIMES (Feb. 17, 2022), https://www.nytimes.com/2022/02/15/nyregion/sandy-hook-families-settlement.html [https://perma.cc/B5FN-W29H].

266. N.Y. GEN. BUS. Law § 898-b(2) (McKinney 2021).

267. *Id.* § 898-b(1).

268. Complaint at 3, Nat'l Shooting Sports Found., Inc. v. James, 604 F.Supp.3d 48 (N.D.N.Y. 2021) (No. 01348), ECF No. 1.

to circumvent the Legislative branch of government to regulate interstate and foreign commerce through judgments and judicial decrees."[269]

The scope of liability under these predicate statutes remains uncertain. In New Jersey, a federal court recently held that New Jersey's similar law "does not fall within the predicate exception of the PLCAA and is therefore preempted by the PLCAA."[270] As this Article was being finalized, the Supreme Court had heard but not yet decided a major PLCAA case in which Mexico is suing the gun industry for billions of dollars based on allegations that they have contributed to gun trafficking and bloodshed in Mexico.[271] Such cases have the potential to significantly reshape the tort landscape. But at least for now, because federal law limits the reach of both state tort law and federal regulations to compel safer firearms, manufacturers are subject to lower legal duties to innovate.

B. Constitutional Limitations on Safety Innovations

With tort law and regulation limited by federal statute, states might have a role to play influencing the pace and direction of firearm technology either by restricting innovative weaponry—including new technologies like

269. 15 U.S.C. §§ 7901(a)(6)–(8).

270. Nat'l Shooting Sports Found. v. Platkin, No. 22-6646, 2023 WL 1380388, at *7 (D.N.J. Jan. 31, 2023).

271. Smith & Wesson Brands v. Estados Unidos Mexicanos, No. 23-1141, 2024 WL 4394115 (U.S. Oct. 4, 2024); Lindsay Whitehurts, *Supreme Court Will Weigh Mexico's $10 Billion Lawsuit Against U.S. Gun Makers*, ASSOCIATED PRESS (Oct. 4, 2024, 11:13 AM), https://apnews.com/article/gun-manufacturers-mexico-supreme-court-718955b10918f6f13d3e2182bd18b250 [https://perma.cc/4A6C-7EC2]; *see also* Adam Liptak, *Supreme Court to Decide Whether Mexico Can Sue U.S. Gun Makers*, N.Y. TIMES (Oct. 5, 2024), https://www.nytimes.com/2024/10/04/us/supreme-court-mexico-lawsuit-gun-makers.html [https://perma.cc/JQD2-X4ZN] (describing the suit).

automatic weapons,[272] high-capacity magazines,[273] and ghost guns[274]—or by requiring certain safety features on guns.[275] And indeed, some states have attempted to do just that. Those efforts, in turn, have run into constitutional hurdles, especially because of the Supreme Court's heavily originalist approach to the Second Amendment.[276]

In *New York State Rifle and Pistol Association v. Bruen*,[277] the Supreme Court held that modern gun laws cannot be constitutionally justified based solely on whether and to what degree they save lives while respecting the right to armed self-defense: "Rather, the government must demonstrate that the regulation is consistent with this Nation's historical tradition of firearm regulation. Only if a firearm regulation is consistent with this Nation's historical tradition may a court conclude that the individual's conduct falls

272. Gun rights advocates often emphasize that automatic weapons like the Puckle Gun, patented in 1718, have existed for centuries, and those assertions have made their way into judicial opinions. *See, e.g.*, Duncan v. Becerra, 970 F.3d 1133, 1147 (9th Cir. 2020) (arguing that there is a historical basis for multi-shot firearms), *reh'g en banc granted, opinion vacated*, 988 F.3d 1209 (9th Cir. 2021), *and on reh'g en banc sub nom*. Duncan v. Bonta, 19 F.4th 1087 (9th Cir. 2021), *cert. granted, judgment vacated*, 142 S. Ct. 2895 (2022), *and vacated and remanded*, 49 F.4th 1228 (9th Cir. 2022). But the Puckle Gun was essentially a technological curio, hardly a commercially significant development. DeLay, *supra* note 31, at 143–45.

273. Magazines as a means for loading firearms did indeed exist at the time of the Founding—the Girandoni air rifle, first produced in 1779, is typically given as an early example, though even gun rights advocates acknowledge them as rare. Del. State Sportsmen's Ass'n v. Del. Dep't of Safety & Homeland Sec., 664 F. Supp. 3d 584, 599 n.14 (D. Del. 2023). Rather, "[s]ingle-shot muzzle-loaders remained the only handheld firearms that the vast majority of people ever owned, used, or encountered in the late-eighteenth and early-nineteenth centuries." DeLay, *supra* note 31, at 156; *id.* at 153 (noting that air-guns like the Girandoni "were so rare that owners could charge people to see them"); *see also* JIM RASENBERGER, REVOLVER: SAM COLT AND THE SIX-SHOOTER THAT CHANGED AMERICA 3–4 (2021) (concluding that "the guns of 1830 were essentially what they had been in 1430: single metal tubes or barrels stuffed with combustible powder and projectiles" where "[a]fter every shot, the shooter had to carry out a minimum of three steps: pour powder into the barrel; add a projectile . . . ; then ignite the gunpowder and send the projectile on its way"). Magazines did not plausibly come into common use until roughly the time of the Civil War, when the Henry and Spencer repeating rifles became more widespread. S. F. Veteran Police Officers Ass'n v. City & Cnty. of S.F., 18 F. Supp. 3d 997, 1003 (N.D. Cal. 2014).

274. Some connect modern private production of guns to early historical practices. *E.g.*, Joseph G.S. Greenlee, *The American Tradition of Self-Made Arms*, 54 ST. MARY'S L.J. 35, 36 (2023); *see also* Jamie G. McWilliam, *The Unconstitutionality of Unfinished Receiver Bans*, HARV. J.L. & PUB. POL'Y PER CURIAM, Spring 2022, at 1 ("There is a long and storied tradition in the United States of privately manufacturing firearms."). *But see* DeLay, *supra* note 31, at 198–99 (arguing that this argument "defines 'arms-making' to include an implausibly huge range of activities," "conflates amateurs with professionals," and "mischaracterizes what it is that consumers are actually doing with ghost-gun kits and 3D-printers. They are not making guns, but rather *assembling* them").

275. We do not address here the difficult question of whether the Second Amendment directly restricts civil liability for gun-related harms. For an approach to answering that question, see generally Noah, *supra* note 29.

276. Joseph Blocher & Eric Ruben, *Originalism-by-Analogy and Second Amendment Adjudication*, 133 YALE L.J. 99, 102–05 (2023).

277. 142 S. Ct. 2111 (2022).

outside the Second Amendment's unqualified command."[278] The Court recognized that "unprecedented societal concerns or dramatic technological changes may require a more nuanced approach"[279] and even emphasized that the test permits "*new*" regulations,[280] but nonetheless applied the test rigidly—a pattern followed by many lower courts.[281] This is consistent with how some gun rights advocates and scholars have characterized gun regulation as a break from history—even as "innovative"[282] or a "modern orthodoxy."[283]

The Supreme Court's recent decision in *United States v. Rahimi*[284] provides a welcome, albeit partial, corrective to this kind of asymmetric updating. In an 8–1 decision, the Court upheld a federal law disarming people subject to certain domestic violence restraining orders, finding it relevantly similar to Founding-Era laws regarding "sureties" and "affray."[285] The majority redescribed *Bruen*'s historical-analogical test as requiring that modern gun laws be "consistent with the principles that underpin our regulatory tradition,"[286] not that they take the same shape as historical forebears. This higher level of generality should blunt the worst of the rigid historicism associated with *Bruen*, but even after *Rahimi*, some judges continue to define the right in broad terms while casting the regulatory tradition narrowly.[287] This raises hard questions about whether and to what degree laws regarding gun safety innovation will be upheld. Can a backwards-looking constitutional test ever adequately account for new safety innovations? Consider the following case.

California's Unsafe Handguns Act (UHA) was amended in 2007 to require newly developed models of semiautomatic pistols to be equipped

278. *Id.* at 2126; *see also id.* at 2128–29 (summarizing *Heller*'s historical methodology).

279. *Id.* at 2132.

280. *Id.*; *see* Joseph Blocher & Reva B. Siegel, *Guided by History: Protecting the Public Sphere from Weapons Threats Under* Bruen, 98 N.Y.U. L. REV. 1795 (2023) ("[T]he Court's embrace of change under the Second Amendment includes technological change, regulatory change, and change in understandings of community.").

281. Jacob D. Charles, *The Dead Hand of a Silent Past:* Bruen*, Gun Rights, and the Shackles of History*, 73 DUKE L.J. 67, 78 (2023) (collecting cases).

282. *The Second Amendment v. "Innovative" Gun Control*, NRA-ILA (Apr. 10, 2023), https://www.nraila.org/articles/20230410/the-second-amendment-v-innovative-gun-control [https://perma.cc/MFU5-BRCH] ("Gun control advocates are ceaseless innovators in the realm of limiting freedom. They continually devise new and bizarre policies to undermine the Second Amendment rights of law-abiding Americans.").

283. NICHOLAS JOHNSON, NEGROES AND THE GUN: THE BLACK TRADITION OF ARMS 14, 286–97 (2014).

284. 144 S. Ct. 1889 (2024).

285. *Id.* at 1901–02.

286. *Id.* at 1898.

287. Joseph Blocher & Reva B. Siegel, *The Ambitions of "History and Tradition" in the Second Amendment and Beyond*, U. PA. L. REV. (forthcoming 2026).

with three new safety features—magazine-out safeties, chamber load indicators, and bullet microstamping technology—once the state Department of Justice certified that these technologies had reached a certain level of availability.[288] The magazine is the portion of a firearm that holds additional bullets, and many people believe that when the magazine is removed from the gun, it is no longer loaded. But if one of the bullets was moved from the magazine to the firing chamber, the gun is still loaded. A magazine-out safety prevents the gun from firing when the magazine is disengaged. A chamber load indicator similarly informs the user whether a round is in the gun's chamber or not, thereby decreasing accidental shootings. Microstamping attempts to ensure that a gun's make, model, and serial number are imprinted on the bullet casings when the weapon is fired, making it easier to track guns used in crimes.[289]

Interestingly, the Act, before its repeal in 2024, would only go into effect when these technologies are unencumbered by patents.[290] Thus, no firm would have to license patents from its rivals in order to compete in the market. This also means, however, that the requirement to adopt these innovations would only arise two decades after they were invented, given the current length of U.S. patents. In addition, the requirements do not apply to already-approved models, meaning that firms can continue to make and sell older, less safe versions of their weapons.[291]

In 2013, the California Department of Justice certified the availability of these three technologies, triggering the requirement, but gun manufacturers have generally refused to comply with it.[292] Some argue that microstamping technology is unreliable and easy to tamper with.[293] The gun manufacturer Ruger includes the following description of microstamping on its FAQ page for California residents:

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288. Cal. Penal Code § 31910 (a)(2)(D)–(E) (2024) (chamber load indicator and magazine disconnect mechanism); Cal. Penal Code § 31910(b)(6)(A) (2021) (repealed 2023) (microstamp).

289. Whether and to what degree such microstamping requirements are effective is a matter of ongoing debate. Chip Brownlee, *What Is Microstamping, And Can It Help Solve Shootings?*, TRACE (Jan. 23, 2023), https://www.thetrace.org/2023/01/microstamping-gun-bullets-new-york/ [https://perma.cc/JN5T-UH59] (reporting 2004 evaluation finding microstamping is effective, 2006 peer-reviewed study finding it ineffective, and 2012 & 2013 peer-reviewed studies finding more favorable but still imperfect results).

290. Cal. Penal Code § 31910.

291. Cal. Penal Code § 32030 (2012).

292. *E.g.*, Kate Mather, *Smith & Wesson Says It Won't Follow California 'Microstamping' Law*, L.A. TIMES (Jan. 13, 2014, 3:22 PM), https://www.latimes.com/local/lanow/la-me-ln-smith-wesson-microstamping-law-20140123-story.html [https://perma.cc/5EM8-HZVE].

293. *E.g.*, *Washington, D.C. Homicides Down, Too; Calif. Microstamping Law Takes Effect in New Year*, NAT'L SHOOTING SPORTS FOUND. (Dec. 30, 2009), https://www.nssf.org/articles/washington-d-c-homicides-down-too-calif-microstamping-law-takes-effect-in-new-year/ [https://perma.cc/7V78-SXXB].

> The technology does not work. An independent, peer-reviewed study published in the professional scholarly journal for forensic firearms examiners proved that the concept of microstamping is unreliable and does not function as the patent holder claims. It can be easily defeated in mere seconds using common household tools. Criminals could also simply switch the engraved firing pin to a readily available unmarked spare part, thereby circumventing the process. To date, no firearms have been made by any manufacturer that utilizes this unproven technology. Please note that we continue to work with the National Shooting Sports Foundation (NSSF) to support their efforts to overturn the California microstamping law.[294]

To avoid complying with the law, gun manufacturers have been selling new manufactures of existing semiautomatic pistol models that were grandfathered into the list of approved pistols, rather than introduce new models for sale.[295] This is akin to Chevy continuing to sell 1997 model Luminas for another decade rather than adding airbags when they became mandatory in 1998.

As the Ruger statement suggests, however, there has also been active litigation against California's law. Prior to *Bruen*, those challenges had failed in both state[296] and federal courts.[297] But in August 2022, just a few months after *Bruen*, a federal district court enjoined California from enforcing its requirements.[298] Applying the *Bruen* framework, the court explained that the UHA provisions "unquestionably infringe on the right to keep and bear arms" because they prevent plaintiffs from buying "state-of-the-art handguns for self-defense."[299] Because no new semiautomatic pistols have been approved for sale in the state since 2013, the court reasoned that limiting plaintiffs' options to "outdated handguns" renders their right to bear arms meaningless.[300] California has appealed to the Ninth Circuit but is no longer defending its microstamping requirement.[301] Whether this aspect of California's law would have survived a *Bruen* analysis on appeal thus

294. *Customer Service*, RUGER, https://www.ruger.com/dataProcess/customerService/#S19 [https://perma.cc/2K2T-J4W9].

295. Pena v. Lindley, 898 F.3d 969, 991–92 (9th Cir. 2018).

296. Bob Egelko, *California Supreme Court Upholds Bullet Micro-Stamping Law*, S.F. CHRON. (June 18, 2018, 5:13 PM), https://www.sfchronicle.com/news/article/Calif-Supreme-Court-upholds-law-requiring-13035147.php [https://perma.cc/F5SX-RX28].

297. Pena v. Lindley, 898 F.3d 969, 987 (9th Cir. 2018).

298. Boland v. Bonta, 662 F. Supp. 3d 1077, 1081 (C.D. Cal. 2023).

299. *Id.* at 1084.

300. *Id.* at 1085.

301. Notice of Preliminary Injunction Appeal at 2, Boland v. Bonta, 662 F.Supp.3d 1077, No. 23-55276 (C.D. Cal. Mar. 27, 2023), ECF No. 62.

remains an open question. Three other states have microstamping-related rules,[302] but to our knowledge, none of them have yet been challenged.

It seems plausible that microstamping, magazine-out safeties, and chamber load indicators are valuable safety innovations akin to safety switches, which are now widely accepted. But *Bruen*'s historical test threatens to render their functionality irrelevant, seemingly limiting states to requiring the modern equivalents of safety features that existed in 1791 or 1868, when guns were far less deadly and likely were not even stored loaded. To the extent that weapons have any such features, then they will be driven by the market choices of gun purchasers and gun manufacturers. And as we saw in the previous Part, there are reasons to be skeptical that markets alone will generate socially optimal firearm safety.

C. Asymmetric Constitutional Protection for Modern Weapons over Modern Laws

Bruen and some lower court decisions[303] treat history as a relatively strict limit on gun regulation innovation. One might therefore expect the same historical rigidity to apply to the "Arms" that are covered by the Amendment. Indeed, some have suggested that under a truly originalist approach the Second Amendment should be limited to those "Arms" that were in circulation in the Founding Era.[304] But the Court has dismissed this

302. D.C. law prohibits the sale of "any semiautomatic pistol manufactured on or after January 1, 2018 that is not microstamp-ready." D.C. CODE § 7-2504.08(b) (2018). "'Microstamp-ready' means a semiautomatic pistol that is manufactured to produce a unique alpha-numeric or geometric code on at least 2 locations on each expended cartridge case that identifies the make, model, and serial number of the pistol." D.C. CODE § 7-2505.03(a)(3) (2016). NY passed a law in 2022 in the wake of *Bruen* that requires semiautomatic pistols manufactured or delivered to any licensed dealer in the state to be capable of microstamping ammunition. N.Y. PENAL Law § 265.38 (McKinney 2022). This law will not take effect, however, until the state deems the technology "viable." N.Y. EXEC. Law § 837–w(3)(d) (McKinney 2022). Also in 2022, NJ adopted a law directing the AG to test the viability of microstamping technology. Once the technology is certified as viable, gun dealers will be required to sell at least one microstamping-enabled firearm. The state will provide a 10% rebate, up to $30 on the purchase of any microstamping-enabled firearm. N.J. STAT. ANN. § 2C:58-2.13 (2022).

303. Charles, *supra* note 281, at 128.

304. Bryan Garner (@BryanAGarner), TWITTER (May 25, 2022, 4:11 PM), https://twitter.com/BryanAGarner/status/1529555870031527939 [https://perma.cc/9FYC-J9G3] ("If, alas, we can't repeal the Second Amendment, let's say its meaning extends only to technologies of the caliber (ahem) that existed when it took effect: muskets that required eight seconds to reload between shots. The Second Amendment has nothing to do with assault rifles."). Garner is editor-in-chief of Black's Law Dictionary and co-authored two books with Justice Scalia: ANTONIN SCALIA & BRYAN A. GARNER, MAKING YOUR CASE: THE ART OF PERSUADING JUDGES (2008) and ANTONIN SCALIA & BRYAN GARNER, READING LAW: THE INTERPRETATION OF LEGAL TEXTS (2012).

argument as "bordering on the frivolous"[305] and indicated its willingness to expand the category of "Arms" to keep pace with developments in firearms technology. The result is an asymmetric preferencing of innovative gun products over "innovative" gun regulation.

Indeed, the *Bruen* majority specifically signaled that the Second Amendment *does* protect innovation, in that it extends to modern weapons that were unknown to the Framers: "We have already recognized in *Heller* at least one way in which the Second Amendment's historically fixed meaning applies to new circumstances: Its reference to 'arms' does not apply 'only [to] those arms in existence in the 18th century.'"[306] This is because "even though the Second Amendment's definition of 'Arms' is fixed according to its historical understanding, that general definition covers modern instruments that facilitate armed self-defense."[307] (Elsewhere, Justice Thomas, author of the *Bruen* majority, suggested that the Second Amendment covers "modern sporting rifles"[308]—another name for what many call assault weapons.)

The scope of "Arms" protected by the Second Amendment continues to be the subject of significant debate and uncertainty. As *Rahimi* suggests, the Second Amendment's coverage cannot be limited to "muskets and sabers"[309]; it must include some new forms of weaponry, but not all of them. The Supreme Court has repeatedly held that "dangerous and unusual" weapons can be prohibited and has equated that category with those weapons not "in common use at the time."[310] The difficulties of this test are evident: How common? For what uses? Taken literally, the test would permit the gun industry to expand the category of constitutionally protected "Arms" simply by flooding the market with a new model of weapon or accessory before the government can effectively regulate it.[311] The federal courts of appeal are currently wrestling with how to apply this test in light of *Bruen*,[312] and the matter seems destined for Supreme Court review.

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305. Dist. of Columbia v. Heller, 554 U.S. 570, 582 (2008) ("Some have made the argument, bordering on the frivolous, that only those arms in existence in the 18th century are protected by the Second Amendment.").

306. N. Y. State Rifle & Pistol Ass'n v. Bruen, 142 S. Ct. 2111, 2132 (2022).

307. *Id.*

308. Friedman v. Highland Park, 577 U.S. 1039, 1039, *cert. denied* (Thomas, J., dissenting) (2015).

309. United States v. Rahimi, 144 S. Ct. 1889, 1898.

310. *Bruen*, 142 S. Ct. at 2128 (2022) (citing *Heller*, 554 U.S. at 627).

311. *Heller*, 554 U.S. at 721 (Breyer, J., dissenting) ("On the majority's reasoning, if tomorrow someone invents a particularly useful, highly dangerous self-defense weapon, Congress and the States had better ban it immediately, for once it becomes popular Congress will no longer possess the constitutional authority to do so.").

312. *See* Bianchi v. Brown, 111 F.4th 438, 441–42 (4th Cir. 2024) (en banc) (upholding Maryland restriction on assault weapons); Bevis v. City of Naperville, 85 F.4th 1175, 1182 (7th Cir. 2023) (upholding Illinois restrictions on assault weapons and high-capacity magazines).

In the meantime, some lower courts—seemingly following *Bruen*'s lead—have been very quick to connect new firearm technology to centuries of prior innovation, even as they distinguish modern laws from their historical forebears. This has led to conflicting conclusions about what kinds of weapons are covered—assault weapons and high-capacity magazines,[313] for example, or ghost guns.[314] And in many cases, it has led to a kind of asymmetric updating wherein the Amendment protects new technologies of violence but not new forms of regulating them.[315]

This is evident in cases involving restrictions on assault weapons and high-capacity magazines. Starting in 1994, federal law prohibited the manufacture for civilian markets of assault weapons (as defined in the statute) and high-capacity magazines, defined as "a magazine, belt, drum, feed strip, or similar device manufactured after the date [of the act] that has the capacity of, or that can be readily restored or converted to accept, more than 10 rounds of ammunition."[316] The law was allowed to sunset in 2004, however, and since the Supreme Court did not decide *Heller* until 2008, the federal law was never tested against the individual right to keep and bear arms.

The market and the law have changed dramatically since then. Some argue that many if not most guns today are sold with high-capacity magazines, whose manufacture, again, would have been legally forbidden as recently as 2004.[317] (Such claims are hard to evaluate, since federal law does not require gun dealers to report sales information.[318]) And while such

313. *Compare* Herrera v. Raoul, 670 F. Supp. 3d 665, 674 (N.D. Ill. 2023) (holding that such laws were enforceable), *with* Barnett v. Raoul, 671 F. Supp. 3d 928, 935 (S.D. Ill. 2023) (holding that such laws were unenforceable). In *Bevis*, the Seventh Circuit sided with *Herrera.* 85 F.4th 1175.

314. *Compare* Rigby v. Jennings, 630 F. Supp. 3d 602, 615 (D. Del. 2022) (concluding that the plain text of the Second Amendment covers unfinished lower receivers), *with* Def. Distributed v. Bonta, No. CV-22-6200, 2022 WL 15524977, at *4 (C.D. Cal. Oct. 21, 2022) (concluding that the plain text of the Second Amendment does not cover home manufacture of firearms), *adopted*, No. 22-6200, 2022 WL 15524983 (C.D. Cal. Oct. 24, 2022).

315. Joseph Blocher & Reva Siegel, *Gun Rights and Domestic Violence in* Rahimi*—Whose Traditions Does the Second Amendment Protect?*, BALKINIZATION (Oct. 31, 2023), https://balkin.blogspot.com/2023/10/gun-rights-and-domestic-violence-in.html [https://perma.cc/HG8K-ELYM].

316. Violent Crime Control and Law Enforcement Act of 1994, Pub. L. No. 103-322, §§ 110103–110103, 108 Stat. 1796, 1996–99 (1994).

317. Matthew Larosiere*, Losing Count: The Empty Case for "High-Capacity" Magazine Restrictions*, CATO INST.: LEGAL POL'Y BULL. NO. 3 (July 17, 2018), https://www.cato.org/sites/cato.org/files/pubs/pdf/legal-policy-bulletin-3-updated.pdf [https://perma.cc/EY6P-J83A] ("Full-size pistols, like those commonly used by law enforcement officers, overwhelmingly ship with 12- to 20-round magazines as standard. And the most common self-loading rifles in the United States have a standard magazine capacity of between 20 and 30 rounds." (internal citation omitted)).

318. *The Effects of Firearm Sales Reporting, Recording, and Registration Requirements*, RAND CORP.: GUN POL'Y IN AM. (July 16, 2024), https://www.rand.org/research/gun-policy/analysis/firearm-sales.html [https://perma.cc/E5Y9-D8P6].

weapons have been broadly deregulated statutorily and constitutionally, fourteen states do still restrict assault weapons, high-capacity magazines, or both.[319]

Those restrictions have been subject to constitutional challenges, and although most have been upheld, some judges—citing the language from *Bruen* above—have indicated a willingness to extend constitutional protection to these new forms of weapons, while subjecting restrictions on them to an asymmetrically strict test. Striking down California's prohibition on assault weapons and high-capacity magazines, one district court judge concluded that the law had "no historical pedigree" because "[p]rior to the 1990's, there was no national history of banning weapons because they were equipped with furniture like pistol grips, collapsible stocks, flash hiders, flare launchers, or threaded barrels"[320]—disregarding or distinguishing a range of historical restrictions as inapposite. And yet the court found it easy to connect assault weapons with their ancestors, musing:

> [A] semiautomatic pistol with a threaded barrel (*i.e*, an "assault weapon") is is [sic] not much of a technological advancement over an 1868 navy revolver with a smooth barrel. And is a semiautomatic shotgun with a pistol grip and adjustable stock (*i.e*, an "assault weapon") really a dramatic technological advancement over common multi-shot shotguns from the 1800s?[321]

In fact, the court opened its opinion by comparing assault weapons to "the Bowie Knife which was commonly carried by citizens and soldiers in the 1800s,"[322] and yet rejected the relevance of historical restrictions of bowie knives and other bladed weapons because they are *not* firearms.[323]

In another case involving Illinois' prohibition on large-capacity magazines, defined as those able to accept "more than 10 rounds of ammunition for long guns and more than 15 rounds of ammunition for handguns,"[324] a district court concluded that it was "not even a close call" that such magazines are "[A]rms" for purposes of the Second Amendment, and enjoined the law.[325] The Seventh Circuit later lifted that injunction, over a dissent arguing that "the Act's ban on magazines holding more than ten

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319. *Large Capacity Magazines*, GIFFORDS L. CTR. https://giffords.org/lawcenter/gun-laws/policy-areas/hardware-ammunition/large-capacity-magazines/ [https://perma.cc/ECW9-9QVU].

320. Miller v. Bonta, 690 F. Supp. 3d 956, 974 (S.D. Cal. 2023).

321. *Id.* at 988.

322. *Id.* at 965.

323. *Id.* at 994 ("But dirks, daggers, and bowie knives were not guns. (Pistols are addressed separately below.) They were bladed instruments; they were not firearms. Knife laws may not be completely irrelevant, but they are pretty close."). The court was quick to add that "[t]his is not to say that bowie knives are not 'arms' imbued with Second Amendment protection." *Id.* at 995.

324. 720 Ill. COMP. STAT. 5/24-1.10(a) (2024).

325. Barnett v. Raoul, 671 F. Supp. 3d 928, 943 (S.D. Ill. 2023) (quoting challengers' complaint), *vacated sub nom.* Bevis v. City of Naperville, 85 F.4th 1175 (7th Cir. 2023).

rounds for rifles and more than fifteen rounds for handguns effectively bans firearms that come standard with magazines over the limit."[326]

The point here is not to argue that high-capacity magazines (or, for that matter, magazines in general[327]) do or do not fall within the scope of the Second Amendment. There is a perfectly plausible argument that they do, as a necessary concomitant to the effective use of a modern weapon.[328] The point is to highlight that this line of reasoning is itself predicated on the *current* state of the technology of violence; it defines the scope of a constitutional right based on modern markets and innovation. One could do the same for other innovative forms of gun technology such as "ghost gun" kits, which defenders describe as being part of the "American tradition of self-made arms."[329] Whether or not unfinished receivers can be legitimately *analogized* to gunsmithing in 1791, 3D printing and other technological developments have radically *changed* the ways in which people can make and/or finish guns at home.[330] Opponents of ghost gun restrictions want *modern* technology, not access to an 18th century smithy.

In any event, there is a great deal of uncertainty about what *Bruen* allows and prohibits, even in the aftermath of *Rahimi*. For the meantime, the Court's framework is being deployed by some judges in ways that asymmetrically invite some kinds of gun-related innovation while discouraging others. Gun manufacturers and owners can be reasonably confident that new types of firearms will be recognized as "Arms" entitled to constitutional protection. By contrast, some courts have essentially concluded that governments trying to address gun safety issues are limited to the kinds of solutions that were available in the 18th century.

Conclusion

Technologies of violence are not given; they are shaped by markets and by law. Both the kinds of weapons that Americans have and the technologies they have created to respond to those weapons are products of market and legal factors that influence the pace and direction of innovation. Only by understanding the interactions between these factors can scholars and policymakers accurately evaluate the possibilities for reform.

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326. *Bevis*, 85 F.4th at 1209 (Brennan, J., dissenting).

327. *See supra* note 273 and sources cited therein.

328. Ass'n of N.J. Rifle & Pistol Clubs, Inc. v. Att'y Gen. of N. J., 910 F.3d 106, 116 (3d Cir. 2018).

329. *See* Greenlee, *supra* note 274, at 80–82 (arguing that no federal law restricts arms built for personal use).

330. McWilliam, *supra* note 274, at 2 ("Some still engage in th[e] historical process of firearm building. Today, though, the prospective firearm manufacturer has less laborious options for doing so." (internal citation omitted)).

Supply and demand in the market for firearms are meaningfully different than they are for smart phones or automobiles. Innovators will find it harder to bring such firearms products to market, because some investors, established firms, and retailers are wary of them. Moreover, a small cohort of deeply committed consumers can radically alter the market for everyone. The threat of boycotts over smart guns delayed, if not completely destroyed, a meaningful market for those products. Innovation incentives can also backfire, as with New Jersey's attempt to boost the market for smart gun innovations by mandating them.

But failures in one direction may have led to growth in others. America's inability to diminish mass shootings has generated a colossal market in environmental safety measures. Here, the innovation incentive that boosts demand by requiring new technology and paying for it has been an enormous success, at least in terms of market growth. But different innovation incentives come with distinct sets of tradeoffs. With environmental innovations like these, safety is paid for by taxpayers rather than gun owners and manufacturers, and decisions are broadly made by government officials rather than a private market.

Depending on one's point of view, much of this story is disheartening. Various efforts to address gun violence have failed due to unique market and legal forces. But others will see these failures as successes. Again, our goal in this Article is not to support or oppose any particular approach. Our hope is that by bringing together scholarship on innovation and firearms law, we can identify and explain some of the upstream features that shape the uniquely American technologies of violence.

But we also believe that the effort suggests some paths toward addressing gun violence through innovation. Firearms manufacturers' unique immunities from regulation and tort liability are troubling. While regulation and litigation are necessarily costly for any industry whose products cause harm, the pharmaceutical and automotive industries face intense regulatory and litigation scrutiny and yet remain innovative. As of this writing, efforts are underway to pass federal legislation that would give CPSC power to issue safety warnings and even recalls for defective guns.[331] And further litigation in this area may increase the incentives that gunmakers and gun owners face to invest in safer technologies. Perhaps just as importantly, litigation

331. Press Release, Congresswoman Debbie Dingell, Dingell Reintroduces Legislation to Address Safety Defects that Allow Firearms to Discharge Without Pulling the Trigger (June 22, 2023), https://debbiedingell.house.gov/news/documentsingle.aspx?DocumentID=4333 [https://perma.cc/W3XV-FD6M]; *see also* Cavataro, *supra* note 250 (urging Congress to "authorize the CPSC to exercise product safety regulatory authority over the firearms industry").

promises to divulge important information about gunmakers' innovation and marketing strategies.[332]

If smart guns are going to succeed, they will likely need institutional backers like police departments and the military to increase the size of the market and to assuage concerns about reliability. Giving money to firms to develop smart guns is not sufficient if no market for them ever arises. Perhaps if more police departments equipped their officers with smart guns, they could dramatically increase demand for the firearms, presumably making them cheaper to produce at scale. More importantly, people who are anxious that smart guns will not work when needed would likely be reassured to see them being carried by police or military.

Environmental innovations can be valuable, especially because their benefits can be spread over large populations. Communities need flexibility to determine how they want to spend security dollars. Some might choose metal detectors and bulletproof blackboards; others will prioritize mental health resources.

Finally, Second Amendment doctrine should not asymmetrically protect innovations in lethality while prohibiting innovations in regulation. *Rahimi* provides some hope for course correction in that regard, but its ultimate impact remains uncertain.

In any event, our primary goal here is not to convince anyone of these specific prescriptions but to excavate and shine light on the underlying and under-explored market and legal forces that shape the technologies of violence. By bringing together scholarship on innovation and firearms law, we hope to surface some particularly knotty problems in the gun debate and also to show those scholarly approaches have an essential—and, yes, innovative—role to play in resolving them.

332. For example, the Sandy Hook settlement mentioned above included an agreement to release thousands of pages of Remington's internal corporate documents. As of September 2023, at least, that information had not yet been released. Michael Steinberger, *The Lawyer Trying to Hold Gunmakers Responsible for Mass Shootings*, N.Y. TIMES (Sept. 29, 2023), https://www.nytimes.com/2023/09/29/magazine/the-lawyer-trying-to-hold-gunmakers-responsible-for-mass-shootings.html [https://perma.cc/8GWH-KXHZ].