THE COLLISION COURSE BETWEEN OUTDATED STATE LAWS AND AUTOMATED VEHICLES

William Hubbard† *& Colin Starger*†

America stands at the precipice of a vehicular revolution. Myriads of self-driving vehicles—often referred to as "automated vehicles" or "AVs"—are already rolling out across the nation, and innovators assert that AVs will make our roads safer, less congested, and more economically productive. However, reaching these dreams of self-driving utopias will require more than just technological progress. The uses of traditional vehicles are heavily regulated by hundreds of thousands of state laws that ensure public safety, health, and order. Will these traditional laws still make sense when AVs shift the paradigm? Despite the hype and optimism of many AV advocates, this Article sounds a somber warning: State law is perilously unprepared for AV deployment.

This Article provides the first comprehensive empirical study of the issue and shows that more than 40,000 traditional state laws are unclear or ineffective when applied to AVs. At its core, the reason is simple. For more than a century, our laws have correctly assumed that flesh-and-blood humans drive vehicles, but this assumption rings false with self-driving technologies, leaving outdated state laws on a collision course with AVs. Without significant reforms, the resulting chaos and confusion threatens to undermine both safety, technological progress, and economic prosperity.

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† Professor of Law and Director of the Center for the Law of Intellectual Property and Technology at the University of Baltimore. For their insightful comments and input, I thank Michele Gilman and Nancy Modesitt. I also thank my exceptional team of research assistants without whom this project could never have been completed: Taylor Bayat, Michael Blanchard, Christian Coward, Torra Hausmann, Sina Jahanshahi, Jessica Kweon, Nyari James, and Molly Shaffer. I would also like to thank the Maryland Department of Transportation State Highway Administration, which provided funding for some of the empirical research described in this Article. All credit and errors are shared evenly with my coauthor.

† Associate Dean of Academic Affairs, Professor of Law, and Director of Legal Data and Design Clinic at the University of Baltimore.

After describing and analyzing the problem, this Article considers solutions. Fortunately, the empirical analysis indicates that more than 80% of problematic state laws can be remedied through a single fix: updating the legal definitions of "driver" and "operator." Less fortunately, addressing the remaining problematic state laws will require resolution of tricky policy questions across many legal domains. This Article then evaluates which legal institutions are best suited to developing the needed AV reforms. To date, most states have done nothing independently to prepare for AV deployment, while a minority of states have enacted inconsistent reforms, producing an incoherent patchwork of AV laws in the United States. This Article asserts that greater federal leadership is therefore needed to spur harmonized action. Specifically, federal authorities should work in partnership with state governments to develop "best practices" and provide financial incentives to encourage states to adopt them, in a fashion patterned after the highly successful Commercial Driver's License system.

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INTRODUCTION

America runs on vehicles. Vehicles get students to school, employees to work, shoppers to stores, patients to hospitals, and so on. The economy depends on vehicles shipping countless tons of goods and services across the land. More than 276 million cars, trucks, buses, and other motorized machines travel across the nation every day using more than four million miles of roads.[1] Vehicles play such a central role in modern society that we tolerate their remarkable dangerousness. Hundreds of thousands of people have perished on America's roads in the twenty-first century.[2] In 2022 alone, car accidents caused more than 42,000 deaths and 2.38 million injuries.[3]

We now stand at the precipice of vehicular revolution. Self-driving technologies promise to expand the benefits of vehicles while also making our roads safer and less snarled in traffic. In the past, drivers prone to human error controlled all major vehicular systems. In the future, self-driving vehicles—technically referred to as "automated vehicles" or "AVs"—will deploy complex systems of sensors and computers to perform the tasks previously undertaken by humans.[4] In highly automated vehicles, the person may simply identify a destination and leave the rest to the machine.

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1 Off. of Highway Pol'y Info., *Highway Statistics 2019: State Motor-Vehicle Registrations—2019*, U.S. DEP'T OF TRANSP. (Dec. 9, 2020), https://www.fhwa.dot.gov/policyinformation/statistics/2019/mv1.cfm [https://perma.cc/JZ2B-CXU9]; Bureau of Transp. Stats., *State Transportation by the Numbers*, U.S. DEP'T OF TRANSP., https://www.bts.gov/browse-statistical-products-and-data/state-transportation-statistics/state-transportation-numbers [https://perma.cc/NB6F-6NQU].

2 *See, e.g.*, Press Release, National Highway Traffic Safety Administration, United States Department of Transportation, NHTSA Releases 2019 Crash Fatality Data (Dec. 18, 2020), https://www.nhtsa.gov/press-releases/nhtsa-releases-2019-crash-fatality-data [https://perma.cc/HD2A-C6NA] (highlighting the sheer number of deaths in 2019 alone, which exceeded 30,000).

3 NAT'L CTR. FOR STATS. & ANALYSIS, OVERVIEW OF MOTOR VEHICLE TRAFFIC CRASHES IN 2022 1 (2024), https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/813560 [https://perma.cc/78S3-W95Q].

4 This Article uses a broad definition of AV, as further discussed below. *See infra* note 33.

The potential benefits of this AV revolution are legion. Unlike people, AVs will never drink and drive, send texts while navigating traffic, or erupt in road rage. By removing fallible humans from the driver's seat, AVs could make roads substantially safer.[5] AV technology also promises to grease our economic skids. For example, though trucks transport more than seventy percent of American freight, the country is perennially short on truck drivers. AVs can perform this vital but thankless job—and AVs will not mind spending weeks away from family and friends or crave sleep after hours in the saddle. Shipping will thus become faster, cheaper, and safer.[6] Beyond safety and efficiency, AVs could allow for greater freedom of movement for groups currently unable to operate traditional vehicles like children, blind persons, and the elderly.[7] Machine chauffeurs could significantly improve life quality for many.

This AV future is rapidly approaching. In recent years, more than 1,400 automated vehicles have been tested by more than eighty companies throughout the United States.[8] Indeed, the future has partially arrived in multiple jurisdictions across the United States where AV taxis and delivery vehicles can already be seen scurrying without drivers around city streets.[9] Yet, despite the hype and optimism of AV promoters, this Article aims to issue a somber warning: Much legal work needs doing before dreams of self-driving utopias can become reality.

This Article shows how thousands of laws governing dozens of domains—from the rules of the road to safety regulations to statutes apportioning liability for accidents and more—are simply not ready for

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5 *See* Framework for Automated Driving System Safety, 85 Fed. Reg. 78058, 78061 (proposed Dec. 3, 2020) (to be codified at 49 C.F.R. pt. 571) (describing the impact on accidents of "distraction, impairment, fatigue, errors in judgment, and decisions not to obey traffic laws"). By one estimate, ninety-four percent of serious motor vehicle crashes involve driver-related factors. U.S. DEP'T OF TRANSP., PREPARING FOR THE FUTURE OF TRANSPORTATION: AUTOMATED VEHICLES 3.0, at 3 (2019), https://www.transportation.gov/av/3 [https://web.archive.org/web/20250315191932/https://www.transportation.gov/av/3].

6 Peter S. Goodman, *The Real Reason America Doesn't Have Enough Truck Drivers*, N.Y. TIMES (Feb. 9, 2022), https://www.nytimes.com/2022/02/09/business/truck-driver-shortage.html [https://web.archive.org/web/20250207155624/https://www.nytimes.com/2022/02/09/business/truck-driver-shortage.html].

7 Tony Leys & KFF Health News, *How Autonomous Vehicles Could Help People with Disabilities*, SCI. AM. (Dec. 29, 2023), https://www.scientificamerican.com/article/autonomous-vehicles-give-people-with-disabilities-hope-for-independence [https://perma.cc/6F99-VV2T].

8 Darrell Etherington, *Over 1,400 Self-Driving Vehicles Are Now in Testing by 80+ Companies Across the US*, TECHCRUNCH (June 11, 2019, 8:54 AM), https://techcrunch.com/2019/06/11/over-1400-self-driving-vehicles-are-now-in-testing-by-80-companies-across-the-u-s [https://perma.cc/8XZR-X6W6].

9 *See infra* Section II.A.

AV deployment. At its core, the reason the law is not ready is simple. For more than a century, our ubiquitous rules intersecting with vehicles have assumed that *humans* drive, attend, and control those vehicles. With the AV paradigm shift, this assumption fails. Laws that were previously clear can suddenly become ambiguous or even nonsensical. The potential for chaos and confusion is massive. Until relevant laws are systematically reviewed and updated, AVs will be underregulated legal misfits.

To appreciate the nature of the problem, consider some typical examples. For instance, Maryland requires that a "person" use "an appropriate signal" before turning a vehicle.[10] So, does this law require AVs to signal? The answer should obviously be "yes," but the law as it exists is unclear at best since Maryland law does not define "person" in a fashion that includes AVs.[11] This uncertainty has multitudinous variations, some more problematic than others. For instance, California prohibits vehicles from being "unattended" while the engine is running or while the brakes are not engaged.[12] Under this law, would an empty AV be permitted to drive to a location to pick up a flesh-and-blood person? Myriad state laws regarding "drivers" pose related questions.[13] Does an AV need to obey a state regulation requiring "drivers" of vehicles going in opposite directions to pass each other to the right?[14] Or what

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10 *See, e.g.*, MD. CODE ANN., TRANSP. § 21-604(c) (West 2024) ("A person may not, if any other vehicle might be affected by the movement, turn a vehicle until he gives an appropriate signal in the manner required by this subtitle.").

11 Maryland vehicle law defines "person" to include humans, businesses, and governmental entities. MD. CODE ANN., TRANSP. § 1-101 (West 2024). Maryland law thus does not define "person" to include physical objects like AVs.

12 *E.g.*, CAL. VEH. CODE § 22515 (West 2024); MD. CODE ANN., TRANSP. § 21-1101 (West 2015).

13 *See infra* notes 132–134 and accompanying text.

14 *See, e.g.*, MD. CODE ANN., TRANSP. § 21-302 (West 2024); *accord id.* § 21-303(b) ("The driver of a vehicle overtaking another vehicle that is going in the same direction shall pass to the left of the overtaken vehicle at a safe distance."); MD. CODE ANN., TRANSP. § 21-402(a) (West 2024) (requiring the "driver of a vehicle" to "yield the right-of-way" when turning left); *id.* § 21-404(a) ("The driver of a vehicle about to enter or cross a highway from a private road or driveway or from any other place that is not a highway shall stop."). Some state laws also target the "operators" of vehicles, and states generally define "driver" and "operator" equivalently. ARIZ. REV. STAT. ANN. § 28-101 (2024); CONN. GEN. STAT. § 14-1 (2024); IDAHO CODE § 49-116 (2024); 625 ILL. COMP. STAT. 5/1-154.2 (2024); IOWA CODE § 321.1 (2024); LA. STAT. ANN. § 32:1 (2024); ME. REV. STAT. tit. 29-A, § 101 (2024); MD. CODE ANN., TRANSP. § 11-142 (West 2024); MICH. COMP. LAWS § 257.35a (2025); NEB. REV. STAT. ANN. § 60-473 (West 2025); N.H. REV. STAT. ANN. § 259:24 (2024); N.J. STAT. ANN. § 39:1-1 (West 2024); N.M. STAT. ANN. § 66-1-4.13 (2024); N.Y. VEH. & TRAF. LAW § 113 (McKinney 2025); N.C. GEN. STAT. § 20-4.01 (2024); N.D. CENT. CODE § 39-01-01 (2023); OKLA. STAT. ANN. tit. 47, § 1-140 (2024); 31 R.I. GEN. LAWS § 31-1-17 (2024); S.C. CODE

about traffic tickets? Existing state laws generally assume the presence of human drivers for ticketing purposes and fail to identify who should be penalized if an AV breaks a traffic law when no human driver is present.[15]

How big is this potential problem? Remarkably, prior to the study described in this Article, no state has systematically evaluated its laws to determine which laws require revision or which laws pose the greatest concerns regarding AVs. This Article fills this critical gap by reporting on a groundbreaking empirical evaluation of one state's entire corpus of laws and regulations—Maryland—and then extrapolating from that study to the entire United States. We conclude the problem is large indeed. Tens of thousands of laws across the United States likely need updating before the legal environment can support large-scale AV deployment. Put succinctly, AVs are currently on a collision course with outdated state laws.

To avoid legal wreckage, this Article also plots a sensible path forward. After identifying the scope and dimensions of the AV collision course problem, we consider substantive solutions and procedural approaches to implementing them. In so doing, we make a timely and much-needed contribution to the literature. The nation stands on the threshold of the widespread rollout of AVs, and state and federal lawmakers need to act now to prepare the legal landscape for their deployment.[16]

The Article proceeds in six parts. After this Introduction, Part I sets the stage by providing readers with necessary background and vocabulary regarding AVs. This includes descriptions of the relevant types of AV technology, the levels of AV autonomy, and the current state of AV deployment.

ANN. § 56-1-10 (2024); S.D. CODIFIED LAWS § 32-35-1 (2025); TENN. CODE ANN. § 55-8-101 (2025); VT. STAT. ANN. tit. 23, § 4 (2025); VA. CODE ANN. § 46.2-100 (2024); WASH. REV. CODE § 46.04.370 (2024); W. VA. CODE § 17B-1-1 (2024).

15 This concern is not farfetched. In April 2022, police officers in San Francisco stopped a vehicle for failing to use its headlights at night, only to discover that the vehicle was an AV with no human driver. Hyunjoo Jin, *April Fools! San Francisco Police Pull Over Driverless Car*, REUTERS (Apr. 13, 2022, 5:34 PM), https://www.reuters.com/business/autos-transportation/april-fools-san-francisco-police-pull-over-driverless-car-2022-04-13 https://web.archive.org/web/20220413214139/https://www.reuters.com/business/autos-transportation/april-fools-san-francisco-police-pull-over-driverless-car-2022-04-13]. Shortly thereafter, the AV drove away from police officers. *Id.* Ultimately, officers did not issue any traffic citations even though the car had violated California law. *Id.*; CAL. VEH. CODE § 2800(a) (West 2023) (requiring that drivers "comply with a lawful order, signal, or direction of a peace officer"); *id.* § 24400(b) (West 2024) (requiring the use of headlights at night).

16 Jin, *supra* note 15.

Part II then turns to our empirical evaluation of the scope of the AV collision course problem. The study initially focuses on Maryland, which provides a useful baseline. Maryland has not yet enacted significant AV law reform and represents a typical state in terms of its transportation system and laws. This Part describes the rigorous methodology used to review over 70,000 Maryland laws and regulations, and concludes that 842 Maryland rules are unclear, ineffective, or otherwise ill-suited for AVs.[17] Extrapolating to all fifty states, this suggests that more than 42,000 traditional state laws are poorly suited to regulating AVs.[18] This Part further explains why updating legal definitions for key terms of art like "driver" and "operator" should resolve the problems associated with most laws flagged by the study. However, even after implementing needed definitional updates, hundreds of laws will remain problematic. Revising these laws will require the resolution of numerous fine-grained policy issues.

Parts III and IV together evaluate legal institutions that might address the widespread shortcomings of state laws in light of analytical concerns and policy issues identified in Part II. Part III begins by evaluating state and federal efforts to date to update statutory and regulatory laws to account for AVs. This Part presents an up-to-date fifty-state survey on AV-related law reform and demonstrates that states have either failed to update their laws or have adopted widely varying approaches. The resulting inconsistent patchwork of state laws undermines both AV development and safety. This Part also examines efforts by federal authorities to address AVs. Since numerous federal laws target vehicles, federal agencies have therefore already wrestled with some of the issues that plague state law.

Building from this foundation, Part IV evaluates the capacities of state and federal authorities to address the widespread unpreparedness of state law for AV deployment. This Part argues that state legislatures, state agencies, and state courts are poorly equipped to independently revise their own AV-implicated laws. At the same time, federal authorities are unlikely to reform state laws through preemption because the problematic state laws identified in this study arise in a legal sphere that historically has been exclusively reserved for the states. Nevertheless, this Part offers a way out of this dilemma: State and federal lawmakers should work in partnership to update state laws. Using their superior expertise

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17 *See infra* Section II.A.

18 *See infra* Section II.C. Each of the fifty states has tens of thousands of laws, so analyzing each of these laws directly to identify AV-related issues is prohibitively difficult in one single study.

and resources, federal authorities should develop effective reforms and then use federal funding to incentivize the adoption of the most important AV legal standards, an approach already used in the context of the Commercial Driver's License system.

The Article ends with a brief conclusion summarizing the Article's original empirical research and normative argument.

I. AV TECHNOLOGY: CATEGORIES, CONTEXTS, AND CURRENT STATE

Analyzing the legal challenges of AV deployment first requires a basic understanding of the diversity of AV technologies and the terms used to describe them. As later shown, AVs are not a single uniform concept. Indeed, the sheer diversity of AV contexts and categories is itself a central challenge to AV regulation.

A. *SAE Levels and AV Technology*

AV technologies vary significantly along two independent dimensions: (1) sophistication of automation, and (2) operational contexts.

First, AVs vary in their level of sophistication. The Society of Automotive Engineers International (SAE) has developed a highly influential typology describing these different levels, categorizing vehicles into six levels based on their degree of automation.[19] SAE Level 0 describes a traditional vehicle containing no automated features whatsoever, while a Level 5 AV is a fully self-driving vehicle capable of performing the entire driving task without any human supervision.[20]

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19 SAE MOBILUS, TAXONOMY AND DEFINITIONS FOR TERMS RELATED TO DRIVING AUTOMATION SYSTEMS FOR ON-ROAD MOTOR VEHICLES 4 (2021), https://saemobilus.sae.org/content/J3016_202104 [https://perma.cc/T2QQ-KCJD]. Technically, the SAE provides a categorization for vehicle features, not entire vehicles. A single vehicle may have features of different automation levels depending on driving conditions. However, in common parlance, the SAE categories are often used to describe vehicles with the understanding that the SAE designation only applies to a particular vehicle in certain circumstances. *Id.* Moreover, SAE levels "[r]eflect the [d]esign [i]ntent" of a manufacturer, rather than being based on a conclusive determination of automative capability. *Id.* at 36. In fact, the SAE asserts that "it is not possible to describe or specify a complete test or set of tests which can be applied to a given [AV] *feature* to conclusively identify or verify its level of *driving automation*." *Id.*

20 *Id.* at 4.

In between the poles of Levels 0 and 5, the SAE separates vehicles into four additional levels based on (a) the sophistication of the automated systems in the vehicle, and (b) the extent to which the driver must monitor those systems.[21] In a Level 1 AV, automation systems can control either (1) steering (technically "lateral motion"), or (2) acceleration and braking (technically "longitudinal motion").[22] However, a Level 1 vehicle cannot control both steering and acceleration simultaneously.[23] In contrast, a Level 2 AV can control both lateral and longitudinal motion at the same time.[24] For both Level 1 and Level 2 vehicles, a human driver constantly supervises the vehicle and "intervenes as necessary to maintain operation."[25]

SAE Level 3 AVs contain automation systems capable of performing the entire driving task for sustained periods of time.[26] The vehicle also monitors performance to determine when a human must intervene.[27] Level 3 AVs will request human drivers take control of the vehicle when necessary.[28] Finally, a Level 4 AV is capable of reliably performing all driving tasks without any human intervention.[29] A Level 4 vehicle can determine whether its automated capacity is about to be exceeded and, if so, achieve a "minimal risk condition" even without human intervention.[30] As such, no human need supervise a Level 4 vehicle.[31] The only limit on Level 4 vehicles is contextual—they can operate at Level 4 capacity only in certain "operational design domain[s]," such as geo-fenced locations.[32] By contrast, as mentioned above, a Level 5 AV is fully autonomous in all operational contexts.[33]

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21 *Id.*

22 *Id.* at 4, 9.

23 *Id.* at 24.

24 *Id.* at 25.

25 *Id.* at 28.

26 *Id.* at 26.

27 *Id.* at 19.

28 *Id.*

29 *Id.* at 31–32.

30 *Id.* at 11.

31 *Id.* at 31.

32 *Id.* at 32–33.

33 The SAE's system allows for greater precision regarding the meaning of "AV" used in this Article. Specifically, this Article uses the term "AV" to include (1) any vehicle that is designed to operate at Level 2 or higher in some context, and (2) vehicles where technological systems allow for remote operation, such as platooned trucks. *See infra* notes 45–47 and accompanying text (describing platooned trucks). Some jurisdictions and commentators use "AV" in a more limited

The second type of AV variability relates to the contexts in which these vehicles operate. Some AVs face geographical limitations, such as geo-fencing or confining AV operation to freeways or city streets.[34] Other variable contexts relate to AV vehicle type and user. Perhaps the best-known type of AV is the consumer automobile manufactured with integrated AV technologies. For instance, Tesla currently sells vehicles equipped with a "Full Self-Driving" capability.[35] Post-sale modification of otherwise ordinary consumer automobiles may soon be possible as innovators develop kits to convert traditional vehicles to AVs.[36] In addition to direct-to-consumer markets, AV regulations will need to contend with robust commercial uses. AVs already provide ride services.[37] Indeed, AV taxis are being developed that bear scant resemblance to traditional automobiles, lacking any manual controls like steering wheels.[38] Other commercial AVs will include shuttles and buses designed to transport large numbers of people.[39]

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sense to refer only to vehicles with features that are Level 3 to Level 5. *See, e.g.*, SAE MOBILUS, *supra* note 19, at 6; *see also* EUR. COMM'N, ON THE ROAD TO AUTOMATED MOBILITY: AN EU STRATEGY FOR MOBILITY OF THE FUTURE 4 (2018), https://transport.ec.europa.eu/system/files/2018-10/on_the_road_to_automated_mobility.pdf [https://perma.cc/NT57-6AJZ]. This Article uses a broader notion of "AV" because the goal is to assess the clarity of state law regarding AVs, and the application of state law to Level 2 features is potentially unclear. With a Level 2 feature, the vehicle simultaneously controls lateral movement (i.e. steering) and longitudinal movement (i.e. braking and acceleration). SAE MOBILUS, *supra* note 19, at 31. Indeed, the SAE describes Level 2 features as "Partial Driving Automation." *Id.* Hence, a traditional human driver does not perform many core driving tasks in a Level 2 vehicle, and state law may therefore be unclear regarding such vehicles. To evaluate that potential uncertainty, this Article thus uses a broader notion of "AV."

34 For example, Waymo's Level 4 AVs *operate* only in certain cities. *Waymo One*, WAYMO, https://waymo.com/waymo-one [https://perma.cc/W6VK-VVF5].

35 *Autopilot and Full Self-Driving (Supervised)*, TESLA, https://www.tesla.com/support/autopilot [https://web.archive.org/web/20250212220204/https://www.tesla.com/support/autopilot].

36 Dave VanderWerp, *Is a $1000 Aftermarket Add-On as Capable as Tesla's Autopilot and Cadillac's Super Cruise?*, CAR & DRIVER (Feb. 10, 2020), https://www.caranddriver.com/features/a30341053/self-driving-technology-comparison [https://web.archive.org/web/20200216004157/https://www.caranddriver.com/features/a30341053/self-driving-technology-comparison].

37 James McCandless, *Robotaxis May Be the Transportation Industry's Next Major Disruptor*, NEWSWEEK (Nov. 5, 2021, 6:00 AM), https://www.newsweek.com/robotaxis-may-transportation-industrys-next-major-disruptor-1644957 [https://perma.cc/STT3-B8US].

38 *See, e.g.*, Matt Day & Ed Ludlow, *Amazon's Autonomous Cars Unit Zoox Expands Testing to Seattle*, SEATTLE TIMES (Oct. 18, 2021, 5:09 PM), https://www.seattletimes.com/business/amazons-autonomous-cars-unit-zoox-expands-testing-to-seattle [https://perma.cc/4FHZ-MFZS].

39 Andrew J. Hawkins, *Polaris and Optimus Ride Are Co-Developing "Fully Autonomous" Low-Speed Shuttles*, VERGE (Mar. 30, 2021, 6:00 AM), https://www.theverge.com/2021/3/30/22356398/polaris-optimus-ride-av-ev-lsv-shuttle-announce [https://perma.cc/DAF3-JDAQ].

Goods as well as people will be moved by AVs.[40] Consumers and businesses have already started to receive products delivered by driverless personal delivery devices ("PDDs").[41] The size, speed, and deployment of PDDs varies widely. Some PDDs are relatively small and slow, weighing less than 100 pounds and traveling at relatively slow speeds.[42] These tiny PDDs are designed to travel like pedestrians, often on sidewalks.[43] Meanwhile, large PDDs can weigh thousands of pounds and travel forty-five miles per hour.[44]

AV technology will also be harnessed to transport goods at commercial scale. One developing paradigm allows fewer people to move greater amounts of freight by "supervising" AV motor carriers.[45] In so-called "platoons," a lead truck driven by a human is electronically linked to following trucks; the human driver can partially control the steering, brakes, and acceleration of the following trucks.[46] Another paradigm sees AVs independently moving freight. Innovators are currently developing AV technologies that will allow trucks to operate for some or all of a trip without any human supervision whatsoever.[47]

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40 Indeed, some analysts believe that the AV industry is beginning to focus more on the delivery of goods than people. *See* Ran Laviv, Maya Azaria & Vandana Menon, *Which Trends Are Driving the Autonomous Vehicles Industry?*, WORLD ECON. F. (Nov. 8, 2021), https://www.weforum.org/agenda/2021/11/trends-driving-the-autonomous-vehicles-industry [https://perma.cc/97EN-FM9A].

41 *See, e.g.*, Nick Carey & Lisa Baertlein, *FedEx to Test Package Deliveries with Self-Driving Startup Nuro*, REUTERS (June 15, 2021, 2:56 PM), https://www.reuters.com/technology/fedex-test-package-deliveries-with-self-driving-startup-nuro-2021-06-15 [https://perma.cc/48SE-JF49].

42 *See, e.g.*, *Autonomous Robots for Industry 4.0*, STARSHIP, https://starshipdeliveries.com/industry [https://perma.cc/AD35-FMU5].

43 *Id.*

44 *See, e.g.*, Kevin Jost, *Nuro's Third-Gen Delivery Vehicle Is Faster, Carries More*, FUTURRIDE (Jan. 13, 2022), https://futurride.com/2022/01/13/nuros-third-gen-delivery-vehicle-is-faster-carries-more [https://perma.cc/HBZ9-BX5H]; NURO, DELIVERING SAFETY 9 (2021), https://nuro.sfo3.digitaloceanspaces.com/nuro-vssa-2022.pdf [https://perma.cc/WUQ5-7A7Y] (noting a vehicle weight of more than 2000 pounds).

45 *See, e.g.*, *Leader Follower Platooning*, KRATOS, https://www.kratosdefense.com/systems-and-platforms/unmanned-systems/driverless-vehicle-solutions/leader-follower-platooning [https://perma.cc/CXV5-5LZ7]; *Platooning Is Positive for Traffic, the Environment and the Wallet*, TNO, https://www.tno.nl/en/digital/smart-traffic-transport/smart-vehicles/connected-cooperative/platooning-positive-traffic-environment [https://perma.cc/FJZ4-SB9N].

46 FED. HIGHWAY ADMIN., U.S. DEP'T OF TRANSP., FHWA RESEARCH AND TECHNOLOGY EVALUATION: TRUCK PLATOONING FINAL REPORT 5 (2021), https://highways.dot.gov/media/2336 [https://perma.cc/JT9X-TYAK].

47 Rebecca Bellan, *Waymo Via Expands UPS Partnership to Include Autonomous Freight with Class 8 Trucks*, TECHCRUNCH (Nov. 17, 2021, 8:00 AM), https://tcrn.ch/3CpHS8U

It bears emphasis that AVs can vary simultaneously along both the level-of-automation and operational dimensions described above. For example, an AV truck could be Level 4 under the SAE scheme when operating on the highway and Level 2 when operating on city streets. Similarly, an AV consumer vehicle could be Level 2 in one geographic area and Level 3 in another. To effectively regulate AVs, state laws must be able to account for *all* types of AVs as they move between levels of automation and operational contexts.

B. *The Current State of AV Deployment*

AV testing on public roads in the United States began more than a decade ago. In 2012, Nevada became the first state to officially allow AV testing when the Nevada Department of Transportation issued a license to Google to operate AVs in that state.[48] Since then, on-road testing has expanded to at least forty states and involved more than sixty companies.[49]

Building from this testing phase, various companies have begun to commercially deploy AVs throughout the United States. Lower levels of automation have been more widely distributed. For example, as of December 2022, more than 285,000 Tesla vehicles across the country were equipped with Tesla's "Full Self-Driving" technology.[50] Though "full self-driving" sounds like it should describe a high SAE level, Tesla has cautiously approached state regulators, asserting that its "Full Self-

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[https://perma.cc/63AA-D3HA]; Michael Jaeger, Emanuel McMiller & Elsa Bullard, *Challenges for the Autonomous Trucking Industry: Part 1*, LAW360 (Dec. 3, 2020, 6:01 PM), https://www.law360.com/articles/1334034/challenges-for-the-autonomous-trucking-industry-part-1.

48 *Google Gets License to Operate Driverless Cars in Nevada*, CNN BUS. (May 8, 2012, 11:30 AM), https://www.cnn.com/2012/05/07/tech/nevada-driveless-car/index.html [https://perma.cc/BP9N-5JQX].

49 Framework for Automated Driving System Safety, 85 Fed. Reg. 78058, 78060 (proposed Dec. 3, 2020) (to be codified at 49 C.F.R. pt. 571); *see, e.g.*, *Olli Autonomous Shuttle Receives Approval for Operation in Maryland County*, INSIDE UNMANNED SYS. (Dec. 20, 2019), https://insideunmannedsystems.com/olli-autonomous-shuttle-receives-approval-for-operation-in-maryland-county [https://perma.cc/NN43-78PU] (allowing AV testing in Maryland).

50 Fred Lambert, *Tesla Confirms 285,000 People Bought Full Self-Driving*, ELECTREK (Dec. 29, 2022, 2:46 PM), https://electrek.co/2022/12/29/tesla-people-bought-full-self-driving-north-america [https://perma.cc/64BY-RUWC].

Driving" feature only provides Level 2 automation.[51] Meanwhile, in 2023, Mercedes-Benz began offering its "DRIVE PILOT" system in vehicles for sale in California and Nevada, contending that this technology provides Level 3 automation.[52] Honda's "Traffic Jam Pilot" also offers Level 3 automation controlling the steering, acceleration, and braking of the vehicle in the limited context of congested traffic.[53] Though currently, only Japanese drivers can avoid angrily fighting traffic jams on their own, as Honda announced that the "Traffic Jam Pilot" will not be available in the United States until 2029.[54]

In the United States today, no Level 4 or Level 5 vehicles are commercially available for individual consumers.[55] However, AV developers like Waymo have begun offering ride services exhibiting these

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51 *See* Rob Stumpf, *Tesla Admits Current "Full Self-Driving Beta" Will Always Be a Level 2 System: Emails*, THE DRIVE (Mar. 9, 2021, 12:08 PM), https://www.thedrive.com/tech/39647/tesla-admits-current-full-self-driving-beta-will-always-be-a-level-2-system-emails [https://perma.cc/Q645-CX3E]. Tesla asserts that this technology provides significant AV capability, such as the ability to "[a]ctively guide[] your car from a highway's on-ramp to off-ramp, including suggesting lane changes, navigating interchanges, automatically engaging the turn signal and taking the correct exit." *Autopilot and Full Self-Driving (Supervised)*, *supra* note 35. Tesla also states that "Traffic Light and Stop Sign Control" can "[i]dentif[y] stop signs and traffic lights and automatically slow[] your vehicle to a stop on approach, with your active supervision." *Id.*

52 Press Release, Mercedes-Benz, U.S. Availability of DRIVE PILOT (Sept. 27, 2023), https://group.mercedes-benz.com/innovation/product-innovation/autonomous-driving/drive-pilot-launch-usa.html [https://perma.cc/P3PN-NRF6]; Andrew J. Hawkins, *Mercedes-Benz Is the First to Bring Level 3 Automated Driving to the US*, VERGE (Jan. 27, 2023, 1:02 PM), https://www.theverge.com/2023/1/27/23572942/mercedes-drive-pilot-level-3-approved-nevada [https://perma.cc/QE3P-E3Q7]; Press Release, Off. Pub. Affs., Cal. Dep't Motor Vehicles, California DMV Approves Mercedes-Benz Automated Driving System for Certain Highways and Conditions (June 8, 2023), https://www.dmv.ca.gov/portal/news-and-media/california-dmv-approves-mercedes-benz-automated-driving-system-for-certain-highways-and-conditions [https://perma.cc/2C3R-G8WF].

53 Colin Beresford, *Honda Legend Sedan with Level 3 Autonomy Available for Lease in Japan*, CAR & DRIVER (Mar. 4, 2021), https://www.caranddriver.com/news/a35729591/honda-legend-level-3-autonomy-leases-japan [https://perma.cc/4W92-JZKC].

54 *Honda to Develop Advanced Level 3 Self-Driving Technology by 2029*, REUTERS (Nov. 30, 2022, 11:29 AM), https://www.reuters.com/business/autos-transportation/honda-develop-advanced-level-3-self-driving-technology-by-2029-2022-11-30 [https://perma.cc/CH3L-GMTW]; Press Release, Honda, Honda Launches Next Generation Honda SENSING Elite Safety System with Level 3 Automated Driving Features in Japan (Mar. 4, 2021), https://hondanews.com/en-US/releases/release-e86048ba0d6e80b260e72d443f0e4d47-honda-launches-next-generation-honda-sensing-elite-safety-system-with-level-3-automated-driving-features-in-japan [https://perma.cc/CZG5-TPB7].

55 Kim Miller, *States Steer Autonomous Vehicle Legislation*, MULTISTATE.AI (Oct. 2021), https://www.multistate.ai/updates/vol-40 [https://perma.cc/GP9T-MUF8].

higher levels of automation.[56] For instance, in October 2020, Waymo launched driverless ride services in Phoenix, Arizona.[57] Likewise, in February 2022, California issued permission for Waymo and GM Cruise to offer ride services with driverless AVs.[58] These companies asserted that their ride-service vehicles provide Level 4 automation.[59] Waymo recently announced plans to begin offering Level 4 ride services in Atlanta and Washington, D.C.[60] Similarly, multiperson Level 4 shuttles have begun initial deployment in California, Florida, and Hawaii.[61]

The use of AVs for freight delivery is also transitioning from testing to active deployment. For example, the deployment of PDDs for the delivery of lighter goods is rapidly increasing. Since the end of 2020, Nuro has commercially operated PDDs in California that can carry hundreds

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56 Waymo is a sibling corporation of technology giant Google. Lauren Feiner, *Alphabet's Self-Driving Car Company Waymo Announces $2.5 Billion Investment Round*, CNBC (June 16, 2021, 10:11 AM), https://www.cnbc.com/2021/06/16/alphabets-waymo-raises-2point5-billion-in-new-investment-round.html [https://perma.cc/2AZD-JZH6].

57 John Krafcik, *Waymo Is Opening Its Fully Driverless Service to the General Public in Phoenix*, WAYMO: WAYPOINT (Oct. 8, 2020), https://waymo.com/blog/2020/10/waymo-is-opening-its-fully-driverless-service-in-phoenix [https://perma.cc/VP98-VU9W]; Timothy B. Lee, *Waymo Finally Launches an Actual Public, Driverless Taxi Service*, ARS TECHNICA (Oct. 8, 2020, 5:29 PM), https://arstechnica.com/cars/2020/10/waymo-finally-launches-an-actual-public-driverless-taxi-service [https://perma.cc/VM8K-R7MY].

58 David Shepardson, *California Issues Permits to Cruise, Waymo for Autonomous Vehicle Service*, REUTERS (Mar. 4, 2022, 12:01 PM), https://www.reuters.com/technology/california-issues-permits-cruise-waymo-autonomous-vehicle-service-2022-02-28 [https://perma.cc/NN5D-DPWC]. Cruise is an AV innovator that is eighty percent owned by General Motors. Hannah Lutz, *GM to Hike Cruise Ownership Stake to 80%*, AUTO. NEWS (Mar. 18, 2022, 5:25 PM), https://www.autonews.com/mobility-report/gm-hike-cruise-ownership-stake-80 [https://web.archive.org/web/20220319042619/https://www.autonews.com/mobility-report/gm-hike-cruise-ownership-stake-80]; *see also* Press Release, David Caldwell, GM Commc'ns, Gen. Motors Co., GM Announces Additional Investment in Cruise (Mar. 18, 2022), https://investor.gm.com/news-releases/news-release-details/gm-announces-additional-investment-cruise [https://perma.cc/PHK6-KPAD].

59 Evan Ackerman, *What Full Autonomy Means for the Waymo Driver*, IEEE SPECTRUM (Mar. 4, 2021), https://spectrum.ieee.org/full-autonomy-waymo-driver [https://perma.cc/J5P6-VJUG]. In December 2024, GM Cruise exited the AV ride service market. David Shepardson & Nora Eckert, *GM to Exit Loss-Making Cruise Robotaxi Business*, REUTERS (Dec. 11, 2024, 2:29 AM), https://www.reuters.com/business/autos-transportation/general-motors-drop-development-cruise-robotaxi-2024-12-10 [https://perma.cc/QNN2-KTJU].

60 Abrar Al-Heeti, *Waymo's Self-Driving Cars Are in a Growing Number of Cities. Here's Everything to Know*, CNET (May 5, 2025, 5:37 PM), https://www.cnet.com/roadshow/news/waymos-driverless-vehicles-are-hitting-tokyo-streets-everything-to-know-about-the-robotaxi-service [https://perma.cc/KX55-VAX9].

61 *See, e.g.*, *Current Locations*, BEEP, https://www.ridebeep.com/locations/all-locations [https://perma.cc/DE4J-KDFT].

of pounds of cargo.[62] Starship Technologies has developed small PDDs that can carry twenty pounds of cargo at speeds of four miles per hour.[63] To date, Starship PDDs have performed more than six million deliveries worldwide.[64] Meanwhile, AV cargo transportation is just around the corner. For example, Aurora Innovation plans to begin operating driverless trucks in Texas by the end of April 2025.[65]

While large-scale deployment of varied and complex AVs seems both imminent and inevitable, the legal environment in which these vehicles will operate has not evolved at technology's breakneck pace.[66] While engineers grappled with the practical challenges of bringing innovation to our roads, lawmakers have failed to fully grasp the looming regulatory nightmare. The time for ignorance and inaction has long since passed.

II. EMPIRICALLY MEASURING THE NEED FOR STATE LAW REFORM

While every state has rules that could theoretically govern AVs, these rules overwhelmingly predate AV development. By simple virtue of their age, these rules were enacted with the implicit assumption that humans drove vehicles and performed all tasks traditionally associated with vehicular operation. This assumption becomes problematic when applied to AVs in which humans do not undertake some or all traditional driving activities. Moreover, legal uncertainty as to whether old laws can effectively regulate AVs sows doubts in the minds of both consumers and

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62 Jost, *supra* note 44. Kirsten Korosec, *Nuro Can Now Operate and Charge for Autonomous Delivery Services in California*, TECHCRUNCH (Dec. 23, 2020, 12:29 PM), https://tcrn.ch/3mL70PI [https://perma.cc/B9YZ-8AW9]; NURO, *supra* note 44, at 9 (noting its autonomous vehicles weigh more than 2,000 pounds).

63 Steve Banker, *Home Delivery Robots: Last Mile Gamechangers*, FORBES (May 1, 2022, 9:19 AM), https://www.forbes.com/sites/stevebanker/2022/05/01/home-delivery-robots-last-mile-gamechangers [https://perma.cc/ML9W-9YB9].

64 Julie Littman, *Starship Technologies Raises $90M, Reaches $230M in Total Funding*, YAHOO! FIN. (Feb. 6, 2024, 9:05 AM), https://finance.yahoo.com/news/starship-technologies-raises-90m-reaches-140531122.html [https://perma.cc/9YTY-8BUW].

65 Thomas Black, *Driverless Truck Companies Plan to Ditch Human Copilots in 2024*, BLOOMBERG (Jan. 5, 2024, 5:30 AM), https://www.bloomberg.com/news/articles/2024-01-05/aurora-other-driverless-truck-firms-plan-to-ditch-human-copilots-in-2024 [https://perma.cc/H3BK-E85F]; Joann Muller, *Driverless Trucks Are Rolling in Texas, Ushering in New Era*, AXIOS (Apr. 23, 2025), https://www.axios.com/2025/04/23/texas-driverless-trucks [https://perma.cc/V5F9-SW4X].

66 *See* Cassandra Burke Robertson, *Litigating Partial Autonomy*, 109 IOWA L. REV. 1655, 1700–01 (2024).

developers regarding the preparedness of our legal systems for widespread AV deployment, thereby undermining the roll-out of these new technologies.[67]

Unfortunately, prior to this Article, no scholars or policymakers have attempted to empirically and comprehensively assess the scope of the problems regarding state laws and AVs. Some states have enacted isolated AV-related legal reforms, but even these limited reforms left untouched an unknown number of potentially problematic laws.[68] One state, Michigan, did conduct an important widespread review of its own laws. Though useful, the Michigan study employed a limited methodology and did not attempt a holistic review of all laws and regulations in the state.[69] Additionally, the Michigan study did not attempt to extrapolate its results beyond a single state.[70] Such limits are understandable. The fifty states collectively have many hundreds of thousands of statutes and regulations on the books, and they are organized into codes, titles, and chapters based upon different schema.[71]

Rather than study all fifty states separately, the study described in this Article adopted the strategy of comprehensively reviewing every law and regulation in a single representative state—Maryland—and then extrapolating its results to the whole nation. While not without its own limitations, this study nonetheless stands as the first systematic empirical assessment of the scope of the AV-law problem at the state level.[72] Beyond its quantitative ambitions, this section also explores the qualitative dimensions of the problem to identify strategies for effective reform. Once again, this qualitative analysis uses Maryland as a base case and then extrapolates from Maryland to the rest of the United States.

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67 *See* Jeremy A. Carp, *Autonomous Vehicles: Problems and Principles for Future Regulation*, 4 U. PA. J.L. & PUB. AFFS. 81, 103, 125 (2018).

68 *See infra* Section III.A.I.

69 *See* Taylor Waters & Nicholas J. Wittner, Automated Vehicles, Operators, and Drivers (Aug. 12, 2018) (unpublished manuscript) (on file with authors). The Michigan study described a process of keyword searches and manual review in order "to outline the potential scope of further research," but did not perform that analysis. *See also* John Mohyi, Motor Vehicle Code (Continued) and the Leaving Child Unattended in Vehicle Act (Apr. 30, 2018) (unpublished manuscript) (on file with authors).

70 *See* Waters & Wittner, *supra* note 69.

71 *See infra* notes 128–129 and accompanying text (estimating that state legislatures and administrative agencies have enacted more than 350,000 laws).

72 This Article focuses only on potential reforms to state statutes and regulations, and therefore does not explore potential changes to local ordinances or case law. *See* MD. CODE ANN., TRANSP. § 25-102(a) (West 2025) (describing the authority of local governments to regulate vehicles).

A. *Empirically Assessing the Problem in Maryland*

Maryland law currently includes more than 70,000 statutes and regulations.[73] Comprehensively evaluating the potential collision between these myriad rules and AVs required a multi-step strategy. The first step used the power of automated database searches to identify potentially relevant laws. The second stage drew on the power of human expertise to closely read and code laws from step one. In practice, steps one and two involved multiple iterations based on insights gained through the research process. The third stage drew on this iterative experience to identify a final category of problematic law. Each of the three phases of the study are described below.

1. Phase 1: Keyword Searches

The first phase in this empirical study identified an initial universe of laws for further analysis by searching Maryland statutes and regulations for keywords potentially related to AVs. This phase proceeded using searches on the whole corpus of Maryland statutes and administrative regulations as contained in the relevant Westlaw databases.[74]

By design, this initial search was overinclusive, with more fine-grained decision-making waiting for later phases. The basic approach involved identifying all words or phrases that were likely to appear in laws that could intersect with AVs. Thus, for example, the study flagged at the outset all Maryland laws containing broadly relevant terms like "driver" or "vehicle." Other terms required more targeted investigation. Some keywords are relevant to AVs but are also frequently used in unrelated contexts. For instance, "license" can refer to a vehicle license, but may also describe a liquor license, a business license, a gun license, a fishing

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73 This conservative estimate was arrived at in an early stage of the empirical study. One of the authors wrote Python code that "scraped" all Maryland 2019 laws and regulations from the publicly accessible Justia website. *See 2019 Maryland Code*, JUSTIA, https://law.justia.com/codes/maryland/2019 [https://perma.cc/UR87-DXPQ] (laws); *Code of Maryland Regulations*, JUSTIA, https://regulations.justia.com/states/maryland [https://perma.cc/94GA-N8HL] (regulations). This process resulted in the creation of two CSV files, one with 36,835 statutes and the other with 34,787 regulations. Combined, there were a total of 71,622 statutes and regulations. The original CSV files are on file with authors.

74 Westlaw has separate databases for "Maryland Statutes & Court Rules" and "Maryland Regulations." *Maryland*, WESTLAW PRECISION, https://1.next.westlaw.com/Browse/Home/Maryland [https://perma.cc/L7H2-6QCT].

license, or a medical license.[75] Therefore, searches using common terms like "license" were further restricted to particular statutory sections.[76]

The following table provides a full list of the search terms used in the first phase of the study. The table also describes the statutory codes and regulatory titles searched. Researchers used root expanders when performing searches to ensure that closely-related terms were captured.[77]

Figure 1

Search Terms	Statutory Codes	Regulation Titles
"Drive" or "Driver"	All	All
"Vehicle"	All	All
"Car"	All	All
"Automobile"	All	All
"Autonomous"	All	All
"License"	Criminal law, Criminal Procedure, Insurance, Public Safety, Transportation	Department of Transportation, Department of Public Safety and Correctional Services, Department of State Police, Maryland Insurance Administration

75 MD. CODE ANN., BUS. REG. § 17-306 (West 2024) ("license to do business"); MD. CODE ANN., ALCOHOLIC BEVERAGES & CANNABIS § 14-2004 (West 2024) ("beer, wine, and liquor license"); MD. CODE ANN., NAT. RES. § 4-604 (West 2024) ("angler's license"); MD. CODE ANN., PUB. SAFETY § 5-117.1 (West 2024) ("handgun qualification license"); MD. CODE ANN., HEALTH OCC. § 14-301 (West 2024) (license to "practice medicine").

76 Maryland organizes its statutes into different "Codes," which are, in turn, divided into "Titles." For example, the Maryland Transportation Code contains Maryland statutes related to transportation, and Title 21 of this Code addresses "Vehicle Laws—Rules of the Road." *2019 Maryland Code: Transportation*, JUSTIA, https://law.justia.com/codes/maryland/2019/transportation [https://perma.cc/QP6V-K2DA]. Maryland regulations are codified in the Code of Maryland Regulations, which is usually abbreviated "COMAR." Similar to Maryland statutes, COMAR is subdivided into different "Titles" related to different areas of the law. For example, all regulations related to the Department of Transportation are in Title 11 of COMAR. JUSTIA, *supra* note 73.

77 This approach was similar to that used in 2016 in reviewing the Federal Motor Vehicle Safety Standards to identify barriers to the development of automated vehicles. *See* ANITA KIM, DAVID PERLMAN, DAN BOGARD & RYAN HARRINGTON, REVIEW OF FEDERAL MOTOR VEHICLE SAFETY STANDARDS (FMVSS) FOR AUTOMATED VEHICLES 3 (2016), https://rosap.ntl.bts.gov/view/dot/12260 [https://perma.cc/QWQ8-HC93].

Search Terms	Statutory Codes	Regulation Titles
"Operate" or "Operator"	Transportation	Department of Transportation

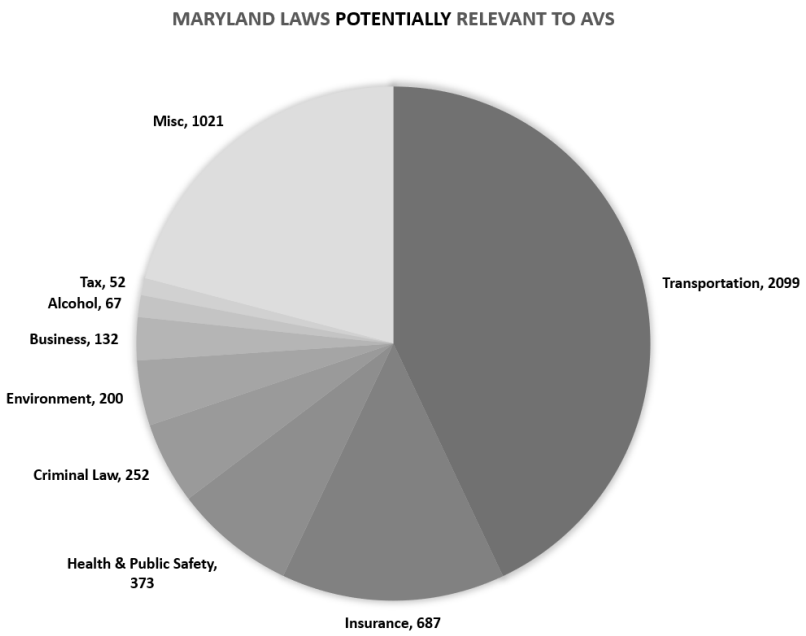
Using the search terms above, researchers identified approximately 5,200 potentially relevant laws and regulations. However, about 350 of these results originated from Titles and Subtitles relating to aviation, ports, railroads, and the licensing of automotive dealerships, and therefore did not fall within the scope of the study.[78]

Removing these irrelevant provisions produced an initial data set of 4,883 Maryland laws and regulations possibly related to AVs. Notably, these laws arose across many parts of the Maryland Code. Even though the Maryland Transportation Code naturally had most of the relevant rules, other sections of the code—from insurance to criminal law and beyond—also proved worthy of a closer look. This shows the necessity of a comprehensive approach to assessing the AV-law problem. Vehicle regulation cuts across many legal domains, and legal reform must consider this breadth.[79] The following chart shows the number of laws identified in this first phase of the study, divided into different subject matter areas.

78 This Article addresses only AVs that are motor vehicles traveling on roads. As a result, this Article does not analyze other vehicles that may utilize AV technology, such as aircrafts, trains, and boats. This study also does not analyze motorcycles.

79 Statutory provisions were categorized based on the Code from which that provision was drawn. For instance, all the statutes drawn from the Maryland Code of Transportation were categorized as "Transportation," while statutes from the Maryland Insurance Code were categorized as "Insurance." Regulations were similarly categorized based on their Title. For example, regulations from the Maryland Department of the Environment appear in COMAR Title 26, and those regulations accordingly were categorized as "Environment." *See COMAR Online*, MD. DEP'T ENV'T, https://mde.maryland.gov/programs/permits/pages/comaronline.aspx [https://perma.cc/SSP4-B36H].

Figure 2



2. Phase 2: Manual Review and Hand Coding

In the second phase of the study, a team of researchers manually reviewed each of the 4,883 laws flagged in the first phase to determine if the rule still worked sensibly when applied to AVs. Because the project's goal was to identify state laws requiring reform to support AV development and deployment, the manual review process was circumscribed in two important respects.

First, the study focused on finding problems with existing state laws; it did not seek to identify gaps in the regulatory architecture for AVs requiring wholly new legislation. Without doubt, new state laws will be needed to properly support AV testing and deployment.[80] This study did not explicitly consider, for example, what new laws should be enacted to

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80 Some states have, in fact, enacted detailed testing regimes for AVs. *See, e.g.*, CAL. CODE REGS. tit. 13, § 227.00 (2025) (addressing the testing of AVs in California). Regarding testing, AVs are typically subject to heightened requirements that do not apply to traditional vehicles. For example, a common requirement for testing AVs is insurance of at least $5,000,000. *See, e.g.*, NEV. REV. STAT. ANN. § 482A.060 (West 2025).

determine whether AVs are "safe enough" to test or deploy on public roads. Nevertheless, this Article's analysis provides useful background to develop a wider legal framework. After mapping out problems with existing laws, navigating the waters requiring new legislation will be far easier.

Second, the study sought to flag state laws that became unclear or ineffective in AV contexts; it did not aim to identify legal restrictions that might be merely unnecessary as a matter of policy. Some laws on the books are perfectly clear when applied to AVs, but policymakers might ultimately opt to change them. For example, Maryland law currently dictates that "a taxicab driver . . . may not operate a taxicab for more than 12 hours of any continuous 24-hour period."[81] Since machines do not need to sleep, the "12 in 24" limitation on an AV taxicab "driver" may not be necessary. Yet the rule is clear and effective. This study therefore does not identify this provision—or ones like it—as needing reform. More generally, this study did not strive to "optimize" state laws for AVs.

Even after limiting analysis to existing laws that are unclear or ineffective, determining whether AVs render an existing state law problematic proved challenging. To start, researchers needed to stay aware of the diverse and rapidly evolving nature of AV technology.[82] Beyond this, the subtleties of Maryland law required careful reading to assess whether laws implicitly assume that vehicles are driven by humans or not. For example, COMAR 03.03.04.06 addresses a fuel use tax assessed on leased vehicles "without drivers."[83] In its original context, vehicles "without drivers" referred to vehicles leased for individual use as opposed to vehicles leased as taxicabs, livery services, or limousines. Is this provision affected by AV technology? If AVs are interpreted as providing nonhuman "drivers," this would mean that leased personal AVs are not "without drivers," which could affect the application of the fuel tax provision. Since this result may conflict with lawmakers' initial goals, regulations like this were classified by researchers as impacted by AV technology.

Given the challenges of such careful reading across varied statutory and regulatory provisions, the manual review stage of the study used an iterative multi-layered approach. First, a group of six law student research assistants ("RAs") applied a coarse analysis to determine which of the

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81 MD. CODE ANN., PUB. UTIL. § 10-208(a) (West 2025).

82 *See infra* Section II.B.

83 MD. CODE REGS. 03.03.04.06 (2024).

4,883 laws from the first phase were "relevant" to AVs.[84] Next, a group of four experienced law professors applied a fine-grained lens to determine which of the student-labeled "relevant" laws actually raised issues requiring reform when applied to AVs.[85] This approach ensured multiple human eyes reviewed the complicated and varied provisions identified by keyword searches.

To ensure consistency across the student team, the RA review began with three rounds of "beta testing" involving relatively small batches of laws to help the RAs recognize how the laws should be coded.[86] After completing this training, the RAs spent four months reviewing each of the 4,883 laws identified in the first phase of the study, coding the laws as "Relevant," "Potentially Relevant," or "Not Relevant."[87] Thereafter, building from their experiences reviewing hundreds of laws, the RAs reevaluated the laws tagged as "Potentially Relevant" to categorize those as "Relevant" or "Not Relevant." Ultimately, this labor-intensive process whittled down the 4,883 laws algorithmically identified in the first phase of the study to 573 "relevant" laws.

These 573 laws provided the starting point for the professor review stage. The four law professors were tasked with applying their legal expertise in closely reading statutes and regulations to confirm which Maryland laws truly created interpretative problems. As with the RA review, consistency across the law professor team was key. Thus, the law professors also engaged in a round of beta testing, collectively reviewing ten randomly selected laws from the 573 and then discussing whether these laws became unclear or ineffective when applied to AVs. Following this training, the law professors reviewed all of the laws identified as

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84 These six research assistants were Taylor Bayat, Michael Blanchard, Christian Coward, Torra Hausmann, Sina Jahanshahi, Nyari James, and Molly Shaffer. We cannot express enough our gratitude for their hard work.

85 The four law professors were the authors of this Article, as well as Professors Michele Gilman and Nancy Modesitt. We appreciate the excellent contributions of Professors Gilman and Modesitt to this project.

86 During the first round of Beta testing, the six RAs and the two authors of this Article reviewed twenty-five randomly selected laws from the initial universe of 4,883 laws identified in the first phase of the study. Each reviewer categorized the laws as "Relevant" or "Not Relevant." Reviewers could also tag laws as "Potentially Relevant," so that those laws could be reviewed a second time later in the study. The entire group then met to discuss their results and reach a consensus on the categorization of the laws. The second stage of beta testing proceeded in the same fashion as the first but with a new group of twenty-five randomly selected laws. The final round of beta testing paralleled the first two, except that (1) the third round involved seventy-five laws, and (2) the meeting to obtain consensus on the categorization of these laws involved only the six RAs and not the authors of this Article.

87 The laws from the beta testing were not reviewed a second time by the RAs.

relevant by the RAs.[88] Ultimately, the law professors found 303 problematic Maryland laws that they adjudged required reform for them to sensibly regulate AVs. The professors further identified five duplicate laws that had been included in the search due to amendments to those laws.[89] The remaining 265 laws were thus deemed clear when applied to AVs. Here it is worth emphasizing that even though AVs may struggle to comply with certain clear laws because of technological limitations, the laws were still coded as not requiring legal reform.[90]

3. Phase 3: Laws Involving Problematic Definitions

The initial design of this study contemplated only the two phases above. However, through the process of manually reviewing hundreds of laws, this Article's authors uncovered a wide-ranging problem: The legal definitions of "driver" and "operator" render unclear for AVs *all laws* in Maryland using those terms. Hundreds of Maryland laws include these terms. For instance, Section 21-302 of the Maryland Transportation Code states, "Drivers of vehicles that are going in opposite directions shall pass each other to the right."[91] Though Section 21-302 should obviously apply to AVs, whether Maryland law actually supports that result is at best unclear.

Part of the problem is textual. Because lawmakers safely assumed that all "drivers" would be human, the definitions of "driver" and "operator" are terse and conclusory. The Maryland Transportation Code

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88 The law professors did not review the laws from the beta testing a second time.

89 Specifically, duplication arose because the underlying Westlaw databases included multiple versions of certain laws with different effective dates. For instance, Westlaw provided two versions of Section 27-501 of the Maryland Insurance Code, with one being operative from October 1, 2020, to June 30, 2021, while the other version went into effect on July 1, 2021. MD. CODE. ANN., INS. § 27-501 (West 2024).

90 For example, Section 21-107 of the Maryland Transportation Code provides that a "school crossing guard" may "may stop or otherwise direct vehicles." MD. CODE. ANN., TRANSP. § 21-107 (West 2024). Developing AV technologies that can identify a "school crossing guard" and follow verbal commands and hand signals may be difficult. However, this requirement is not unclear when applied to AVs.

91 MD. CODE ANN., TRANSP. § 21-302 (West 2024); *id.* § 21-303(b) ("The driver of a vehicle overtaking another vehicle that is going in the same direction shall pass to the left of the overtaken vehicle at a safe distance."); *id.* § 21-402(a) (West 2024) (requiring the "driver of a vehicle" to "yield the right-of-way" when turning left); *id.* § 21-404 (West 2024) ("The driver of a vehicle about to enter or cross a highway from a private road or driveway or from any other place that is not a highway shall stop.").

defines "driver" as "any individual who drives a vehicle."[92] Maryland law defines "operator" simply as being equivalent to "driver."[93] Other provisions in Maryland law provide little clarification. Notably, Maryland defines "drive" in largely circular terms to mean "to drive, operate, move, or be in actual physical control of a vehicle."[94]

More importantly, two deeper problems lurk in Maryland's definition of "driver." The first is a line-drawing problem. As AVs become more sophisticated, humans in those vehicles perform fewer activities traditionally associated with driving.[95] After all, the fundamental goal of AVs is to relieve humans of the need to perform some or all driving tasks. However, Maryland's definitions fail to indicate when the contributions of a human in an AV become so minimal that the human is no longer a "driver." For instance, how much control is required to provide "actual physical control"? In a traditional vehicle, a human in the driver's seat is clearly the driver, and a human in a fully autonomous AV behaves more like a passenger.[96] But in between these extremes, Maryland law simply fails to establish a dividing line between contexts in which the human in the AV is the driver and when that human is not. The second problem with Maryland's definition of "driver" is an identification problem. Existing Maryland law fails to indicate who the "driver" of an AV is if no human is a traditional human driver. As a result, Maryland law does not identify an entity that is subject to laws

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92 *Id.* § 11-115 (West 2024). In fact, "individuals" might be limited to flesh-and-blood humans. The Maryland Transportation Code does not define "individual," but its likely meaning may be derived by parsing the statutory definition of "person." Specifically, the Maryland Transportation Code defines "person" to include an "individual, receiver, trustee, guardian, executor, administrator, fiduciary, or representative of any kind and any partnership, firm, association, public or private corporation, or other entity." *Id.* § 1-101 (West 2024). The law thus distinguishes between an "individual" and various business entities, like "corporations." Maryland law may therefore indicate that an "individual" must be different from an entity, implying that an "individual" is a human being. However, other parts of the Maryland Transportation Code are not so clear in using "individual" to reference a human person. For example, Section 16-803 of the Maryland Code of Transportation provides that "'Employer' means any individual, including the United States, a state, or a political subdivision of a state, who owns or leases a commercial motor vehicle." *Id.* § 16-803 (West 2024).

93 *Id.* § 11-142 (West 2024).

94 *Id.* § 11-114 (West 2024). Though not relevant to AVs, Maryland law further provides that "drive" includes "the exercise of control over or the steering of a vehicle being towed by a motor vehicle." *Id.*

95 *See supra* Section I.A (describing the SAE's spectrum of AV sophistication).

96 Such humans would behave as passengers and thus would not be "drivers." State v. Wallace, 812 A.2d 291, 304 (Md. 2002) (stating that, under Maryland law, there is a "distinction between drivers and owners and passengers of vehicles").

targeting "drivers," such as the law noted above about driving on the right side of the road.[97] While advanced AVs should drive on the right side of the road, no Maryland law clearly requires it.

The bottom line is that, as currently defined, the meaning of "driver" is unclear when applied to all AVs. For less sophisticated AVs, the definition does not indicate with any clarity whether humans are "drivers." For all AVs, when a human is not a traditional driver, the definition of "driver" does not identify a nontraditional driver. This twofold uncertainty creates many problems. For instance, a police officer who stops an AV cannot determine whom to ticket. Likewise, an accident victim will struggle to decide whom to sue. An insurance company will face further challenges in identifying nontraditional AV drivers, undermining the development of insurance rates that accurately reflect risk.

To pull into the study all laws using "driver" or "operator," the authors searched again for those terms across all Maryland law.[98] This identified another 539 problematic laws. When added to the 303 laws from phases one and two, the total increased to 842 problematic laws.[99]

One critical feature of the 539 problematic laws from this phase of the study is that they all could be rendered *unproblematic* by fixing the definitions of "driver" and "drive" (and, by extension, "operator"). Since the prospect of a definitional fix had not been considered when the 303 laws were identified in phases one and two, the authors reexamined those laws. They were heartened to discover a definitional fix would correct 147

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97 *See supra* note 91 and accompanying text.

98 Specifically, we performed two searches of all Maryland statutes and regulations. The first search was for laws including the term "drivers" but not the term "driver's license" (i.e. "drivers" BUT NOT "driver's license"), so that the results related to laws targeting the conduct of drivers, not laws related to the acquisition or loss of driver's licenses. The second search was for laws including references to both an "operator" and a "vehicle."

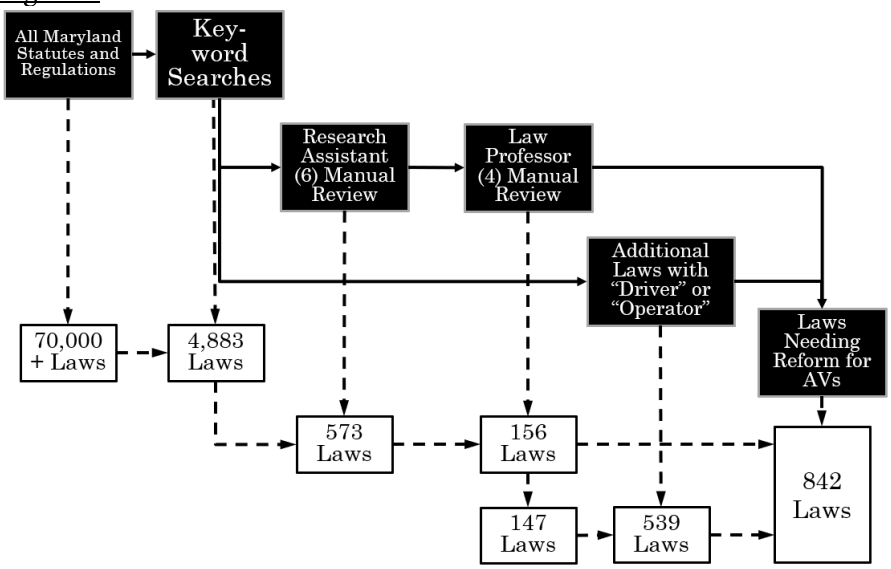
99 In fact, this figure likely undercounts the number of Maryland laws that are problematic due to the term "driver" because the 539 laws noted above do not include laws with phrases effectively equivalent to "driver," such as a law that states a "person may not drive" in a certain fashion. *E.g.*, MD. CODE ANN., TRANSP. § 21-1120 (West 2024). For example, Maryland law states that "[a] person may not drive . . . [faster than] 30 miles per hour on . . . [u]ndivided highways in a residential district." *Id.* § 21-801.1 (West 2024). This law refers to "a person" who "drive[s]," rather than a "driver." *Id.* However, Maryland law also defines a "driver" as "any individual who drives a vehicle." *Id.* § 11-115 (West 2024). As a result, the speed limit provision implicitly references a "driver." *Id.* Thus, the estimate noted above that 842 Maryland laws are problematic when applied to AVs is a conservative estimate. The actual shortcomings of Maryland law are probably worse.

of the 303 laws. Thus, of the 842 unclear laws identified in the study, the sole issue with 686 laws resided with the definitions of "driver."[100]

B. *Analyzing the Results for Maryland*

The three-phase search process described above ultimately identified 842 laws that are unclear or ineffective when applied to AVs. These results and the process of this review of Maryland laws is shown in the following diagram:

Figure 3



Further analysis of these 842 laws supports four significant conclusions.

First, Maryland currently has a worryingly large number of laws that are unclear or ineffective when applied to AVs. Without question, 842 should not be taken as a perfectly precise count of laws that need change. The review process undertaken by RAs and law professors inherently

100 This figure of 686 laws is the sum of the 539 laws based on the additional searches for "driver" and "operator" plus the 147 laws noted above.

involved subjectivity and thousands of laws were reviewed by hand.[101] Nevertheless, the process used to identify these 842 laws was robust and provides a reliable estimate of the size of the problem. We can state with confidence that close to a thousand Maryland laws implicitly assume that vehicles are driven by traditional human drivers and are therefore ill-suited to regulating AVs.

Second, updating Maryland's definitions of "driver" and "operator" will fix the vast majority of problematic laws identified.[102] It is significant that 686 of the 842 unclear and ineffective laws—eighty-one percent—trace their inability to properly regulate AVs solely to the definitions of "driver."[103] As such, revising this definition is critical to preparing Maryland laws for AV deployment. Revising the definition of "individual" would also effectively fix ten laws (a little more than one percent).[104]

Third, after subtracting the 696 laws that can be fixed via definitional updates, there remain 146 problematic laws—seventeen percent—that require more searching for substantive reform.[105] These remaining problematic regulations lie scattered across many different legal areas.[106]

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101 Though the study method featured redundant readers and frequent iterations, judgment calls could have gone differently with a different research team, leading to a slightly higher or lower total of problematic laws.

102 For instance, Section 21-302 of the Maryland Transportation Code states, "Drivers of vehicles that are going in opposite directions shall pass each other to the right." MD. CODE ANN., TRANSP. § 21-302 (West 2024). This provision would be clear if the term "driver" were clear.

103 *See supra* note 100.

104 Updating the legal definition of "individual" would also help AV deployment. As mentioned above, the term "individual" may be limited to human beings. *See supra* note 92. Though affecting fewer laws than "driver" and "operator," the law professors working on this study determined that clarifying the meaning of "individual" would remedy concerns regarding ten out of the 842 problematic laws.

105 Although 81% + 1% + 17% = 99%, the apparent discrepancy is explained by rounding.

106 *See supra* note 86 (discussing the methodology of categorizing these laws).

Figure 4

Category	Statutes	Regulations	Total
Alcohol	0	0	0
Business	3	0	3
Criminal Law	1	0	1
Environment	0	4	4
Health & Public Safety	3	9	12
Insurance	15	3	18
Misc	11	8	19
Tax	3	0	3
Transportation	56	30	86
Total	92	54	146

Not surprisingly, most of these 146 laws relate to transportation. However, more than forty percent of these laws appear in areas outside of core transportation areas, such as laws related to insurance, business, and the environment. Moreover, the four law professors involved in the study manually reviewed each of these 146 laws and identified subcategories that describe the kinds of laws that require detailed reform:

Figure 5

Category	Laws
Children in Vehicles	2
Commercial Vehicles: Operation and Other Obligations	14
Criminal Law	6
General Definitions	4
Driving Records	3
Emergency Vehicles	1
Enforcement Penalties and Civil Liability	7
Insurance	20
Licensing: General Issues	16
Licensing: Commercial	11
Prohibited Activities in Vehicles, e.g., Alcohol	12
Registration	6
Required Actions Related to Accidents	12
School Buses	5

Tax	2
Taxicabs, Limousines, and Other Ride Services	1
Unattended Vehicles	3
Use of Avs by the Department of Natural Resources	2
Vehicle Equipment: Required, Optional, and Inspections	19
Total	146

The sheer range of issues underscores the difficulty in identifying laws potentially impacted by AVs and the need to review legal regimes beyond just the rules of the road. Additionally, these results hammer home that AV-related reform will require the attention of many government actors, not just those players focused on transportation who are already aware of the impending AV collision course.

Fourth and finally, reforming those 146 laws not amenable to basic definition fixes generally will involve individualized policy choices. Law professors analyzed each of the 146 laws to determine whether they could be amended to effectively govern AVs. Over and over again, their analysis concluded that amendments depended on resolving policy questions across disparate areas of law. For example, one Maryland regulation requires that school bus drivers be at least twenty-one years of age, undergo medical examinations, and wear seat belts.[107] Since none of these requirements make sense when applied to AVs, it could be tempting to amend the regulation to cover only "human" bus drivers. Yet such an amendment might inadvertently suggest that AVs should be permitted to chauffeur and to supervise school children. Lawmakers need to decide what roles are appropriate for AVs when it comes to school children. Ultimately, the law professor reviewers found that only a handful of the 146 problematic laws could be easily amended to account for AVs.[108]

107 MD. CODE REGS. 13A.06.07.06 (2025).

108 For example, Maryland law provides that the "gender," "date of birth," and "race or ethnicity" of the "driver" be recorded following a traffic stop. MD. CODE ANN., TRANSP. § 25-113 (West 2024). Plainly, this law is designed to apply only to human drivers. As a result, the law could be amended to add the word "human" where necessary. Our spreadsheet with the data we compiled on Maryland's 146 problematic laws is viewable at the following link: https://archive.org/details/md-statutes_202505.

C. *Extrapolating to All States*

If the 842 problematic Maryland laws identified by this study are representative of the collision course imminent in the other forty-nine states, this suggests that at least 42,100 laws nationwide require reform for successful AV deployment.[109] When it comes to its legal regime implicating AVs, there is every reason to believe that Maryland is representative of the larger issue and no good reason to believe that it is an outlier state.

While every state boasts unique qualities, "nothing in Maryland's history suggests that it has taken a radically different path from its neighboring states or from the nation as a whole."[110] Indeed, across many different dimensions, Maryland is a typical state. Geographically, Maryland's diversity mirrors the broad range of environments found throughout the United States. Maryland has coastal areas and mountainous regions;[111] it features both dense urban areas (near Baltimore and Washington, D.C.) and rural areas (particularly on the Eastern Shore and in western parts of the state).[112] Maryland's well-developed road system reflects this city and country richness, with more than 12,000 miles of rural roadways and more than 18,000 miles of urban roadways.[113]

Focusing on the critical transportation perspective, Maryland is average in key respects. The Old Line State[114] ranks thirty-third in the country in terms of population (approximately six million), twenty-ninth in the country in terms of yearly miles traveled by drivers (approximately 56.6 billion), and twenty-fourth in fatal crashes per year (564).[115] There is no reason to believe that the legal regime that has developed to regulate

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109 The math is simple: 842 x 50 = 42,100.

110 *Cf.* Colin Starger, *The Argument That Cries Wolfish*, MIT COMPUTATIONAL L. REP., Aug. 2020, at 1, 9, 9 n.33 (making a similar argument that Maryland is representative in its criminal justice dynamics).

111 *See Maryland Topography*, MD. OFF. TOURISM, https://www.visitmaryland.org/info/maryland-topography [https://perma.cc/NQ8U-H8KB].

112 *See* OFF. OF THE COMPTROLLER, MARYLAND 2023: STATE OF THE ECONOMY 6 (2023), https://www.marylandtaxes.gov/reports/static-files/SOTE.pdf [https://perma.cc/2EZQ-VLMV].

113 MD. DEP'T OF TRANSP., 2022 MILEAGE REPORTS 2 (2023), https://roads.maryland.gov/OPPEN/2022_Mileage_Reports.pdf [https://perma.cc/4ZDT-AA3Y].

114 *Maryland's Nicknames*, MD. MANUAL ONLINE, https://msa.maryland.gov/msa/mdmanual/01glance/html/nickname.html [https://perma.cc/5KTS-V339].

115 IIHS HLDI, *Fatality Facts 2022: State by State* (June 2024), https://www.iihs.org/topics/fatality-statistics/detail/state-by-state [https://perma.cc/VXT4-F6XL].

this average transportation network varies significantly from the rest of the union.

Perhaps more importantly, Maryland's vehicular laws have much in common with those of other states. Notably, Maryland has adopted substantial portions of the Uniform Vehicle Code (UVC), which is a set of uniform laws designed to "advanc[e] uniformity in our traffic laws and regulations" to "reduc[e] . . . loss of life, personal injury and property damage upon our streets and highways."[116] Maryland is not alone in embracing the UVC. Nearly all of the states have adopted portions of the UVC, particularly those aspects related to the rules of the road.[117] To further promote legal consistency between Maryland and other states, Maryland law states that "portions of the Maryland Vehicle Law that are identical with corresponding portions of the Uniform Vehicle Code shall be interpreted and construed to make uniform the law of those states that enact them."[118]

Maryland has further coordinated its vehicle laws with those of other states by joining certain interstate compacts. For example, in 1979, Maryland joined the Nonresident Violator Compact.[119] This interstate agreement ensures that nonresident drivers who violate vehicle laws are

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116 NAT'L CONF. ON ST. AND HIGHWAY SAFETY, FINAL TEXT OF UNIFORM VEHICLE CODE, at v (1926); Anthony G. Brown, Thomas S. Chapman & Patrick B. Hughes, *Whether A Local Ordinance Prohibiting Local Police Officers from Stopping Drivers Solely for Certain Traffic Offenses Would Be Preempted by the Maryland Vehicle Law*, 108 MD. OP. ATT'Y GEN., at 81, 87 (2023); *see also* Klarman v. Haraszti, 332 A.2d 291, 292 (Md. Ct. Spec. App. 1975) (discussing how, in 1968, the Legislative Council appointed a special committee—the Warnken Commission—to revise the Motor Vehicle Laws in Maryland "to conform as closely as possible with the provisions of the Uniform Vehicle Code").

117 NAT'L COMM. ON UNIF. TRAFFIC L. AND ORDINANCES, UNIFORM VEHICLE CODE AND MODEL TRAFFIC ORDINANCE, at vi (1987); *see also* State v. Regis, 32 A.3d 1109, 1112 n.2 (N.J. 2011) ("All states have enacted laws similar to Uniform Vehicle Code § 11-309(a)."). Notably, nearly every state has adopted highly consistent statutes that define "driver" (or a closely related term, like "drive" or "operator") to be a person who "drives" or is in "actual physical control" of a vehicle. *See* William Hubbard, *Drivers of Effective Laws for Automated Vehicles*, 70 VILL. L. REV. 115, 127–28 (Apr. 1, 2025).

118 MD. CODE ANN., TRANSP. § 11-202 (West 2024); *see also Haraszti*, 332 A.2d at 840–42 (examining statutes in Ohio and California pursuant to § 11-202).

119 *Nonresident Violator Compact*, NAT'L CTR. FOR INTERSTATE COMPACTS, https://compacts.csg.org/compact/nonresident-violator-compact [https://perma.cc/QN54-VBBY]; *see Non-Resident Violators Compact (NRVC)*, MD. DEP'T OF TRANSP., https://mva.maryland.gov/about-mva/Pages/info/26100/26100-61T.aspx [https://perma.cc/Y3XB-94ZV].

subject to the same enforcement procedures as residents.[120] In total, forty-six states have joined the Nonresident Violator Compact.[121] Similarly, in 1987, Maryland entered the Driver's License Compact, which facilitates the exchange of information between states regarding violations of vehicle laws.[122] Under this agreement, when a nonresident is convicted of violating a state law related to the operation of motor vehicles, authorities in the convicting state must report the conviction to the nonresident's "home state," that is, where the nonresident is licensed.[123] The compact requires that the home state automatically treat certain serious offenses, such as felonies, as in-state convictions for the purposes of suspending or revoking a driver's license.[124] Home states otherwise exercise discretion regarding the impact on licensing of less serious convictions, such as speeding tickets.[125] Forty-seven states have joined this compact.[126]

Thus, Maryland is highly consistent with other states when it comes to the basic business of regulating vehicles. Additionally, Maryland, like most states, has made relatively few changes to its laws to account for AVs.[127] As a result, Maryland's laws provide a useful baseline for evaluating the need for reforms to traditional state laws to account for AVs. Consequently, the empirical study above supports four major conclusions regarding the preparedness of state law for AV deployment across the United States.

First, identifying all of the state laws that are problematic when applied to AVs is difficult. As noted, Maryland law includes more than 70,000 statutes and regulations.[128] If Maryland is relatively representative of other states, then the total number of state laws in the United States is

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120 *Nonresident Violator Compact*, *supra* note 119. For instance, the Nonresident Violator Compact provides that an officer issuing a citation cannot require the driver to post collateral to secure appearance, unless for a mandatory appearance, so long as the driver acknowledges that they will comply with the citation's terms. NAT'L CTR. FOR INTERSTATE COMPACTS, NONRESIDENT VIOLATOR COMPACT, art. III (2011).

121 *Nonresident Violator Compact*, *supra* note 119.

122 *Driver's License Compact*, NAT'L CTR. FOR INTERSTATE COMPACTS, https://compacts.csg.org/compact/driver-license-compact [https://perma.cc/5TWG-35PP]; MD. CODE ANN., TRANSP. § 16-702 (West 2024).

123 NAT'L CTR. FOR INTERSTATE COMPACTS, DRIVER'S LICENSE COMPACT, art. III.

124 *Id.* art. IV.

125 *Id.*

126 *Driver's License Compact*, *supra* note 122.

127 Maryland has passed two narrow laws related to AVs. *See* MD. CODE ANN., TRANSP. § 21-104.3 (West 2024) (regarding PDDs); *see also* MD. CODE ANN., TRANSP. § 21-310 (West 2024) (regarding platooned trucks); *infra* Section III.A (discussing AV reforms in various states).

128 *See supra* note 73 and accompanying text.

more than 350,000. The enormous scale of state law confirms the utility of the approach used in this Article of intensely studying a single state and extrapolating to the entire country. Simply combing through these laws looking for AV-related problems may be prohibitively expensive and slow.

Second, tens of thousands of state laws may be poorly suited for AVs. If other states, on average, have about as many problematic laws as Maryland, then approximately 42,100 state laws are unclear or ineffective when applied to AVs.[129] Of course, some states have already begun developing AV-related reforms and therefore may have fewer problematic laws.[130] On the other hand, many more states have not enacted any AV-significant reforms, and some AV reforms are likely ineffective, as explained below.[131] "Tens of thousands" of problematic state laws in the United States is thus an entirely justifiable ballpark estimate of the number of laws ill-suited to regulating AVs. This large number should be ringing alarm bells.

Third, the structure of the problem in Maryland provides useful insights into potential reforms in all states. As in Maryland, revising the legal definitions of core terms like "driver" and "operator" will likely address the vast majority of problematic state laws.[132] Based on the Maryland analysis, more than eighty percent of problems arise solely from the shortcomings of these definitions.[133] This is good news. The problematic laws may be legion, but the lion's share can be solved through effective reforms to a relatively small number of definitions.[134]

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129 *See supra* note 109 and accompanying text.

130 *See infra* Section III.A (describing state laws regarding AVs).

131 *See infra* Section III.A.

132 As noted above, the definitions for these terms are highly consistent across states, and the shortcomings of these terms when applied to AVs are therefore similar. *See supra* notes 92–96 and accompanying text (describing the problems with these definitions when applied to AVs); *supra* note 117 (describing the textual similarities of the definitions among the states).

133 The empirical study of Maryland laws found that eighty-one percent of laws that were unclear or ineffective when applied to AVs were problematic solely because of uncertainty regarding the terms "driver" and "operator." *See supra* Section II.B. As noted above, this figure may actually understate the number of laws that rely on these terms. *See supra* note 99. Refining definitions of other terms like "individual" may also help to address AV issues. *See supra* note 93. Additional reforms might be used to clarify that references to the movement of a vehicle effectively establish duties of conduct for drivers. For instance, Texas law states that "a reference to an operator includes a reference to the vehicle operated by the operator if the reference imposes a duty or provides a limitation on the movement or other operation of that vehicle." TEX. TRANSP. CODE ANN. § 545.002 (West 2025).

134 On the other hand, flawed reforms to these definitions of these key terms might generate widespread problems.

Fourth and finally, even assuming revisions to key definitions are implemented, states must enact significant additional reforms. In Maryland, 146 problematic laws were not amendable to basic definitional fixes, and instead require detailed reforms that often involve policy-driven analysis. The Maryland study further demonstrates that these laws are scattered across diverse legal domains. Extrapolating to the rest of the country, approximately 7,300 laws nationwide will likely require individualized consideration, including the evaluation of disparate policy issues to develop reforms.[135]

Without question, applying the empirical study of Maryland's law to the nation as a whole provides only rough estimates. Yet the big picture is crystal clear. Legislators, regulators, consumers, pedestrians, and businesses all have significant cause for concern regarding legal readiness for AV deployment. Myriad state laws—likely tens of thousands—must be addressed to pave the way for the deployment of AVs. At a minimum, this current climate of legal uncertainty around AVs could slow and limit AV deployment. Without full assessment of the status of AV legal preparedness in every state, AV manufacturers and their consumers alike will be unable to assess accurate potential liabilities related to AVs. Rather than risk the unknown, these stakeholders may opt to hit the brakes and delay what could otherwise be a welcome innovation. At worst, proceeding blindly with the AV deployment without identifying and reforming unclear laws could lead to unintended negative outcomes, such as reduced safety. The collision course could become literal and result in unnecessary injuries and fatalities. To avoid these harms, the remainder of this Article first assesses the current status of AV legal reform in the states and federally, and then evaluates the best legal approaches for reforming state vehicle laws to properly prepare for AV deployment.

III. CURRENT STATUS OF AV REFORMS

The study of Maryland laws described in the previous Part is the only comprehensive analysis of the laws of a state to assess legal preparedness for AV deployment. While no other state has undertaken such a review of its laws, both states and the federal government have started to consider how to regulate AVs and have begun adopting nascent reforms. This Part reviews these efforts and ultimately argues that current

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135 The empirical study of Maryland laws found that revisions to key terms would not resolve the issues of 146 laws that were unclear or ineffective when applied to AVs. *See supra* Section II.B. 146 multiplied by fifty is 7,300.

approaches are too piecemeal, uncoordinated, and limited to succeed. Though this Part tentatively identifies potential shortcomings with competing reform strategies, the primary goal is not to assess the individual merits of any particular state or federal law. Rather, the aim is to categorize strategic efforts and to demonstrate that they cannot succeed on their own. Coordinated investigation and intervention are needed.

A. *State Efforts To Reform State AV Law*

Because state governments are the source of the laws that are problematic when applied to AVs, these governments are well placed to enact appropriate revisions. Indeed, depending on how one counts, somewhere between one-third and one-half of the states have adopted reforms intended to make some aspect of AV deployment possible.[136] Nineteen states have enacted general reforms apparently intended to lay the foundations for widespread AV deployment.[137] Section 1 below examines these high-level approaches, which essentially seek to regulate AVs by changing key definitions to incorporate AVs into existing legal regimes or otherwise mandate that AVs follow existing laws. After this, Section 2 catalogs more specific reforms that address fine-grained issues like reporting requirements or niche AV technologies such as electronically-linked trucks and PDDs. As will be seen, neither the general nor the specific reforms are sufficient to address the problems with state laws identified above.

1. General Reforms

Given the prominence and promise of AV technology, it is unsurprising that some states have recognized that laws designed for traditional vehicles may be ill-prepared to account for AVs and therefore have attempted to rectify the problem. Even without undertaking a systematic assessment of laws akin to the study described in Part II above, some states have attempted to lay the legal foundations for AV deployment. In doing so, however, some states have evidently failed to

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136 *See infra* Sections II.A.2, III.A.1. States have also adopted laws regarding the testing of AVs. However, the focus of this Article is the laws supporting the deployment of AVs, not their initial development. *See supra* notes 48–49 and accompanying text.

137 *See infra* Section III.A.1. Some states use language equivalent to "driver," such as "operator."

grasp the importance of addressing key terms like "driver" and "operator." At least six states have enacted laws that generally allow for widespread AV use but without adopting new legal understandings for these terms.[138] In contrast, nineteen states have either explicitly or implicitly revised their definitions of "driver" (and related terms like "operator").[139]

Arizona provides a robust example. In 2021, Arizona amended its laws to add a detailed provision regarding the "Operation of Autonomous Vehicles."[140] This statute begins by declaring that "the operation of autonomous vehicles with or without a human driver is subject to all applicable federal and state laws," though this provision does not otherwise address the crux of this issue by clarifying which laws are "applicable."[141] The Arizona AV law then authorizes "licensed human driver[s]" to engage "automated driving system[s]" if they are "able to resume" driving when necessary.[142] On the other hand, the law permits "fully autonomous vehicle[s]" to operate on state roads "without a human driver" if a "person" submits detailed paperwork including a "law enforcement interaction plan" and declarations attesting, *inter alia*, that the person's AV can comply with "all applicable traffic and motor vehicle safety laws."[143]

Critically, the Arizona AV law then adds two provisions that effectively amend the definition of "driver." First, the law states that "[w]hen engaged, the automated driving system is considered the driver

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138 ARK. CODE ANN. § 27-51-2001 (2025); COLO. REV. STAT. § 42-4-242 (2025); KAN. STAT. ANN. § 8-2901 (2024); N.M. STAT. ANN. § 66-7-13 (2024); N.D. CENT. CODE § 39-01-01.2(1)(a)–(c) (2023); OKLA. STAT. TIT. 47, § 1708 (2025). North Dakota law provides that a human in a vehicle is not the "driver" of a highly advanced AV but does not specify in that instance who is. N.D. CENT. CODE § 39-01-01.2(1)(d) (2023).

139 ALA. CODE § 32-9B-4(b) (2025) ("The automated driving system is considered to be licensed to operate the vehicle."); ARIZ. REV. STAT. ANN. § 28-9702 (2024); CAL. VEH. CODE § 38750 (West 2025); FLA. STAT. ANN. § 316.85 (2024); GA. CODE ANN. § 40-1-1 (2024); IOWA CODE ANN. § 321.514 (2024); KY. REV. STAT. ANN. § 186.410 (West 2024); LA. STAT. ANN. § 32:400.4 (2024); MICH. COMP. LAWS § 257.665 (2024); MISS. CODE ANN. § 63-35-9 (2024); NEB. REV. STAT. § 60-3306 (2024); NEV. REV. STAT. § 484A.080 (2025); N.C. GEN. STAT. § 20-401 (2024); OKLA. STAT. tit. 47, § 6-102 (2024); 75 PA. CONS. STAT. § 8510.1 (2025); TENN. CODE ANN. § 55-30-106 (2025); TEX. TRANSP. CODE ANN. § 545.453 (West 2023); UTAH CODE ANN. §§ 41-26-102.1, 41-6a-102 (West 2024); W. VA. CODE § 17H-1-9 (2025).

140 H.R. 2813, 55th Leg., 1st Reg. Sess. (Ariz. 2021). This act also contained numerous other minor amendments regarding AVs.

141 ARIZ. REV. STAT. ANN. § 28-9702(A) (2024).

142 *Id.* § 28-9702(B).

143 *Id.* § 28-9702(C). Once again, this provision does not clarify which "traffic and motor vehicle safety laws" are "applicable."

or operator of the autonomous vehicle" regarding "all physical acts required by a driver or operator of the vehicle."[144] The "automated driving system" ("ADS") is the technological system that automates the driving tasks.[145] Presumably, this provision extends to AVs for any Arizona laws that physically target "drivers." For instance, one Arizona vehicle law requires that the "driver of a vehicle intending to turn left shall approach the turn in the extreme left-hand lane."[146] By declaring that the ADS is the "driver" for "physical acts," this left-turn law presumably applies to AVs.[147] The second part of the redefinition of "driver" relates to legal responsibility, at least for fully autonomous AVs, stating that the person who provided the detailed paperwork for the AV, as described above, "may be issued a traffic citation or other applicable penalty if the vehicle fails to comply with traffic or motor vehicle laws."[148] The Arizona AV law does not address legal responsibility for AVs that are not "fully" autonomous, such as Level 2 and Level 3 AVs.[149]

Arizona is not alone in enacting broad reforms regarding the deployment of AVs, though states have taken widely varying approaches to developing new laws. As noted above, a definition of "driver" for AVs must grapple with two issues: (1) when the automated systems in an AV become sufficiently robust that a human in the vehicle is no longer the driver (the line-drawing problem), and (2) who is the nontraditional driver when no traditional human driver is present (the identification problem).[150] Most states that have updated their definitions of "driver" for AVs have adopted similar approaches to the line-drawing problem. The laws in these states typically provide that a human is not a driver if the AV contains an ADS and that such technology is "engaged."[151]

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144 *Id.* § 28-9702(E).

145 *Id.* § 28-101.

146 *Id.* § 28-751.

147 Problems may nevertheless arise with this approach because the ADS may not be entirely housed within the AV. Some software aspects might be accessed by an AV remotely. *See* SAE MOBILUS, *supra* note 19, at 6 (defining the ADS to include "[t]he hardware and software that are collectively capable of performing the entire DDT on a *sustained* basis"). If so, a portion of the ADS would not "approach" a left turn at all, leaving the applicability of the left-turn law unclear.

148 ARIZ. REV. STAT. ANN. § 28-9702(C) (2024).

149 *See infra* notes 152–53 and accompanying text.

150 *See supra* Section II.A.3.

151 *E.g.*, ARIZ. REV. STAT. ANN. § 28-9702(E) (2024) ("When engaged, the automated driving system is considered the driver or operator of the autonomous vehicle . . . ."); FLA. STAT. § 316.85(3)(a) (2024) ("[T]he automated driving system, when engaged, shall be deemed to be the operator of an autonomous vehicle . . . ."); GA. CODE ANN. § 40-1-1(38) (2024) ("'Operator' means

However, the term "automated driving system" is taken from the SAE's automation typology, which states that only AVs that are Level 3, 4, or 5 contain an ADS.[152] As a result, with one exception, states that define "driver" based on ADS engagement do not address Level 2 AVs and therefore do not address the line-drawing problem for some AVs that possess substantial automation technology.[153]

Looking more closely, general-reform states vary considerably regarding the problem of identifying a nontraditional driver of an AV when there is no traditional human. Most commonly, the nontraditional driver of an AV is defined to be the ADS in the vehicle; at least ten states

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any person who . . . causes a fully autonomous vehicle to move or travel with the automated driving system engaged."); IOWA CODE § 321.515(3) (2024) ("The automated driving system, while engaged, shall be deemed to fulfill any physical acts required of a conventional human driver to perform the dynamic driving task."); KY. REV. STAT. ANN. § 186.410 (West 2024) ("When an automated driving system . . . is installed on a motor vehicle and is engaged, . . . the[] [o]wner of the motor vehicle is considered the operator of the fully autonomous vehicle . . . ."); LA. STAT. ANN. §§ 32:400.3–.4 (2024) (providing an implicit new definition of "operator" for AVs that can be driven "without a conventional driver physically present in the vehicle"); MICH. COMP. LAWS § 257.665(5) (2024) ("When engaged, an automated driving system allowing for operation without a human operator is considered the driver or operator of a vehicle . . . ."); MISS. CODE ANN. § 63-35-9 (2024) ("When an automated driving system installed on a motor vehicle is engaged the automated driving system is considered the driver or operator . . . ."); NEB. REV. STAT. § 60-3306 (2024) ("[T]he automated driving system of such vehicle, when engaged, shall be deemed to fulfill any physical acts required of a conventional human driver to perform the dynamic driving task . . . ."); NEV. REV. STAT. § 484A.080(2) (2024) ("If a vehicle is an autonomous vehicle . . . and the automated driving system . . . is engaged, 'driver' means a person who causes the automated driving system of the autonomous vehicle to engage."); N.C. GEN. STAT. § 20-401(a) (2024) ("[T]he operator of a fully autonomous vehicle with the automated driving system engaged is not required to be licensed to operate a motor vehicle . . . ."); OKLA. STAT. tit. 47, § 6-102 (2024) ("When an [ADS] . . . is engaged, . . . [it] is considered the driver or operator . . . .") ; TENN. CODE ANN. § 55-30-106(b) (2024) ("When the ADS is fully engaged, operated reasonably and in compliance with manufacturer instructions and warnings, the ADS shall be considered the driver or operator of the motor vehicle . . . ."); TEX. TRANSP. CODE ANN. § 545.453(a)(2) (West 2023) ("When an automated driving system installed on a motor vehicle is engaged . . . the automated driving system is considered to be licensed to operate the vehicle."); W. VA. CODE § 17H-1-9(a)(1) (2024) ("When an automated driving system (ADS) installed on a motor vehicle is engaged . . . [t]he ADS is considered the driver or operator . . . ."). Some jurisdictions consider both whether the ADS is engaged as well as additional factors, such as whether a person is in the driver's seat. *E.g.*, CAL. VEH. CODE § 38750(4) (West 2025) ("An 'operator' of an autonomous vehicle is the person who is seated in the driver's seat, or, if there is no person in the driver's seat, causes the autonomous technology to engage.").

152 SAE MOBILUS, *supra* note 19, at 6–7; *see also* NEV. REV. STAT. ANN. § 482A.025 (West 2025) (explicitly referencing the SAE as the source of the term "automated driving system").

153 The one exception is Utah, which provides a broader definition, stating that the "operator" of an AV is a "human driver" or an ADS. UTAH CODE ANN. §§ 41-6a-102, 41-26-102.1 (West 2024). As a result, in Utah, the driver of a Level 2 AV would be the "human driver." The incompleteness of the definitions in other states is discussed in more detail below. *See infra* Section IV.A.

use some variation of this approach.[154] Defining "driver" as the ADS may have some intuitive appeal, as the ADS is the technological system that is performing the driving tasks normally undertaken by humans. However, this reform strategy introduces a new set of problems regarding what happens when an ADS fails to follow the law. An ADS is electronic equipment, not a human or corporate legal actor capable of being held responsible for failing to effectively control the vehicle.[155] For instance, an ADS cannot receive a speeding ticket any more than a steering wheel can receive a ticket.

Other states have avoided these problems by identifying a nontraditional driver who is a legal person. Three states define the nontraditional AV driver to be the human causing the automated technology in the AV to engage.[156] Three other states consider an AV's human owner to be its driver.[157] In two more states, a person sitting in the driver's seat of certain AVs is considered the driver even if the AV is operating autonomously, somewhat undermining the benefits of automation.[158] One state identifies the nontraditional driver as the person who registered the AV.[159] Finally, in three states (including Arizona for

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154 ARIZ. REV. STAT. ANN. § 28-9702 (2024) (for non-fully-autonomous-vehicles); FLA. STAT. § 316.85 (2024); IOWA CODE § 321.514 (2024); MICH. COMP. LAWS § 257.665 (2024); MISS. CODE ANN. § 63-35-9 (2024); NEB. REV. STAT. § 60-3306 (2024) (for "driverless capable"-AVs only); OKLA. STAT. tit. 47, § 6-102 (2024); TENN. CODE ANN. § 55-30-106 (2025); UTAH CODE ANN. § 41-26-102 (West 2024); W. VA. CODE § 17H-1-9 (2024). Some states have also enacted laws that provide that when an ADS is engaged, it is considered to be licensed. *E.g.*, MISS. CODE ANN. § 63-35-9 (2024); OKLA. STAT. tit. 47, § 6-102 (2024).

155 By not identifying a legal actor, this definition of "driver" may cause numerous problems. *See* Hubbard, *supra* note 117, at 154–56.

156 CAL. VEH. CODE § 38750 (West 2025) (defining the "driver" as a human, causing the AV to engage only if there is no person in the driver's seat of the AV); GA. CODE ANN. § 40-1-1 (2024) (defining the "driver" as a human, causing the AV to engage for fully autonomous vehicles only); NEV. REV. STAT. § 484A.080 (2024) (defining the "driver" of an AV to be the "person who causes the automated driving system of the autonomous vehicle to engage"). For fully automated vehicles, Nevada further requires that the operator own the vehicle. *Id.*

157 ALA. CODE § 32-9B-4 (2024); KY. REV. STAT. ANN. § 186.410 (West 2025); TEX. TRANSP. CODE ANN. § 545.453 (West 2023).

158 CAL. VEH. CODE § 38750 (West 2025) (regarding AVs that are Level 3 to Level 5); NEB. REV. STAT. § 60-3303 (2024) (regarding Level 3 AVs only).

159 North Carolina law provides that "[t]he person in whose name [a] fully autonomous vehicle is registered is responsible for . . . a moving violation." N.C. GEN. STAT. § 20-401 (2024). North Carolina law states that an "occupant" of a "fully autonomous vehicle" that provides "solely strategic driving functions" is *not* the "driver," but North Carolina law does not affirmatively state who *is* the "driver" of such a vehicle. *Id.* § 20-400. North Carolina law further defines "[f]ully autonomous vehicle" narrowly to include only vehicles in which manual controls are inoperable or stowed "when the automated driving system is engaged." *Id.*

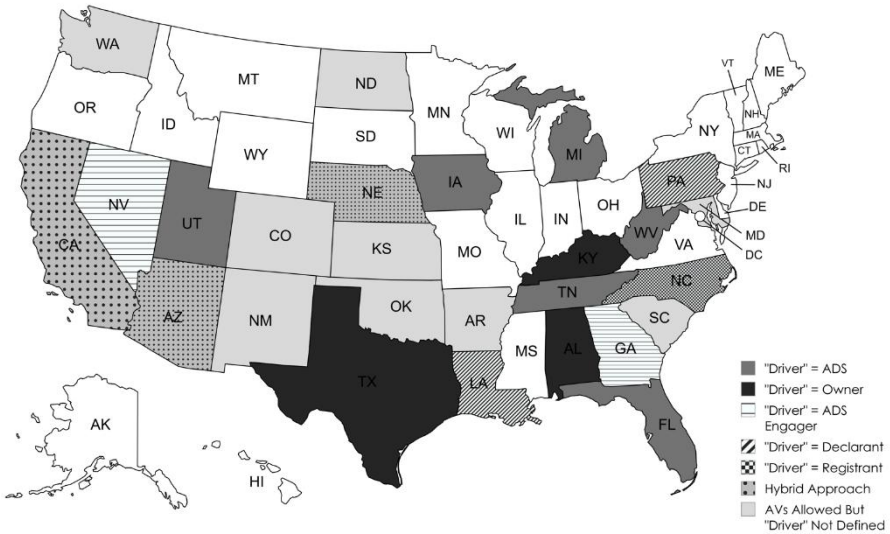
certain AVs) the nontraditional driver is the entity that has provided certain declarations to state authorities.[160] Thus, even among the forward-looking states that have adopted broad AV reforms regarding the definition of "driver," there is considerable variation on who exactly is a nontraditional driver.[161]

In sum, the nineteen states that have adopted definitional reforms do not have a unified approach. Figure 6 below visually demonstrates the patchwork of state approaches regarding the term "driver."

160 *See* ARIZ. REV. STAT. ANN. § 28-9702 (2024); LA. STAT. ANN. § 32:400.4 (2024); 75 PA. CONS. STAT. § 8510.1 (2025). Louisiana law states that the person who filed certain declarations with state authorities is "subject to" Louisiana vehicle laws, but stops short of explicitly identifying the "operator." LA. STAT. ANN. § 32:400.4 (2019).

161 The inconsistent approaches to identifying a nontraditional driver also undermine the operation of the Driver's License Compact. DRIVER'S LICENSE COMPACT, *supra* note 123, arts. II–III. Under this compact, a conviction in one state can lead to the suspension or revocation of a license in another state. *Id.* art. IV. However, if different states define the nontraditional driver of an AV differently, a conviction in one state may not impact licensing in another state. For example, while operating in Texas, a state where the driver of an AV is the owner, an AV could violate a traffic law, leading to a conviction for the owner. TEX. TRANSP. CODE ANN. § 545.453 (West 2023). However, the owner might be licensed in a state where the nontraditional driver is the entity that filed certain declarations with state authorities, like Arizona. ARIZ. REV. STAT. ANN. § 28-9702 (2024). Under the Driver's License Compact, Texas authorities would report the conviction to Arizona, potentially leading to a suspension of the owner's license even though Arizona does not consider the owner the driver of the AV. The basic problem is that the Driver's License Compact implicitly assumes that the meaning of "driver" is consistent in all states. While this assumption may have been well-placed regarding traditional human drivers, regarding AVs, this assumption is false.

Figure 6



Even with these new definitions of "driver," it deserves emphasis that tens of thousands of state laws remain unclear. Thirty-one states have not adopted new definitions to key terms, so that tens of thousands of state laws likely remain unclear and ineffective when applied to AVs.[162] Even in the states with new definitions, those reforms are incomplete insofar as they fail to address certain types of AVs (like those that are not fully autonomous), so that regarding these omitted AVs, many thousands of laws containing the terms "driver" and "operator" remain unclear.[163]

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162 The study described above estimates that at least 686 laws are unclear solely due to the definitions of "driver" and "operator." *See supra* note 100 and accompanying text. Multiplying 686 laws by 31 states yields an estimate of 21,266 unclear laws.

163 For instance, only one state has adopted a definition of "driver" that can apply to Level 2 AVs. *See supra* note 153. As a result, the meaning of "driver" regarding Level 2 AVs is unclear in 49 states, yielding an estimate of 33,614 unclear state laws regarding these vehicles (49 times 686). Similarly, the new definitions of "driver" in four states are limited to Level 4 and Level 5 AVs. GA. CODE ANN. § 40-1-1 (2025) (providing a new definition of "operator" but only for "fully autonomous vehicle[s]"); KY. REV. STAT. ANN. §§ 186.410, 186.760 (West 2025) (stating that the "owner of the motor vehicle is considered the operator of the fully autonomous vehicle"); LA. STAT. ANN. §§ 32:400.3, 32:400.4 (2024) (requiring a "person or entity" to submit a certification regarding an AV designed to operate "without a conventional driver present" and stating that this "person or entity . . . may be issued a traffic citation"); N.C. GEN. STAT. ANN. § 20-401 (West 2024) (stating that "[t]he person in whose name the fully autonomous vehicle is registered is responsible for . . . a moving violation"). As a result, only fifteen states have enacted definitions of "driver" regarding Level 3 AVs. *See supra* note 139 (demonstrating that nineteen states have adopted new definitions

For instance, some states have enacted new definitions regarding only certain AVs, such as commercial AVs, leaving the meaning of "driver" unclear for many other AVs.[164] Because states vary regarding which AVs are regulated, the patchwork problem described above is actually even worse. Finally, additional problems likely remain even in states with robust AV statutes, like Arizona. As described above, revising key definitions will not address all of the laws that are problematic when applied to AVs.[165] Ultimately, the sheer variety of approaches to revising the definition of "driver" further highlights the complexity of the underlying issues.[166]

2. Specific Reforms

As discussed above, the centrality of vehicles to modern life means that laws with vehicular aspects can be found across various substantive domains. A limited number of states have initiated reform across nonobvious domains. Other states have attempted more fine-grained reforms dealing with subsets of AV technology. This Section briefly surveys these more fine-grained reforms.

One relatively common type of specific reform concerns reporting. In many states, "drivers" of cars involved in serious accidents must report

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of "driver" for AVs). The meaning of "driver" regarding Level 3 AVs is therefore unclear in at least thirty-five states, producing an estimate of 24,010 problematic laws regarding Level 3 AVs (thirty-five times 686). In fact, these estimates are only a lower bound regarding the number of state laws that remain problematic when applied to AVs despite amendments to the definition of "driver." Because states have taken widely different approaches to revising key terms like "driver," at least some of these revisions may be ineffective to some extent.

164 Alabama and Louisiana have adopted a new definition of "driver" only regarding commercial AVs. ALA. CODE § 32-9B-4 (2025); LA. STAT. ANN. § 32:400.4 (2024).

165 *See supra* Section II.B (finding that 156 Maryland laws are problematic even if the definition of "driver" was updated).

166 Perhaps hoping to avoid some of the concerns regarding the application of state law described earlier, many states adopting AV reforms have also enacted statutes stating that AVs must be able to comply with state law. ARK. CODE ANN. § 27-51-2002 (2021); COLO. REV. STAT. § 42-4-242 (2025) (noting that violations can result in impoundment); KAN. STAT. ANN. § 8-2909 (2024); LA. STAT. ANN. § 32:400.3 (2024); NEB. REV. STAT. § 60-3302 (2025); N.D. CENT. CODE § 39-01-01.2 (2023); N.M. STAT. ANN. § 66-7-13 (2024); OKLA. STAT. tit. 47, § 1703 (2024); UTAH CODE ANN. § 41-26-103 (West 2024); W. VA. CODE § 17H-1-5 (2025). Similarly, new AV laws in some states provide that liability will be determined in accordance with state law but without clarifying how state law will determine liability. ARK. CODE ANN. § 27-51-2006 (2025); COLO. REV. STAT. § 42-4-242 (2025). However, these laws may have little impact if the application of state vehicle laws to AVs is unclear due to confusion regarding the meaning of "driver."

those collisions to authorities.[167] Because AVs may not have human drivers, some states have adjusted these reporting requirements.[168] For example, Mississippi law requires that the owner of the AV report the accident.[169] Similarly, certain equipment requirements for vehicles also make little sense with fully autonomous AVs, and some states have undertaken individualized reforms to account for this. California leads the pack here as it has legislation providing that certain AVs need not have windshields, windshield defrosters, windshield wipers, mirrors, or speedometers.[170]

Another category of lower-level reform involves less well-known AV technologies. One significant example involves electronically-linked trucks, also known as "platoons." States have long had laws that prohibit vehicles from following other vehicles too closely, so that drivers must leave space to react to hazards like other vehicles stopping or debris in the road.[171] Recently, at least twenty states have relaxed these laws for trucks with electronically-linked driving systems.[172] For example, while Maryland law generally requires that trucks "leave enough space [between vehicles] so that an overtaking vehicle may enter and occupy the space without danger," this requirement does not apply to trucks

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167 *See, e.g.*, LA. STAT. ANN. § 32:398 (2024); MISS. CODE ANN. § 63-3-411 (2024); NEB. REV. STAT. § 60-696 (2025); *see also* NAT'L COMM. ON UNIF. TRAFFIC L. AND ORDINANCES, UNIFORM VEHICLE CODE AND MODEL TRAFFIC ORDINANCE 51–52 (1987) (describing reporting requirements for "drivers").

168 *See, e.g.*, KY. REV. STAT. ANN. § 189.635 (West 2024) ("If the accident involves a fully autonomous vehicle . . . the responsibility to file the report under this subsection shall rest with the owner of the fully autonomous vehicle or a person on behalf of the vehicle owner."); LA. STAT. ANN. § 32:400.5 (2019); NEB. REV. STAT. § 60-3307 (2025).

169 MISS. CODE ANN. § 63-35-13 (2024); *accord* N.C. GEN. STAT. ANN. § 20-401 (West 2024); OKLA. STAT. ANN. tit. 47, § 1705 (2024); 75 PA. CONS. STAT. § 3746 (2025).

170 CAL. VEH. CODE §§ 24017, 26700, 26706, 26709, 26712 (West 2024).

171 *E.g.*, CAL. VEH. CODE § 21705 (West 2024) (prohibiting driving motor vehicles "less than 100 feet between each vehicle or combination of vehicles so as to enable any other vehicle to overtake or pass"); *see also* NAT'L CONF. ON ST. & HIGHWAY SAFETY, *supra* note 116, at 73 (stating that a "driver of any motor truck . . . shall not follow another motor truck within one hundred feet"). *See generally 50-State Survey*, SIMON L. FIRM, P.C., https://simonlawpc.com/wp-content/uploads/2019/12/platooning-legislation-50-state-survey.pdf [https://perma.cc/V2CF-UQTS] (surveying laws regarding following too closely).

172 *E.g.*, N.C. GEN. STAT. § 20-152(c) (2024); N.D. CENT. CODE § 39-10-18(4) (2023); OR. REV. STAT. § 811.485(3)(a) (2024); 75 PA. CONS. STAT. § 8532(b) (2024); TENN. CODE ANN. § 55-8-124(d) (2025); UTAH CODE ANN. § 41-6a-711(3) (West 2024); LA. STAT. ANN. § 32:81(E) (2024); WIS. STAT. § 346.14(2)(c) (2023); S.C. CODE ANN. § 56-5-1930(D) (2024); MISS. CODE ANN. § 63-3-619(3)(a) (2024). *See generally 50-State Survey*, *supra* note 171 (collecting laws).

"[t]raveling in a unified manner with electronically coordinated speed and braking systems."[173]

Another emergent AV technology that has garnered legal attention is the use of PDDs.[174] New PDD laws generally place limitations on the size and speed of these devices but also allow these AVs to operate in places normally used by pedestrians.[175] However, the specifics of these laws vary in significant respects.[176]

States also differ regarding the application of vehicle laws to PDDs. Maryland law states that PDDs are not "vehicles," thereby rendering inapplicable numerous Maryland vehicle laws.[177] Instead, unless otherwise specified, Maryland treats PDDs as pedestrians or bicycles.[178] Pennsylvania law similarly provides that, absent any contrary laws, PDDs must be operated in accordance with laws applicable to pedestrians.[179] As a result, PDDs in Maryland and Pennsylvania are subject to laws not designed for motorized technology, but rather for humans on foot. As such, problems may arise in applying these AV laws that were designed for pedestrians and bicycles.[180]

While noteworthy, these lower-level reform efforts certainly fail to address all the laws rendered problematic by AVs. The empirical study described above found that problematic laws are scattered over a broad range of topics.[181] However, no state has undertaken a comprehensive reform effort to find problematic laws, and consequently no state is likely

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173 MD. CODE ANN., TRANSP. § 21-310 (West 2024).

174 *Id.* § 21-104.3; 75 PA. CONS. STAT. § 8516 (2024); WASH. REV. CODE ANN. § 46.75.010 (West 2024); *see supra* notes 41–44 and accompanying text (describing PDDs).

175 MD. CODE ANN., TRANSP. § 21-104.3 (West 2024); 75 PA. CONS. STAT. § 8516 (2024); MD. CODE ANN., TRANSP. § 8516(d) (West 2024); MD. CODE ANN., TRANSP. § 8518 (West 2024); WASH. REV. CODE § 46.75.010 (2024).

176 For example, in Maryland, PDDs can weigh up to 550 pounds and can travel at no more than seven miles per hour on sidewalks and crosswalks. MD. CODE ANN., TRANSP. § 21-104.3 (West 2024). Pennsylvania law, on the other hand, limits the size, but not the weight, of PDDs, and further specifies that PDDs may not travel faster than twelve miles per hour in a pedestrian area or twenty-five miles per hour on a roadway. 75 PA. CONS. STAT. § 8516 (2024); *id.*§ 8516(d); *id.*§ 8518. Finally, Washington state law provides that PDDs can weigh no more than 120 pounds (excluding cargo) and may not travel faster than six miles per hour. WASH. REV. CODE § 46.75.010 (2024).

177 MD. CODE ANN., TRANSP. § 11-176 (West 2024).

178 *Id.* § 21-501.1(a); *id.*§ 21-1201(c).

179 75 PA. CONS. STAT. § 8516(b) (2024).

180 However, a full assessment of the suitability to AVs of laws for pedestrians or bicycles is beyond the scope of this Article.

181 *See supra* Section II.B.

to have addressed all of those laws, even regarding specialized AVs like platooned trucks or PDDs.[182]

B. *Federal Efforts to Address State AV Law*

Given the challenges inherent in a state-based approach, AV legal reformers might naturally look to federal law to provide a more effective and coordinated avenue for legal reform. A centralized reform approach could help to address the patchwork of inconsistent state AV laws described above.[183] Certainly, Congress and federal agencies are well-placed to develop harmonized AV reforms.[184] To start, at least in gross terms, federal agencies possess significantly more financial resources than any individual state. In 2023, the total budget for the United States Department of Transportation (USDOT) was $142 billion.[185] In contrast, the budgets for state departments of transportation are much smaller, even for large, populous states. For example, the two-year budget for the Texas Department of Transportation spanning both 2024 and 2025 is only $37.2 billion, even though Texas is by far the state with the most miles of road.[186]

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182 Mississippi has taken a drastically different approach by effectively exempting AVs from any law that implicitly assumes that vehicles are driven by humans. Specifically, Mississippi law states that for commercial AVs, "any provision that by its nature reasonably applies only to a human driver does not apply to such a vehicle operating with the automated driving system engaged." MISS. CODE ANN. § 63-35-21 (2024). This approach might provide clarity, but it also fails to determine whether such a broad exemption for AVs is warranted.

183 *See infra* note 271 and accompanying text.

184 However, some commentators have critiqued federal authorities like NHTSA for being slow to develop new regulations regarding motor vehicles. Kenneth S. Abraham & Robert L. Rabin, *Automated Vehicles and Manufacturer Responsibility for Accidents: A New Legal Regime for a New Era*, 105 VA. L. REV. 127, 137 (2019).

185 Press Release, Press Office, U.S. Dep't of Transp., U.S. Transportation Secretary Pete Buttigieg Announces the President's Fiscal Year 2023 Budget for the U.S. Department of Transportation (Mar. 28, 2022), https://www.transportation.gov/briefing-room/us-transportation-secretary-pete-buttigieg-announces-presidents-fiscal-year-2023 [https://perma.cc/5P2J-4RSC].

186 TX. DEP'T OF TRANSP., ANNUAL COMPREHENSIVE FINANCIAL REPORT: FOR THE FISCAL YEAR ENDED AUGUST 31, 2024, at 2 (2024), https://www.txdot.gov/content/dam/docs/financial/acfr/2024-txdot-annual-comprehensive-financial-report.pdf [https://perma.cc/B8D7-2M4R]; Off. of Highway Pol'y Info., *Highway Statistics 2019: Functional System Lane-Length—2022*, U.S. DEP'T OF TRANSP. (Jan. 18, 2024), https://www.fhwa.dot.gov/policyinformation/statistics/2022/hm60.cfm [https://perma.cc/7LUA-GA2S]. Similarly, the most recent budget for the California Department of Transportation was $33 billion. *The 2023-24 California Spending Plan: Transportation*, LEGIS. ANALYST OFF. (Oct. 16, 2023), https://lao.ca.gov/Publications/Report/4804 [https://perma.cc/

Beyond access to impressive resources, federal authorities also have developed substantial expertise regarding the regulation of AVs. As described below, agencies within the USDOT have already been working to update federal regulations to remove unintended barriers to AV development and deployment.[187] Additionally, federal agencies have investigated thousands of crashes involving AVs and gathered extensive information regarding AVs by mandating that AV manufacturers self-report crash information.[188] Using this information as well as additional research and analysis, the USDOT has issued five detailed policy papers regarding AVs.[189] The USDOT has further leveraged all of this experience and expertise to serve as a "convener between public safety officials, technology companies, automobile manufacturers, and other stakeholders to build consensus."[190] Indeed, the USDOT has explicitly offered to provide "technical assistance" to states regarding AVs.[191]

The next Sections therefore provide an overview of federal reform efforts and place those reform efforts in the context of federal vehicle regulation more broadly. As will be seen, the advanced state of federal AV work will help justify this Article's ultimate conclusion that the path to successful AV legal reform will require cooperation between the states and the federal government.

1. Federal Safety Statutes and Regulations

A primary avenue for federal regulation of motor vehicles is via binding safety standards.[192] The two agencies responsible for promulgating and enforcing safety standards are the National Highway Transportation Safety Administration (NHTSA) and the Federal Motor Carrier Safety Administration (FMCSA). Both NHTSA and FMCSA are

36V5-QZM4]. Not surprisingly, the departments of transportation for smaller states are commensurately more limited. For instance, Iowa's Department of Transportation has a budget of only about $4 billion. DEP'T OF TRANSP., IOWA BUDGET REPORT 2023, at 4 (2023), https://publications.iowa.gov/48854/1/FY2023_transportation_budget.pdf [https://perma.cc/HR96-3FA6].

187 *See infra* Section III.B.1.

188 *See infra* Section III.B.2.

189 *See infra* Section III.B.3.

190 U.S. DEP'T OF TRANSP., *supra* note 5, at 33.

191 *Id.* at 20.

192 Other federal laws and agencies impact vehicles but are unrelated to the issues raised by AVs and addressed in this Article. For example, the Environmental Protection Agency issues regulations regarding the emissions of new vehicles sold in the United States. 42 U.S.C. § 7521.

subunits of the USDOT, and both have been actively engaged in AV legal reform.

NHTSA prescribes the Federal Motor Vehicle Safety Standards (FMVSSs), which are seventy-three detailed regulations specifying technical standards for vehicle equipment.[193] For example, the FMVSSs require that vehicles have "power-driven windshield wiping system[s]" and side-view mirrors.[194] Similarly, since 2009, FMVSSs have required new cars to have headrests for front seats.[195] Federal law prohibits manufacturers from selling vehicles that do not comply with the FMVSSs.[196]

Typically, NHTSA does not scrutinize vehicles to determine whether they comply with the FMVSSs; rather, NHTSA relies on manufacturers to self-certify that their vehicles conform to the FMVSSs that were in effect when the vehicles were manufactured.[197] Thereafter, if a manufacturer determines that a vehicle does not satisfy applicable safety standards, the manufacturer must notify vehicle owners through a recall notice.[198] NHTSA may also identify defects by "testing, inspection, investigation, or research" and then inform a manufacturer of that defect.[199] In either case, the manufacturer is responsible for remedying with a recall notice any noncompliance related to an FMVSS.[200] Like the state laws described above, NHTSA developed the FMVSSs in an era when only human drivers operated vehicles. As a result, the FMVSSs required vehicles to include equipment necessary for humans to safely operate them, such as steering wheels and side mirrors.[201] The FMVSSs further provided that equipment be configured to "minimize chest, neck, and facial injuries to the driver as a result of impact."[202]

Following the early stages of the development of AVs, federal authorities recognized that such FMVSSs were ill-suited to regulating AVs with no human drivers. As a result, in 2015, the USDOT's John A.

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193 Federal Motor Vehicle Safety Standards, 49 C.F.R. § 571.1 (2024); 49 U.S.C. § 30111 ("The Secretary of Transportation shall prescribe motor vehicle safety standards."); *see* KIM ET AL., *supra* note 77, at 1.

194 49 C.F.R. §§ 571.104, 571.111 (2024). *See generally* 49 U.S.C. § 30111.

195 49 C.F.R. § 571.202(a) (2024).

196 49 U.S.C. § 30112 (2024).

197 49 C.F.R. § 571.567.4 (2024); *accord* 49 U.S.C. § 30115.

198 49 C.F.R. § 577.5 (2024).

199 49 U.S.C. § 30118.

200 *Id.* § 30120; 49 C.F.R. § 573.5 (2024).

201 49 C.F.R. § 571.111 (2025).

202 *Id.* § 571.203.

Volpe National Transportation Systems Center ("Volpe") began examining the FMVSSs to identify regulations that might impose unnecessary restrictions on AVs, and in March 2016, issued a report summarizing the analysis (the "Volpe FMVSS Report").[203] The Volpe FMVSS Report concluded that many regulations in the FMVSSs "assume[d] the presence of a human driver," and therefore were poorly suited for AVs.[204] Notably, the Volpe FMVSS Report found that its definition of "driver" could be problematic in the context of AVs.[205] While the Volpe FMVSS Report identified issues, it did not recommend reforms.

Four years after the publication of the Volpe FMVSS Report, NHTSA issued a Notice of Proposed Rulemaking, recommending changes to the FMVSS regulations identified in the Volpe FMVSS Report.[206] Following a notice-and-comment period, on March 10, 2022, NHTSA issued a final regulation supporting the development of AVs without human drivers.[207] The new rule updated the FMVSS regulations in part through the use of new definitions, such as for the term "manually operated driving controls."[208] However, the final rule left untouched the definition of "driver," largely because the proposed reforms narrowly focused on vehicle safety crashworthiness rather than a holistic evaluation of the broader legal issues that might be impacted by defining a key term like "driver."[209]

NHTSA has also begun exploring whether and how to develop new FMVSSs specifically targeting AV technologies.[210] Yet despite issuing an

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203 *See* KIM ET AL., *supra* note 77.

204 *Id.* at viii. In particular, the Volpe FMVSS Report identified sixty-five regulations that were poorly suited to AVs and therefore could impair AV development and deployment. *Id.* at 12–19.

205 The FMVSS defines "driver" in distinctly human terms as "the occupant of a motor vehicle seated immediately behind the steering control system." 49 C.F.R. § 571.3 (2024). The Volpe FMVSS Report concluded that any FMVSS regulation containing "driver" was also concerning. *See* KIM ET AL., *supra* note 77, at 8, 12 (noting that 33 provisions of the FMVSS "may present certification challenges for certain types of [AVs] because they contain references to a driver").

206 Following the Report, NHTSA conducted further research and consulted with industry stakeholders. *See* Occupant Protection for Automated Driving Systems, 85 Fed. Reg. 17624, 17626–27 (proposed Mar. 30, 2020) (to be codified at 40 C.F.R pt. 571).

207 *See* Occupant Protection for Vehicles with Automated Driving Systems, 87 Fed. Reg. 18560, 18566–67 (Mar. 30, 2022) (to be codified at 40 C.F.R pt. 571) (approving NHTSA's Final Rule).

208 *Id.* at 18567.

209 *Id.* at 18566.

210 In late 2020, NHTSA issued an Advance Notice of Proposed Rulemaking soliciting public feedback on these issues. Framework for Automated Driving System Safety, 85 Fed. Reg. 78058 (proposed Dec. 3, 2020) (to be codified at 49 C.F.R. pt. 571). While NHTSA acknowledged that "it

Advance Notice of Proposed Rulemaking soliciting public feedback on AV issues in late 2020,[211] NHTSA has not proposed new FMVSSs based on this notice.[212] NHTSA has explained its inaction as stemming from its previous experiences that "establishing FMVSS prior to technology readiness can lead to adverse safety consequences."[213] For now, NHTSA's AV reform efforts are on hold.

NHTSA's sister agency, FMCSA, provides an additional layer of safety regulation of larger vehicles, like trucks and busses.[214] A key part of this oversight is the Federal Motor Carrier Safety Regulations (FMCSRs), which govern both vehicle equipment and operation. The FMCSRs generally prohibit drivers from operating a motor carrier "in such a condition as to likely cause an accident or a breakdown of the vehicle."[215] Regulations issued by FMCSA run the gamut from requiring motor carriers to be equipped with fire extinguishers and extra electrical fuses, to mandating that drivers of commercial vehicles stop at railroad crossings, to prohibiting commercial drivers from using radar detectors or texting while driving.[216]

Like the FMVSSs, when the FMCSRs were developed, all vehicles were operated by human drivers, and lawmakers implicitly (and reasonably) assumed that the drivers of these vehicles would be natural persons. For example, the FMCSRs provide that a "driver" must be

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may be premature for NHTSA to develop and promulgate a specialized set of FMVSS or other performance standards for ADS competency," it also asserted that "[i]t is not too soon . . . with input from stakeholders, to begin identifying and developing the elements of a framework that meets the need for motor vehicle safety." *Id.* at 78059, 78062.

211 Framework for Automated Driving System Safety, 85 Fed. Reg. 78058.

212 The last formal activity by NHTSA regarding this proposed rulemaking was to extend the time for submitting comments until April 1, 2021. *See* Framework for Automated Driving System Safety; Extension of Comment Period, 86 Fed. Reg. 7523 (proposed Jan. 29, 2021) (to be codified at 49 C.F.R. pt. 571). Instead, NHTSA noted that in the short term it would continue to regulate AVs using its "defect investigation and remediation authority." Framework for Automated Driving System Safety, 85 Fed. Reg. at 78059 (providing requisite Advance Notice of Proposed Rulemaking).

213 Framework for Automated Driving System Safety, 85 Fed. Reg. at 78069. Moreover, federal law requires that any new mandatory safety standards be "objective" and "practicable," requirements that can be difficult to develop with rapidly evolving AV technology. 49 U.S.C. § 30111. NHTSA suggested that stakeholders recommend "performance-oriented approaches and metrics" rather than specifying design characteristics or technical requirements. Framework for Automated Driving System Safety, 85 Fed. Reg. at 78059.

214 Though not the subject of this Article, federal agencies outside of the USDOT also regulate motor vehicles, such as the Environmental Protection Agency's regulation of vehicle emissions. *See generally* Control of Emissions from New and In-Use Highway Vehicles and Engines, 40 C.F.R. pt. 86 (2024) (vehicle and engine emission standards).

215 *See* 49 C.F.R. § 396.7(a) (2025).

216 *See id.* §§ 393.95, 392.10, 392.80.

"properly restrained by the seat belt assembly."[217] The FMCSRs also limit the number of hours that a "driver" may drive a commercial motor vehicle and prohibits "driver[s]" from operating a vehicle when suffering from "fatigue" or "illness."[218]

As it did with NHTSA's FMVSSs, Volpe analyzed FMCSA's FMCSRs to identify regulations that might impose unnecessary restrictions on certain AVs and issued a report summarizing its analysis ("the Volpe FMCSR Report").[219] Like the 2016 Volpe report regarding the FMVSSs, the March 2018 FMCSR report likewise concluded that the relevant regulations "were drafted without consideration for the possibility that they might one day apply to commercial vehicles that are either partially or entirely driven without input from a human driver."[220] As a result, the FMCSRs may "pose compliance and enforcement challenges" for AVs.[221] Once again, the report both highlighted the definition of "driver" as a key issue that "may require explicit clarification" in the context of AVs but declined to offer particular reforms.[222]

Since the issuance of the Volpe FMCSR Report, the FMCSA has begun working to update its safety regulations to account for AVs. In July 2019, the FMCSA issued an Advance Notice of Proposed Rulemaking regarding the applicability of the FMCSRs to AVs.[223] Notably, the FMCSA sought public comments regarding whether the definition of "driver" in the FMCSR should be amended "to reduce the potential for misinterpretation of the requirements."[224] In early 2023, the FMCSA issued a supplemental notice, posing additional issues for public feedback and extending the time for submissions.[225] The FMCSA has not yet proposed particular revisions to the FMCSRs based on this process.

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217 *Id.* § 392.16.

218 *Id.* §§ 392.3, 395.3. Similarly, the FMCSRs require that a "driver" be "medically examined" from time to time. *Id.* § 391.45.

219 JOHN A. VOLPE NAT'L TRANSP. SYS. CTR., REVIEW OF THE FEDERAL MOTOR CARRIER SAFETY REGULATIONS FOR AUTOMATED COMMERCIAL VEHICLES 1–2 (2018), https://rosap.ntl.bts.gov/view/dot/35426 [https://perma.cc/LPC5-2V7Q].

220 *Id.* at v.

221 *Id.*

222 *Id.* at vi.

223 Safe Integration of Automated Driving Systems-Equipped Commercial Motor Vehicles, 84 Fed. Reg. 24449 (proposed May 28, 2019) (to be codified at 49 C.F.R. ch. 3).

224 *Id.* at 24458.

225 Safe Integration of Automated Driving Systems (ADS)-Equipped Commercial Motor Vehicles (CMVs), 88 Fed. Reg. 6691, 6691–95 (proposed Feb. 1, 2023) (to be codified at 49 C.F.R. ch. 3).

2. Federal Investigations and Recalls

Congress has also given federal agencies authority to regulate motor vehicles through investigations into the safety of equipment. Thus, NHTSA has the power to identify safety-related defects in vehicle equipment and to require manufacturers to remedy those defects.[226] In pursuing its investigations, NHTSA has the power to issue subpoenas to "any person, sole proprietorship, partnership, corporation, or other entity."[227] If NHTSA determines that a vehicle suffers from a safety-related defect, NHTSA will notify the manufacturers, who in turn must notify consumers of the defect through a recall notice and offer to repair or replace the affected vehicles.[228] A manufacturer that fails to comply with this process may face stiff penalties up to $21,000 per affected vehicle, and aggregate penalties may be as high as $105 million.[229]

Because NHTSA's investigatory authority is broadly framed to encompass "any defect in performance," NHTSA has in recent years begun investigating concerns regarding AVs. Perhaps most prominent are NHTSA investigations in vehicles manufactured by Tesla.[230] In August 2021, NHTSA's Office of Defects Investigation began examining the performance of Tesla's Autopilot system, noting that since 2018, the Office had identified eleven accidents in which Tesla vehicles struck emergency responder vehicles.[231] NHTSA estimates that this investigation involves more than 750,000 Tesla vehicles.[232] In February

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226 Defect and Noncompliance Responsibility and Reports, 49 C.F.R. § 573.5 (2025) (stating that "[e]ach manufacturer of a motor vehicle shall be responsible for any safety-related defect"). Notably, in contrast to the detailed specificity of the FMVSSs, Congress granted NHTSA broad investigatory authority by defining "defect" flexibly to include "any defect in performance" or "construction." 49 U.S.C. § 30102. Notably, federal law distinguishes between defects and compliance with the FMVSSs, so that a vehicle might contain a defect even if it complies with formal safety standards. *See id.* §§ 30118–30120. Pursuant to this power, NHTSA's Office of Defects Investigation determines whether a vehicle has a defect through "testing, inspection, investigation, or research." *Id.* § 30118; *see also id.* § 30166 (describing investigatory powers).

227 Information Gathering Powers, 49 C.F.R. § 510.4 (2024); *see also id.* § 510.12 (describing consequences for failing to comply with a NHTSA subpoena).

228 49 U.S.C. §§ 30118–30120.

229 49 U.S.C. § 30165.

230 Congress has given NHTSA the authority to undertake inspections and investigations "related to a motor vehicle accident." 49 U.S.C. § 30166(b)(1)(B).

231 *See* NAT'L HIGHWAY TRAFFIC SAFETY ADMIN., ODI RESUME 1 (2021), https://static.nhtsa.gov/odi/inv/2021/INOA-PE21020-1893.PDF [https://perma.cc/4LQY-PX29].

232 *Id.* This investigation began as a Preliminary Evaluation, but in June 2022, NHTSA upgraded the investigation to a more fulsome Engineering Analysis. *See* NAT'L HIGHWAY TRAFFIC SAFETY

2022, NHTSA initiated another investigation of Tesla vehicles based on hundreds of consumer complaints regarding so-called "phantom braking," that is, unexpected and significant braking initiated by Tesla's automated systems.[233] NHTSA estimates that this second investigation involves more than 400,000 vehicles.[234] Neither of these NHTSA investigations of Tesla vehicles has completed. Tesla is not the only company that has been the subject of NHTSA investigations. In December 2022, NHTSA began an investigation into a few hundred vehicles manufactured by Cruise LLC involving "inappropriately hard breaking" and vehicle "immobilization."[235] In 2024, NHTSA also began an investigation into approximately 130,000 vehicles manufactured by Ford and equipped with certain driver assistance technologies.[236]

Furthermore, NHTSA has become proactive in its efforts to identify defects in AVs by requiring automotive manufacturers to report to federal authorities certain AV-related accidents. In general, federal law requires manufacturers to notify NHTSA regarding safety-related defects in their vehicles.[237] Pursuant to this authority, in June 2021, NHTSA issued a general order requiring manufacturers of AVs to notify NHTSA of any serious crashes involving an AV.[238] NHTSA stated that the data

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ADMIN., ODI RESUME 1 (2022), https://static.nhtsa.gov/odi/inv/2022/INOA-EA22002-3184.PDF [https://perma.cc/D8ES-7ZEG] (involving autopilot and first responder scenes).

233 NAT'L HIGHWAY TRAFFIC SAFETY ADMIN., ODI RESUME 1 (2022), https://static.nhtsa.gov/odi/inv/2022/INOA-PE22002-4385.PDF [https://perma.cc/HA53-HUTC] (involving unexpected break activation).

234 *Id.*

235 NAT'L HIGHWAY TRAFFIC SAFETY ADMIN., ODI RESUME 1 (2022), https://static.nhtsa.gov/odi/inv/2022/INOA-PE22014-4871.PDF [https://perma.cc/NW95-4LQ7] (involving autonomous driving systems).

236 *See* NAT'L HIGHWAY TRAFFIC SAFETY ADMIN., ODI RESUME 1 (2024), https://static.nhtsa.gov/odi/inv/2024/INOA-PE24012-12041.pdf [https://perma.cc/P9F7-G8AQ].

237 49 U.S.C. § 30118(c). In addition, Congress has given NHTSA the authority to issue general orders requiring persons to "file reports or answers to specific questions." *Id.* § 30166(g)(1)(A).

238 *Standing General Order on Crash Reporting*, NAT'L HIGHWAY TRAFFIC SAFETY ADMIN., https://www.nhtsa.gov/laws-regulations/standing-general-order-crash-reporting [https://perma.cc/M5N7-5TSM]. NHTSA issued an initial order in June 2021 and then amended that order in August 2021 and again in April 2023. *Id.*; NAT'L HIGHWAY TRAFFIC SAFETY ADMIN., SECOND AMENDED STANDING GENERAL ORDER 2021-01, at 2 (2023), https://www.nhtsa.gov/sites/nhtsa.gov/files/2023-04/Second-Amended-SGO-2021-01_2023-04-05_2.pdf [https://perma.cc/X6KH-WZLZ]. In particular, manufacturers must report any crash where (1) AV technology was "engaged at any time during the period from 30 seconds immediately prior to . . . the crash"; (2) the crash led to "any person being transported to the hospital for medical treatment"; or (3) there was a fatality, a vehicle tow-away, or an airbag deployment. *Id.* at 16–18. Moreover, manufacturers must report even minor crashes on public roads involving AV systems that the manufacturer classifies as SAE Level 3, 4, or 5. *Id.*

gathered through this reporting will allow it to identify AVs with safety defects and "to ensure that unsafe vehicles are taken off public roads."[239]

In June 2022, NHTSA published two reports regarding the crash data for AVs gathered pursuant to its general order. The first report states that between June 2021 and May 2022, 367 crashes occurred involving Level 2 AVs.[240] The crashes were scattered across more than forty states, and the vast majority of crashes (273) involved vehicles made by Tesla.[241] The second report addresses crashes involving Level 3, 4, or 5 AV systems.[242] NHTSA noted that at the time, none of these vehicles were available for sale to the general public.[243] Nevertheless, NHTSA reported approximately 130 crashes between June 2021 and May 2022 involving these high-level AVs, with the largest number of accidents involving vehicles operated by Waymo and the majority of these crashes occurring in California.[244] NHTSA's AV reporting requirements may prove useful in identifying additional AV defects.[245]

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239 *Standing General Order on Crash Reporting*, *supra* note 238.

240 NAT'L HIGHWAY TRAFFIC SAFETY ADMIN., SUMMARY REPORT: STANDING GENERAL ORDER ON CRASH REPORTING FOR LEVEL 2 ADVANCED DRIVER ASSISTANCE SYSTEMS 5 (2022), https://www.nhtsa.gov/sites/nhtsa.gov/files/2022-06/ADAS-L2-SGO-Report-June-2022.pdf [https://perma.cc/D3SF-ARS2]. NHTSA admitted that its data could understate the number of accidents involving AVs because some accidents may not have been reported. *Id.* at 3. In other respects, NHTSA cautioned that the data might overstate the number of accidents because some accidents may have been reported multiple times. *Id.* at 4.

241 *Id.* at 6, 8. NHTSA further noted that the data has not been "normalized." *Id.* at 4. For example, the data has not been adjusted to account for the fact that some manufacturers may "operate a higher number of vehicles for many more miles." *Id.* As a result, NHTSA did not conclude that Tesla vehicles are more dangerous than vehicles made by other manufacturers.

242 NAT'L HIGHWAY TRAFFIC SAFETY ADMIN., *supra* note 240, at 2.

243 *Id.*

244 *Id.* at 4–5, 7. NHTSA admitted that its data could both understate and overstate the number of accidents. *Id.* at 3.

245 *See, e.g.*, *Special Crash Investigations*, NAT'L HIGHWAY TRAFFIC SAFETY ADMIN., https://www.nhtsa.gov/crash-data-systems/special-crash-investigations [https://perma.cc/RV58-VUED]. Other regulatory efforts by NHTSA related to AVs are likewise significant but focused on equipment safety rather than vehicle operation. *Id.* For instance, NHTSA has begun working to gather more information regarding AV safety through its Special Crash Investigations (SCI) Program. *Id.* Through this program, professional crash investigators scrutinize individual crashes in order to develop "an anecdotal data set useful for examining special crash circumstances or outcomes from an engineering perspective." *Id.* Since 2016, NHTSA has opened more than forty investigations into individual crashes involving Tesla vehicles. David Shepardson, *U.S. Safety Agency Probes Two More Tesla Crashes Involving Suspected Driver Assistance*, REUTERS (Dec. 22, 2022, 2:49 PM), https://www.reuters.com/business/autos-transportation/us-safety-agency-probing-two-new-tesla-driver-assistance-crashes-2022-12-22 [https://perma.cc/RGQ9-KBEH]. However, NHTSA is not gathering information through these SCI investigations as part of a

Few agencies outside of the USDOT investigate the safety of AVs. One exception is the National Transportation Safety Board ("NTSB"). Concerned that other government agencies may suffer from various biases, Congress established the NTSB as an independent agency empowered to address various transportation issues.[246] Specifically, while the NTSB cannot issues regulations or otherwise make laws, it can investigate accidents and makes safety recommendations.[247] The NTSB is perhaps best known for its work on plane crashes, but the agency also investigates highway accidents.[248] Pursuant to this power, the NTSB has examined various crashes involving AVs manufactured by Tesla.[249]

Following these investigations, the NTSB issued recommendations for improving the safety of Tesla vehicles, such as encouraging the development of "driver monitoring systems to minimize driver disengagement, prevent automation complacency and account for foreseeable misuse of the automation."[250] The NTSB also issues more general safety recommendations, including some related to AVs. For example, the NTSB currently recommends that vehicles in the United States be required to utilize connected vehicle technologies and automatic braking to reduce collisions.[251] However, NTSB does not develop and enact regulations, and instead directs its recommendations to agencies with lawmaking authority, such as the NHTSA.

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targeted effort to develop new federal regulations. *Special Crash Investigations*, *supra* note 245. Rather, NHTSA intends that the data from the SCI program be used more broadly "by the automotive safety community to improve the performance of its advanced safety systems." *Id.*

246 49 U.S.C. § 1111(a).

247 *Id.* §§ 1111(g), 1116.

248 *Id.*

249 *See, e.g.*, *NTSB Solves Mystery of Deadly Tesla Crash with No One Behind the Wheel*, CBS NEWS (Feb. 9, 2023, 9:45 AM), https://www.cbsnews.com/news/tesla-crash-spring-texas-deaths-mystery-solved-ntsb [https://perma.cc/5NTE-5G62]; *Collision Between a Sport Utility Vehicle Operating with Partial Driving Automation and a Crash Attenuator*, NTSB, https://www.ntsb.gov/investigations/pages/HWY18FH011.aspx [https://perma.cc/2M57-RU9U].

250 *Tesla Crash Investigation Yields 9 NTSB Safety Recommendations*, AUTO. SAFETY COUNCIL (Feb. 25, 2020), https://www.automotivesafetycouncil.org/announcement/ntsb-tesla-crash-investigation-report [https://perma.cc/KD2Z-ZSQ6].

251 *Require Collision-Avoidance and Connected-Vehicle Technologies on All Vehicles*, NTSB (Dec. 23, 2022), https://www.ntsb.gov/Advocacy/mwl/Pages/mwl-21-22/mwl-hs-04.aspx [https://perma.cc/2FAA-RPK3].

3. Nonbinding Federal Laws and Activities Related to Vehicles

Beyond enacting regulations focused on vehicle equipment, federal authorities have also addressed various aspects of vehicular operation. Federal authorities have generally accomplished this by using financial incentives to encourage states to voluntarily incorporate federal standards into state law.[252] Examples of federally incentivized driving regulations implemented by states include laws requiring seat belts and prohibiting drunk driving.[253]

One of the most substantial uses of federal incentives to shape state vehicle laws is the Commercial Driver's License (CDL) system. The goal of this system is to ensure that throughout the United States, the drivers of large vehicles, such as trucks, buses, and hazardous material transporters, meet a uniform level of safety.[254] Importantly, the system operates as a partnership between federal and state governments.[255] By federal statute, a driver must have a CDL to operate a commercial vehicle.[256] However, leveraging their traditional authority to issue driver's licenses, states issue CDLs, not federal authorities.[257] Nevertheless, federal law determines the standards that states apply when issuing CDLs.

Specifically, Congress has empowered the FMCSA to establish detailed regulations regarding the licensing of commercial drivers.[258] These standards are designed to ensure that drivers have the knowledge

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252 The history of federal financial incentives is best related through the Congressional efforts to raise the national drinking age to twenty-one years through the passage of the National Minimum Drinking Age Act. Pub. L. No. 98-363, 98 Stat. 435 (1984). Under this law, any state that allowed "purchase or public possession . . . of any alcoholic beverage by a person who is less than twenty-one years of age" would lose federal highway funds. 23 U.S.C. § 158. Soon after the passage of this law, South Dakota challenged its constitutionality, ultimately taking the case to the Supreme Court. *See* South Dakota v. Dole, 483 U.S. 203 (1987). The Court held that "Congress may attach conditions on the receipt of federal funds," provided that those conditions are clear, in pursuit of the "general welfare," and relate to some "federal interest in particular national projects or programs." *Id.* at 206–08. In finding these requirements satisfied, the Court highlighted the importance of interstate highway safety, noting that "differing drinking ages in the States created particular incentives for young persons to combine their desire to drink with their ability to drive." *Id.* at 208.

253 *See* 23 U.S.C. § 153 (requiring seat belts); *see also* 23 U.S.C. § 163 (prohibiting drunk driving).

254 49 U.S.C. § 31100; 49 C.F.R § 383.1 (2025).

255 49 U.S.C. § 31100.

256 *Id.* § 31302; *see also* 49 C.F.R § 383.23 (2025) (prohibiting operation of a commercial motor vehicle without obtaining a CDL).

257 49 U.S.C. § 31311.

258 *Id.* § 31305.

and skills necessary to operate commercial vehicles safely.[259] For example, FMCSA regulations address various aspects of commercial driving, including driver qualifications and the knowledge and skills tests drivers must pass to obtain CDLs.[260] Moreover, state law enforcement and departments of transportation are responsible for enforcing federal and state regulations governing commercial driving.[261]

Notably, the CDL system is not imposed on states through binding federal law.[262] Rather, this system is largely enforced through financial incentives, with federal law stating that a portion of federal transportation funds normally allocated to the states shall be withheld from any state that "does not comply substantially" with federal law regarding CDLs.[263] Federal authorities also help to support the CDL system directly by operating the Commercial Driver's License Information System (CDLIS), a database that helps to ensure that drivers hold only one CDL and that tracks driving records across states.[264] Thus, the CDL system in the United States is a detailed, collaborative effort between the federal government and state authorities focused on providing consistent national regulations for commercial vehicles. The FMCSA has announced a goal of evaluating whether and how the CDL system should be updated to account for AVs but has not yet initiated any regulatory amendments on that front.[265]

In addition to using federal funds to incentivize states to adopt legal reforms, the USDOT also supports legal reform through research and reporting.[266] Since 2016, the USDOT has published five major policy

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259 49 C.F.R. § 383.1 (2025).

260 *Id.* § 383.71 (describing basic qualifications); *id.* § 383.73 (stating that "State[s]" must require applicants to "pass test[]" to receive a CDL); *id.* § 383.111 (describing required knowledge); *id.* § 383.113 (describing required skills).

261 *See* 49 U.S.C. § 31311. The CDL system also provides that a driver who commits certain serious traffic violations will lose her CDL. 49 C.F.R. § 383.51 (2025).

262 In contrast, other FMCSA regulations apply regardless of state law. For instance, regardless of state laws, FMCSA regulations require drivers of commercial vehicles to stop before crossing railroad tracks and limit the number of hours commercial drivers can work without taking breaks. *Id.* §§ 392.10, 395.3; *see also id.* § 392.1 (stating that commercial drivers must comply with certain rules regarding the operation of commercial vehicles).

263 49 U.S.C. §§ 31311, 31314, 31141 (noting that federal transportation law in some instances may preempt state laws); *see also* 23 U.S.C. § 104 (describing the apportionment of federal transportation funds for states).

264 49 U.S.C. § 31302 (providing that a person may have only one CDL).

265 U.S. DEP'T OF TRANSP., *supra* note 5, at 10.

266 "NHTSA maintains a comprehensive ADS research program evaluating and researching a wide array of aspects related to ADS performance." Framework for Automated Driving System Safety, 85 Fed. Reg. 78058, 78064 (proposed Dec. 3, 2020) (to be codified at 49 C.F.R pt. 571).

papers regarding AVs, culminating in January 2021 with the USDOT's Automated Vehicles Comprehensive Plan.[267] These high-level analyses do not propose or establish any laws regulating AVs. Rather, the USDOT describes these documents as providing "guidance" to stakeholders, including state governments and private industry.[268] Through these publications, USDOT has indicated a commitment to using its authority to support the development and deployment of AVs.[269] For example, in 2018, the USDOT announced that it will "interpret" and "adapt the definition[]" of "driver" in a fashion that does not "refer exclusively to a human, but may in fact include an automated system."[270]

The USDOT has thus displayed a wide-ranging commitment to supporting AV deployment, both by amending binding federal laws and by offering support to state authorities. The next Part argues that this model of federal-state cooperation provides the most realistic mechanism to address the thousands of state laws that are problematic when applied to AVs and asserts that the FMCSA's Commercial Driver's License system provides a blueprint for leveraging federal leadership into state action.

IV. POTENTIAL PATHS FORWARD

Though some states have taken some initial legal steps to avoid the collision course between AV deployment and outdated state laws, the previous Part showed that these state efforts constitute an incomplete and inconsistent patchwork. The enormous variation in current state

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267 U.S. Dep't of Transp., Automated Vehicles: Comprehensive Plan (2021), https://www.transportation.gov/sites/dot.gov/files/2021-01/USDOT_AVCP.pdf [https://perma.cc/TB59-HUHD]; U.S. Dep't of Transp., Ensuring American Leadership in Automated Vehicle Technologies: Automated Vehicles 4.0 (2020), https://www.transportation.gov/sites/dot.gov/files/2020-02/EnsuringAmericanLeadershipAVTech4.pdf [https://perma.cc/U3WC-YCGM]; U.S. Dep't of Transp., *supra* note 5; U.S. Dep't of Transp., Automated Driving Systems: A Vision for Safety 2.0 (2017), https://www.nhtsa.gov/sites/nhtsa.gov/files/documents/13069a-ads2.0_090617_v9a_tag.pdf [https://perma.cc/2WRX-YGJW]; U.S. Dep't of Transp., Federal Automated Vehicles Policy: Accelerating the Next Revolution in Roadway Safety (2016), https://www.transportation.gov/sites/dot.gov/files/docs/AV%20policy%20guidance%20PDF.pdf [https://perma.cc/LYQ8-3Z96].

268 U.S. DEP'T OF TRANSP., AUTOMATED VEHICLES COMPREHENSIVE PLAN, *supra* note 267, at 15.

269 Throughout the development of these policy positions, the USDOT has also sought feedback from the public regarding the policy positions in these guidance documents. Automated Vehicles Comprehensive Plan; Request for Comments, 86 Fed. Reg. 6410 (Jan. 21, 2021).

270 U.S. DEP'T OF TRANSP., *supra* note 5, at iv.

approaches to AV reform means that there is no coherent nationwide strategy for AV deployment.

Sometimes, the legal diversity of the United States can be a strength. As Justice Brandeis famously wrote, different states may "try novel social and economic experiments without risk to the rest of the country," providing what later scholars have termed "laborator[ies] of [d]emocracy."[271] Indeed, state vehicle laws differ somewhat from jurisdiction to jurisdiction. For instance, in some states people may drive their vehicles with their hazard lights illuminated at any time, while in other states doing so is illegal.[272] State law variation regarding traditional vehicles, such as it is, has not created major issues largely because manufacturers simply design their vehicles to be capable of operation by human drivers in conformity with applicable laws.[273]

However, significantly inconsistent vehicle laws are problematic. For nearly a century commentators have recognized that because people travel between states, major differences in state vehicle laws can undermine safety.[274] In the split second before an accident, a driver travelling in an unfamiliar state might fail to comply with a local law, leading to a collision. For this reason, many state vehicle laws have been largely harmonized, including through the widespread adoption of portions of the Uniform Vehicle Code.[275]

In fact, legal consistency may be more important with AVs than with traditional vehicles because the vehicle itself must operate in conformity with state law. Manufacturers may be unable to rely on human drivers to determine and apply the law, particularly with AVs that provide higher levels of autonomy. Moreover, the responsibility for complying with the law may change when an AV crosses state lines since state laws often hold the driver of a vehicle liable for transgressions, and the identity of the "driver" may be different in different states.[276]

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271 New State Ice Co. v. Liebmann, 285 U.S. 262, 311 (1932) (Brandeis, J., dissenting); Matthew T. Wansley, *Regulation of Emerging Risks*, 69 VAND. L. REV. 401, 426 (2016).

272 U.S. DEP'T TRANSP., FED. HIGHWAY ADMIN., DETAILED ANALYSIS OF ADS-DEPLOYMENT READINESS OF THE EXISTING TRAFFIC LAWS AND REGULATIONS 29 (2020), https://ops.fhwa.dot.gov/publications/fhwahop20013/fhwahop20013.pdf [https://perma.cc/BE3K-BRC8].

273 For example, typical vehicles allow hazard lights to be turned on manually, so that human drivers can illuminate them in compliance with relevant state laws.

274 NAT'L CONF. ON ST. & HIGHWAY SAFETY, *supra* note 116, at v.

275 *See supra* notes 116–18 and accompanying text.

276 *See infra* Section IV.A.

As a result, the current inconsistent regulatory patchwork for AV regulation increases nationwide legal complexity, thereby hampering the ability of actors who operate in multiple fora to evaluate legal consequences, such as tort liability.[277] This problem impacts both manufacturers who sell in multiple states and consumers who operate AVs to travel between states. Indeed, the patchwork approach to AV regulation stands in stark contrast to the widespread consensus regarding the treatment of human drivers in traditional vehicles.[278]

This Part therefore evaluates potential paths out of the developing legal morass. One possibility is to maintain the status quo by leaving AV reform exclusively to state laboratories of democracy. Section A briefly reviews this option and, unsurprisingly, concludes it is not tenable. A second possible path would be to nationalize the effort through federal preemption of relevant vehicle laws. Section B weighs this option and ultimately rejects it as too disruptive and ultimately unnecessary. Rather than relying exclusively on the states or the federal government, the third and final path considers a middle ground involving a partnership between federal and state authorities. Building on the example of the CDL system, Section C describes this approach and argues that it provides the best strategy to avoid the current collision course.

A. *Exclusive State Reform*

The most obvious legal reform path is the current one: leave it all to the states. Whether by state legislatures adopting new laws or by state agencies promulgating new regulations, the entities that created the outdated laws might be tasked with updating them. Though logical, this approach is unlikely to succeed.

To start, state authorities may lack sufficient resources to tackle this difficult problem. Identifying all the laws that require modification to facilitate AV deployment may take considerable resources.[279] Even

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277 Abraham & Rabin, *supra* note 184, at 148–49; *see also* U.S. DEP'T OF TRANSP., *supra* note 5, at 5 (describing the importance of "national consistency for travel in interstate commerce").

278 Indeed, traditional definitions of "driver" are nearly identical in all fifty states. *See supra* note 117.

279 Laws regulating vehicles occupy disparate domains and identifying those laws consequently would likely require hundreds of hours of legal research in each state. A comprehensive review of state laws has only been performed for one state: the empirical analysis of Maryland laws described in Part III. This study involved hundreds of hours of research over the course of more than a year by six research assistants and four law professors. While the analysis in Part III suggests that the

assuming all relevant laws are identified, state lawmakers face challenges in developing effective reforms. AV technology is complex and rapidly changing, and some state authorities may lack the technological expertise needed to effectively regulate AVs.[280] With limited budgets, those lawmakers may also be unable to hire experts to overcome any in-house deficiencies.

State authorities may also face additional challenges. Changing existing laws to account for AVs may negatively impact particular people and businesses more than others, leading to political problems in developing the consensus necessary to enact new laws.[281] AV-related reforms also raise the specter of industry capture, given the large and powerful businesses involved and currently working to develop AV technology.[282] Indeed, industry groups have already proposed model laws and urged states to adopt them.[283]

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vast majority of problematic laws can be addressed by revising the definition of the term "driver," it also demonstrates that many state laws would remain problematic even with a revision to this central term and that these laws would be spread over disparate areas of law. *See supra* Part III.

280 Some laws may also implicate other forms of expertise. For example, input from experts in child development or family law may be needed to effectively reform laws regarding children using AVs without a licensed human driver.

281 For example, in Maryland, AV reform efforts failed due at least in part to disagreements between industry players. In 2017, a bill was proposed in the Maryland legislature that would have, among other things, "provid[ed] for the application of certain provisions of the Maryland Vehicle Law to AV[s]" by adjusting the definition of "driver." S.B. 902, 2017 Gen. Assemb., 437th Sess. (Md. 2017). However, at a legislative hearing, some industry members opposed the bill as "anticompetitive." *See Judicial Proceeding Committee Hearing on SB902*, 2017 MD. GEN. ASSEMB. (Feb. 22, 2017, 12:24 PM), https://mgahouse.maryland.gov/mga/play/96dbf902-4217-48c6-a9df-9c8305f5a64f?catalog/03e481c7-8a42-4438-a7da-93ff74bdaa4c&playfrom=10953000 (relevant statements beginning at 03:28:00). Following the hearing, the bill failed to receive a favorable committee vote and therefore did not proceed in the legislative process. *Legislation—SB0902*, MD. GEN. ASSEMB. (Feb. 3, 2020, 2:35 PM), https://mgaleg.maryland.gov/mgawebsite/Legislation/Details/SB0902?ys=2017rs [https://perma.cc/J27W-F759] (listing an unfavorable report dated Mar. 17, 2017). More generally, there is also long-running tension between automotive manufacturers and accident victims. *See* BRIANN LADD, AUTOPHOBIA: LOVE AND HATE IN THE AUTOMATIVE AGE 14–28 (2011).

282 *See* William H. Widen & Philip Koopman, *Liability Rules for Automated Vehicles: Definitions & Details*, 27 S.M.U. SCI. & TECH. L. REV. 77, 78 (2024); *see, e.g.*, JACK CAPORAL, JASMINE LIM, SEAN ARRIETA-KENNA & WILL O'NEIL, DRIVING THE FUTURE OF AV REGULATIONS: BARRIERS TO LARGE-SCALE DEVELOPMENT 3 (2021) (Nuro and General Motors).

283 In 2018, for instance, the Self-Driving Coalition for Safer Streets, an industry group that included companies like Ford and Waymo, proposed model legislation that, *inter alia*, defined the driver of an AV to be the "automated driving system." SELF-DRIVING COAL., MODEL LEGISLATION FOR AUTONOMOUS VEHICLES § 3 (2018). In 2022, this industry group changed its name to the Autonomous Vehicle Industry Association. *See Leading Trade Association for Autonomous*

Even if state legislatures and agencies were able to overcome these practical problems, there would remain the substantive problem of which reforms to adopt. State authorities have thus far failed to harmonize their AV reforms. Additionally, the inconsistent patchwork of current state reform strategies suggests that some approaches may be sub-optimal. No one state is the acknowledged leader here, and leadership is sorely needed.

One response to this critique is that state courts might flexibly interpret traditional state laws to effectively apply them to AVs. Without question, scholars have long extolled the capacity of judges to update the law to reach effective outcomes.[284] As problems arise, for example, in traffic enforcement or accidents involving AVs, courts could theoretically tackle general and specific legal quandaries on a case-by-case basis.

However, while providing an immediate and useful backstop to current reform efforts, for at least three reasons, state courts are poorly suited to updating the thousands of state laws that are problematic when applied to AVs. First, legal reform through courts is slow.[285] Courts typically only have an opportunity to opine on legal change after a dispute has arisen.[286] Moreover, because most disputes settle, many disputes may need to arise before an issue can crystalize in a final judgment.[287] Even worse, disputes involving motor vehicles often involve significant injuries and deaths. As a result, updating laws to account for AVs through state courts inherently means waiting for harm rather than proactively seeking its prevention. Second, litigants in AV lawsuits may lack sufficient resources and expertise. Given the complex and rapidly evolving nature of AV technology, anyone seeking to change law through AV litigation would face significant costs related to expert witnesses.[288] The stakes in

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Vehicles Unveils New Brand: Autonomous Vehicle Industry Association, AUTONOMOUS VEHICLE INDUS. ASS'N (Jan. 26, 2022), https://theavindustry.org/newsroom/press-releases/leading-trade-association-for-autonomous-vehicles-unveils-new-brand-autonomous-vehicle-industry-association [https://perma.cc/3XRW-W2QC]. Of course, there are also non-industry-driven examples of model legislation, such as the 2019 Uniform Law Commission proposal. *See* NAT'L CONF. OF COMM'RS ON UNIF. STATE L., UNIFORM AUTOMATED OPERATION OF VEHICLES ACT (2019). So far, however, no state has adopted this proposal.

284 *See* D. Daniel Sokol, *Rethinking the Efficiency of the Common Law*, 95 NOTRE DAME L. REV. 795, 796 (2019); *see also* Robertson, *supra* note 66, at 1694 (asserting that litigation regarding AVs can provide an immediate impact, while legislative reform is slow).

285 Robertson, *supra* note 66, at 1700–01.

286 *See* Jon O. Newman, *The Current Challenge of Federal Court Reform*, 108 CALIF. L. REV. 905, 906 (2020); *see also* Note, *Standing in the Way: The Courts' Escalating Interference in Federal Policymaking*, 136 HARV. L. REV. 1222, 1223–24 (2023).

287 *See* Theodore Eisenberg & Charlotte Lanvers, *What Is the Settlement Rate and Why Should We Care?*, 6 J. EMPIRICAL LEGAL STUD. 1, 111, 112 (2009).

288 *See* Robertson, *supra* note 66, at 1700–01.

typical AV disputes, such as disputes involving traffic tickets or minor accidents, might be too low to justify hiring experts. Other cases might involve larger damages claims, but so long as sufficient relief can be obtained from traditional defendants, plaintiffs face little incentive to seek legal change. Finally, leaving AV legal reform to state courts is undesirable because courts in different states may reach different outcomes on key issues, potentially exacerbating the legal patchwork problem already described.[289]

B. *Federal Preemption*

Federal preemption perhaps offers an attractive avenue for simultaneously reforming and harmonizing state laws that are problematic when applied to AVs.[290] Under the Supremacy Clause of the U.S. Constitution, federal law is "the supreme Law of the Land."[291] As a result, when federal and state powers conflict, federal law supersedes any contrary state law.[292] For example, courts have found some states laws to be preempted by the FMVSSs.[293] While no federal statute or regulation currently regulates the operation of AVs, the federal government theoretically could enact laws that preempt state laws in order to implement nationwide AV reform.[294]

This approach has some initial appeal. A comprehensive federal AV law could, in one fell swoop, eliminate much (if not all) of the legal

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289 *See supra* Section IV.A. To make matters worse, courts *within* a single state could reach different results in the absence of guidance from a higher state court. Though state courts are not well suited to update the thousands of laws rendered problematic by AVs, they still have a role to play. Even if actors outside the court system provide the primary impetus for reform, litigation is inevitable, and courts can help raise and frame issues. At the very least, lawsuits may help to identify laws still needing reform, even if reform to those laws comes from other sources.

290 Mark A. Geistfeld, *A Roadmap for Autonomous Vehicles: State Tort Liability, Automobile Insurance, and Federal Safety Regulation*, 105 CALIF. L. REV. 1611, 1684 (2017).

291 U.S. CONST. art. VI, § 2, cl. 2.

292 Arizona v. United States, 567 U.S. 387, 399 (2012).

293 Geier v. Am. Honda Motor Co., 529 U.S. 861, 867–68 (2000) (concluding that a claim for tort recovery under state laws was preempted by an FMVSS); *see also supra* Section III.B.1 (describing the FMVSSs).

294 *See* William H. Widen & Philip Koopman, *Autonomous Vehicle Regulation & Trust: The Impact of Failures to Comply with Standards*, 27 UCLA J.L. & TECH. 169, 219–20 (2022) (stating that the federal government has not developed any legislation or regulations regarding automated vehicles).

uncertainty stemming from outdated state laws in all fifty states.[295] The authority for such sweeping preemption might be found in the Commerce Clause.[296] With traditional vehicles, supreme federal law has long focused on equipment safety, while valid (non-preempted) state laws have governed vehicle operation.[297] AVs clearly pose a challenge to this traditional equipment/operation distinction because AV equipment operates the vehicle. Consequently, federal lawmakers might assert their traditional authority over vehicle equipment to regulate the operation of AVs.[298]

While theoretically plausible, for at least three reasons, it is unrealistic that federal lawmakers would choose to expand federal law to preempt state laws that are problematic when applied to AVs. First, jumping into the business of regulating vehicle operation nationwide would be a massive undertaking. Most currently binding federal motor vehicle laws relate to vehicle equipment, and while some federal laws address the operation of vehicles, many of those laws are technically optional, as in the case of the CDL program. Preempting the *tens of thousands* of state laws that are problematic regarding AVs could open up a legal and political Pandora's Box. Federal lawmakers would have to consider an expansive range of issues raised by state laws, including (1) establishing standards and testing procedures for issuing noncommercial drivers licenses; (2) addressing vehicle registration and insurance requirements; and (3) defining the basic rules of the road.[299] Developing effective new federal laws in these areas would be a massive new undertaking.

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295 For this reason, some scholars have suggested using federal law to preempt state law related to AVs. Abraham & Rabin, *supra* note 184, at 148–49.

296 *Arizona*, 567 U.S. at 399. A new federal law regarding AVs might be grounded in the federal government's authority to regulate interstate commerce. U.S. CONST. art. I, § 8, cl. 3.

297 BILL CANIS, CONGR. RSCH. SERV., R45985, ISSUES IN AUTONOMOUS VEHICLE TESTING AND DEPLOYMENT 8 (2021). For instance, federal law requires that vehicles *have* effective brakes, while state laws largely determine when drivers must *use* them. *See* 49 C.F.R. § 571.105 (2025); *see, e.g.*, CAL. VEH. CODE § 21461 (West 2024) (stating that it is "unlawful for a driver of a vehicle to fail to obey" traffic signals).

298 In addition, federal law has long addressed the operation of commercial vehicles, such as requiring drivers of commercial vehicles to stop at railroad crossings. *See* 49 C.F.R. § 392.10 (2025). Congress could conceivably regard the profound potential impact of AVs on commercial vehicles as further justifying its writing a preemptive AV law.

299 For example, state laws determine speed limits, require signaling before changing lanes, and obedience to traffic signals. *See generally* NAT'L HIGHWAY TRAFFIC SAFETY ADMIN., SUMMARY OF STATE SPEED LAWS (2013), https://www.nhtsa.gov/sites/nhtsa.gov/files/summary_state_speed_laws_12th_edition_811769.pdf [https://perma.cc/PY95-NRCJ].

Second, beyond the extensive work involved, federal lawmakers would also likely buck at the need to address complex enforcement issues. State law currently provides for the enforcement of state vehicle laws through state mechanisms, including commonplace consequences like tickets requiring payment of fines, license suspension and revocation, and, in extreme cases, arrest.[300] Many states currently rely on lower-level courts to address violations of vehicle laws, like speeding tickets. State courts also preside over civil claims related to traffic accidents. An act that federalizes vehicle laws regarding AVs would generate enforcement problems and significantly increase the burdens on the federal courts (since the violation of federal laws may provide federal jurisdiction).[301]

Finally, and perhaps most importantly, the political will to implement such a massive change is also likely lacking. Only a sweeping federal law could be comprehensive enough to address the broad range of state vehicle laws potentially impacting AVs. Crafting such legislation while also finding political consensus would be, to say the least, extremely difficult. Even if Congress was unified and willing to work, the states would likely resist ceding their power over vehicle regulation. State law has long played a significant role regarding the regulation of vehicles, and federal legislation preempting state vehicle laws would mark a sharp and radical departure from historical practices. Today, every state government includes a department of transportation, as do the District of Columbia and Puerto Rico.[302] Even well-designed federal AV laws might be seen as invading state sovereignty if those laws purport to preempt broad swaths of state law. Given these challenges, commentators predict that Congress will not consider any federal legislation regarding AVs for years to come.[303]

For parallel reasons, it is also unrealistic to look to federal agencies to push for expanded authority to develop AV regulations that preempt

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300 *E.g.*, MD. CODE ANN., TRANSP. § 26-201(a) (West 2024) (tickets); MD. CODE ANN., TRANSP. § 16-402 (West 2024) (points leading to license suspension); MD. CODE ANN., TRANSP. § 16-101 (West 2024) (arrest); *see also* F. Patrick Hubbard, *"Sophisticated Robots": Balancing Liability, Regulation, and Innovation*, 66 FLA. L. REV. 1803, 1812 (2014) (discussing the use of both liability systems and regulatory commands to promote safety with vehicles).

301 *See* 28 U.S.C. § 1331 (describing federal question jurisdiction in civil cases); 28 U.S.C. § 1355 (stating that federal district courts have jurisdiction over "any action or proceeding for the recovery or enforcement of any fine, penalty, or forfeiture, pecuniary or otherwise, incurred under any Act of Congress").

302 *State Transportation Web Sites*, FED. HIGHWAY ADMIN., https://www.fhwa.dot.gov/about/webstate.cfm [https://perma.cc/3EEF-F2ZL].

303 *See* Widen & Koopman, *supra* note 294, at 219–20 (stating that the federal government has not developed any legislation or regulations regarding automated vehicles).

state law.[304] Such an assertion of power and authority would be a marked departure from the approach of federal agencies to AV regulation thus far. For example, while NHTSA and the FMCSA have actively worked to address AVs, these agencies have worked only to update *existing* federal standards. These agencies have not expressed institutional interest in developing new regulations that supplant traditional state law. Moreover, new regulations that preempt broad swaths of state law in a context that has historically been the purview of state governments would likely meet stiff resistance during the notice-and-comment process required by federal law, in the courts, and in the political arena.[305]

In fact, federal agencies have explicitly indicated that states will continue to be key partners in regulating AVs. The USDOT recently noted that "[s]tates and local governments play the lead role in licensing drivers, establishing rules of the road, and formulating policy in tort liability and insurance."[306] Critically, the USDOT has also taken the position that the role of state law "may not change significantly with the deployment of automated vehicles."[307] As such, the USDOT has encouraged states and local governments to "remove barriers—such as unnecessary and incompatible regulations—to automated vehicle technologies."[308] As a result, rather than advocating for federal preemption the USDOT has recommended that state governments "[r]eview laws and regulations" that may inadvertently impair the deployment of AVs.[309]

Agencies within the USDOT have taken similar positions regarding the continued importance of state law. For example, NHTSA has explicitly recognized "the critical role that State and local governments play in traffic safety."[310] NHTSA has acknowledged that state and local authorities "establish[] and enforc[e] their rules of the road," such as "the

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304 *See also* City of New York v. FCC, 486 U.S. 57, 63 (1988) (holding that state laws can in some instances be preempted by federal regulations).

305 *See, e.g.*, Nat'l Fed'n of Indep. Bus. v. Dep't of Lab., Occupational Safety & Health Admin., 595 U.S. 109, 117 (2022) (concluding that certain administrative actions were not likely to be authorized by statute). *See generally Stop Giving Bureaucrats Free Rein*, FOUND. GOV'T ACCOUNTABILITY, https://thefga.org/reins-act [https://perma.cc/C76K-5WWQ]. For instance, a powerful corporation developing AVs likely might dispute a definition of "driver" that potentially imposes liability on that company.

306 U.S. DEP'T OF TRANSP., *supra* note 5, at 5.

307 *Id.* at 18.

308 *Id.* at 9.

309 *Id.* at 18–19.

310 Framework for Automated Driving System Safety, 85 Fed. Reg. 78058, 78061 (proposed Dec. 3, 2020) (to be codified at 49 C.F.R. pt. 571).

speed at which vehicles may be driven."[311] NHTSA posits that state authorities may "establish new rules of the road" to address AVs.[312] Thus, federal agencies are unlikely to advocate for expansive new regulations that preempt thousands of state laws.

C. *Federal Leadership and Incentives*

Fortunately, there may be a Goldilocks position between leaving AV legal reform entirely to the states and asking the federal government to entirely preempt state efforts. This middle ground involves federal authorities working in partnership with the states to enact reform. In particular, federal authorities can use their considerable resources and expertise to develop "best practices" for updating state laws for AVs and then encourage states to adopt some of these reforms with financial incentives.

A critical first step in this reform strategy would be to develop effective reforms to the generally recognized legal definitions of "driver" and "operator." Indeed, federal action regarding the definition of "driver" may be inevitable. Many USDOT regulations target "drivers," and the USDOT has announced that it will "interpret" the term "driver" broadly in these regulations to "include an automated system."[313] However, the USDOT may be unable to adopt the broad interpretation of "driver" without explicitly amending its regulations.[314] Once federal authorities have developed a new definition of "driver," they should use financial incentives to encourage states to adopt consistent definitions for other

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311 *Id.* at 78063, 78070–71.

312 *Id.* at 78071.

313 *E.g.*, 49 C.F.R. § 571.124 (2025) (addressing the operation of "[a]ccelerator control systems" by the "driver"); U.S. DEP'T OF TRANSP., *supra* note 5, at 9.

314 Many USDOT regulations involving "drivers" are distinctly human. For example, the FMVSSs define "driver" as "the occupant of a motor vehicle seated immediately behind the steering control system." 49 C.F.R. § 571.3 (2025). Similarly, the FMCSRs state that a "driver" must be "properly restrained by the seat belt assembly." 49 C.F.R. § 392.16 (2025). Thus, to include AV technologies within the meaning of "driver" (in some sense), NHTSA and the FMCSA may be forced to amend federal definitions of "driver." Concerns regarding AVs and FMCSRs are particularly prominent given that two major types of AVs are commercial vehicles subject to FMCSA regulations: commercial trucks and buses. 49 C.F.R. §§ 383.5, 383.93 (2025); *see also supra* notes 45–47 and accompanying text. Other federal agencies likewise may need to reevaluate their definitions of "driver." For instance, FMCSA may have to evaluate the meaning of "driver" in deciding whether AVs can be licensed as "CDL drivers." *See* 49 C.F.R. § 383.5 (2025) (defining "CDL driver" as a "a person holding a CDL or a person required to hold a CDL").

purposes.[315] States clearly need incentives to change, as most states have so far been reluctant to enact reform.

In developing these new federal laws and incentives, the CDL system provides a blueprint for using the expertise and financial resources of the USDOT to develop sophisticated, uniform state laws regarding AVs. As described above, under the CDL system, federal authorities have developed detailed regulations regarding the operation of commercial motor vehicles. Moreover, federal incentives have encouraged states to voluntarily incorporate these standards into their laws, thereby avoiding the many problems that may arise from preemption. The result is that commercial motor vehicles face a uniform regulatory landscape as they travel across the country.[316] Similarly, federal authorities could use their considerable resources and growing expertise in AVs to develop a system under which AV technologies are evaluated for competence, qualified to control vehicles, and forbidden to control vehicles if those technologies fail to do so safely.[317]

While revising the definitions of key terms like "driver" and "operator" will address the majority of problematic state laws, many other state laws will remain unclear or ineffective when applied to AVs.[318] Regarding these remaining laws, federal authorities should work in partnership with the states to develop "best practices." Whether these reforms should be promoted through financial incentives is less clear, particularly since some AV reforms will require the resolution of subject-matter specific policy questions.[319] As a result, for some of these issues, nationwide harmonization may be less important. Instead, different states may simply resolve certain policy issues differently, just as states do in other areas of law.[320] As such, federal authorities should also evaluate which additional reforms should be promoted with financial incentives.[321] Regarding fine-grained policy decisions that are specific to

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315 The USDOT has already acknowledged that "[d]ifferent use and interpretations of terminology regarding automated vehicles can be confusing for the public, State and local agencies, and industry." U.S. DEP'T OF TRANSP., *supra* note 5, at 20.

316 *See supra* notes 254–65 and accompanying text (describing the CDL system).

317 The CDL system addresses all of these issues for motor carriers. *E.g.*, 49 C.F.R. § 383.23 (2025) (testing); *id.* §§ 383.110–123 (CDL license requirements); *id.* § 383.51 (loss of CDL license).

318 *See supra* Section II.C.

319 *See supra* Section II.C.

320 For example, some states could allow school buses to be AVs while other states could prohibit it. *E.g.*, 75 PA. CONS. STAT. § 8509 (2025) (stating that an AV cannot be a school bus).

321 In an effort to promote safety, federal authorities encourage states to harmonize their laws with other states. NAT'L HIGHWAY TRAFFIC SAFETY ADMIN., UNIFORM GUIDELINES FOR STATE

individual states, those states are likely to continue to exercise substantial independent authority in reforming state laws to account for AVs.

CONCLUSION

AVs have great potential to improve transportation and to bolster the economy, but this potential cannot be realized at scale until the nation's legal and regulatory environments are ready. State law is currently unprepared for the deployment of AVs, and the resulting legal uncertainty threatens to undermine AV development and adoption. As shown by the empirical study described in this Article, the scale of the problem is daunting. Tens of thousands of state laws are likely unclear or ineffective when applied to AVs.

The good news is that effective reform is possible. Fortunately, the bulk of laws currently ill-suited to regulate AVs could be remedied by updating legal definitions of key terms like "driver" and "operator." The less good news is that getting all the states to adopt effective AV reforms will take considerable work. To date, many states have failed to update their laws, and the more proactive states have taken widely different approaches, leading to a confusing regulatory patchwork. The nature of AV technology requires a more uniform and coherent strategy. Compared to the states, the federal government is far better positioned to provide a coordinated approach. However, practical and political realities mean that federal authorities are unlikely to use preemption power to slice through this tangled regulatory web.

Rather than leaving reform exclusively to the states or to the federal government, this Article recommends a third way: Federal authorities should work in partnership with state counterparts to develop "best practices" to address the shortcomings of traditional state laws. The keystone to this approach is for federal authorities to use financial incentives to encourage states to adopt a harmonized definition of "driver" when applied to AVs. Only with such federal leadership can states avoid the looming collision course between AVs and state law.

HIGHWAY SAFETY PROGRAMS: GUIDELINE NO. 6, https://one.nhtsa.gov/nhtsa/whatsup/tea21/tea21programs/pages/CodesLaws.htm [https://perma.cc/SZ5K-KB9F].