

A MODEL FOR TORT LIABILITY IN A WORLD OF DRIVERLESS CARS: ESTABLISHING A FRAMEWORK FOR THE UPCOMING TECHNOLOGY

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* I would like to thank Jerry Mashaw, Guido Calabresi, David Harfst, Roberto Pardolesi, all the participants in the Yale Law School 2017 Workshop on Regulating Emerging Technologies and to the annual meeting of the Law and Society Association: “Law at the Crossroads” (Toronto, Canada, 7-10th June, 2018) for their helpful feedback, constructive criticism and stimulating discussion on an earlier version of this manuscript. I would also like to thank the Yale Law School, the Yale Information Society Project, and the Sant’Anna School of Advanced Studies of Pisa for their constant support in developing this project. All errors and omissions remain, naturally, the sole responsibility of the author.

*“Technology, like art, is a soaring exercise of the human imagination.”*¹

I. INTRODUCTION

The development of driving support and cruise assist systems in the automotive industry has been astonishing, accelerating dramatically in the last ten years. Since the first DARPA Urban Challenge² field tests have multiplied in the US. In California alone, there are currently thirty-nine companies testing self-driving cars,³ the once remote prospect of “driverless” vehicles becoming commercially available might not be so far from reality.⁴ A broad range of scientific studies suggests the implementation of fully automated driving systems may be imminent.⁵

Highly Automated Vehicles (HAVs) are likely to profoundly transform our social habits and to revolutionize our way of interacting with the surrounding environment. In addition, legal scholars have already outlined how automated vehicles create a multi-level challenge in terms of regulating a product capable of impacting so many different areas of the law.⁶

One of the areas where research is much needed is tort liability: in addressing the regulation of accidents caused by automated cars, jurists must assess whether tort liability rules—as they are currently shaped—are suited to govern the “*car minus driver*” complexity, while simultaneously holding on to their theoretical basis. If the current framework proves itself to be inadequate and irreparably “out of tune” with the new circulation dynamics, the only alternative will be to amend or renew it.

In light of these considerations, our aim is to present a hypothetical system for liability arising from road accidents caused by driverless cars. This model should be interpreted as a theoretical guideline, which must be adapted and applied in accordance with the specific attributes entailed within each legal system. The Article is outlined as such: in Part I, we set out and defend some assumptions on which our analysis rests; in Part II, we present the main options available to lawmakers in allocating liability for road accidents caused by HAVs; after analysing each potential “player”, we conclude that the manufacturer is the most appropriate figure to be held liable in the case of a road accident involving driverless cars. Part III of the

1. DANIEL BELL, *THE WINDING PASSAGE: SOCIOLOGICAL ESSAYS AND JOURNEYS* 20 (1991).

2. The first *Urban Challenge* for automated vehicles was held in November 2007 in Victorville, California, and it was organized by the Defense Advanced Research Project Agency (DARPA). Participants were asked to develop and build vehicles “capable of driving in traffic, performing complex maneuvers such as merging, passing, parking and negotiating intersections.” *Urban Challenge*, DARPA, <http://archive.darpa.mil/grandchallenge/> (last visited June 21, 2018).

3. Sam Shead, *There Are Now 39 Companies Testing Self-Driving Cars on Californian Roads*, BUS. INSIDER (Sept. 1, 2017), <http://www.businessinsider.com/dozens-of-companies-testing-self-driving-cars-on-californian-roads-2017-9?r=UK&IR=T>; David Silver, *California DMV Autonomous Vehicle List*, MEDIUM (Sept. 5, 2017), <https://medium.com/self-driving-cars/california-dmv-autonomous-vehicle-list-1e38be0fcd0b>.

4. See AM. ASS’N FOR JUSTICE, *DRIVEN TO SAFETY: ROBOT CARS AND THE FUTURE OF LIABILITY* 34–35 (2017), <https://www.justice.org/sites/default/files/Driven%20to%20Safety%202017%20Online.pdf>.

5. See JAMES ARBIB & TONY SEBA, *RETHINKX: RETHINKING TRANSPORTATION 2020-2030* (2017), https://static1.squarespace.com/static/585c3439be65942f022bbf9b/t/591a2e4be6f2e1c13df930c5/1494888038959/RethinkX+Report_051517.pdf.

6. It has been observed, e.g., how automated cars will create new threats for privacy and data protection law, as well as for the insurance sector. See E. Palmerini et al., *Robolaw: Towards a European Framework for Robotics Regulation*, 86 *ROBOTICS & AUTONOMOUS SYS.* 78, 83 (2016).

Article investigates the most widely preferred solutions proposed to regulate a hypothetical liability system for manufacturers. We focus our attention on (a) product liability and (b) strict liability rules, with specific attention to the model offered by Abraham and Rabin (2017). In Part IV, the Article elaborates and discusses, on the basis of the elements emerging from the two systems previously examined, a new proposal for designing HAVs tort liability rules.

We illustrate, in particular, how our “two-step” system—operating through a negligence assessment and a reward fund—represents an optimal solution to mediate amongst the conflicting needs in the regulation of driverless vehicles. In Part V, finally, we draw some conclusions on the basis of the various aspects addressed in our analysis and present some alternatives we considered in developing our system.

II. CONCEPTUAL COORDINATES BEHIND THE MODEL: POSTULATES IN A REGULATORY ATTEMPT FOR HIGHLY AUTOMATED VEHICLES

In developing tort liability rules for road accidents involving autonomous cars, some preliminary choices must be made. This need arises from the concurrence of two essential elements that shape the driverless car industry.

On one hand, the general notion of “Highly Automated Vehicles” currently encompasses a wide range of different driving support technologies, which impacts the vehicle’s “conduct”—and subsequently the involvement of the human driver—to various degrees.⁷ On the other hand, HAVs are still a technology in development, as such entailing a significant degree of uncertainty: in hypothesizing regulatory rules it is therefore inevitable to engage in a (at least partial) degree of speculation as to how the market will evolve in the near future. In the next section, the central assumptions that guide our analysis are set forth.

A. Not “If”, But “When”

The first element we consider in addressing the liability implications of automated car technologies is the fact that, in consideration of the level of specification that driving supporting systems have already reached (not to mention the significant amount of capital currently invested in Research & Development on the field), the uncertainty surrounding the diffusion of HAVs in society is not related to “if”, but to “when” such technology will be introduced. The path towards a world of autonomous cars might be far away, but we will ultimately reach a degree of technology that is capable of entirely replacing the human driver on the road.⁸

Our society is probably still far from those utopian visions born in science-fiction, literature, and popular culture, which were more the product of the authors’

7. This is well exemplified by the current classification—operated by the Society of Automotive Engineer (SAE)—of automated vehicles in six different levels of automation. See *infra* Section II.C.

8. See AM. ASS’N FOR JUSTICE, *supra* note 4.

imagination than concrete scientific studies,⁹ suggesting the perfect coexistence of organic and artificial beings. Nonetheless, these technologies are increasingly being integrated into our daily lives. This phenomenon already led legislators (e.g. in the European Union)¹⁰ to question whether current legal rules are suitable to regulate the use of robots and of artificial intelligence generally. Moreover, a conscientious glimpse at the flowering of algorithms in private and commercial activities (as well as a look at the debates over high-tech products in the information society)¹¹ supports the idea that new technologies will entail a major challenge for regulatory frameworks worldwide.

B. Fewer Risks and New Threats

The introduction of automated driving systems will unquestionably implicate a massive reduction of the road accident rate. Although the commercialization of HAVs encompasses new risks within the general spectrum of electronic technologies (consider, for example, the problems related to the reliability of driving software, or the ones concerning the risk of hacking activities by third parties), we may reasonably expect that a fully automated driving system will be able to manage the “behavior” of the vehicle safer than its “organic” counterpart: software is immune

9. See JAMES PATTERSON & EMILY RAYMOND, HUMANS, BOW DOWN (2016); PHILIP K. DICK, DO ANDROIDS DREAM OF ELECTRIC SHEEP? (1968); ISAAC ASIMOV, I, ROBOT (1950). With regards to the latter, it is notable to mention the application of Asimov’s “Three Laws of Robotics” to the automotive sector operated by Jeffery Gurney. See Jeffrey K. Gurney, *Crashing Into the Unknown: An Examination of Crash-Optimization Algorithms Through the Two Lanes of Ethics and Law*, 79 ALB. L. REV. 183, 183 (2016).

One, a[n] [autonomous vehicle] may not injure a human being, or, through inaction, allow a human being to come to harm

Two, . . . a[n] [autonomous vehicle] must obey the orders given it by human beings except where such orders would conflict with the First Law

Three, a[n] [autonomous vehicle] must protect its own existence as long as such protection does not conflict with the First or Second Laws.

Id. (quoting Isaac Asimov I, ROBOT 30, 44–45 (1991) (alterations in original)). Even if one might think that a review of fiction literature concerning artificial intelligence is not something a legal scholar should take into account when addressing the “real” implications of technology within modern society it is worth observing—maybe with some scepticism—that those same Three Laws (plus the subsequent Zero Law) have been quoted by the European Parliament as essential guidelines in assessing the impact of robotics on the future generations: “[W]hereas Asimov’s Laws must be regarded as being directed at the designers, producers and operators of robots, including robots assigned with built-in autonomy and self-learning, since those laws cannot be converted into machine code.” *Report with recommendations to the Commission on Civil Law Rules on Robotics* (2015/2103(INL)), at 6 (Jan. 27, 2017), <http://www.europarl.europa.eu/sides/getDoc.do?pubRef=-//EP//NONSGML+REPORT+A8-2017-0005+0+DOC+PDF+V0//EN> [hereinafter *Report with recommendations*]. On the background of the ethics of artificial intelligence, furthermore, the traditional “trolley problem dilemma” (should a car choose to hit pedestrians in the road, or swerve into the path of an oncoming lorry, killing its occupants?) is always present. Cf. Simon Chesterman, *Do Driverless Cars Dream of Electric Sheep?* (Sept. 1, 2016).

10. See *Report with recommendations*, *supra* note 9, at 6.

11. See COMPUTERS, CHESS, AND COGNITION (T. Anthony Marsland & Jonathan Schaeffer eds., 1990) (the Author conducts an investigation on how A.I.s are able to emulate a human’s cognitive mechanisms in decision-making, and refers to the game of chess in order to show how machines, when provided with a sufficient amount of information and time to elaborate it, are capable of making better choices than individuals).

from the most common causes of road casualties (inattention, drowsiness and drunkenness are, according to the main studies on road safety, the reasons for more than 90% of road accidents).¹² Furthermore, HAVs are equipped with detection systems and are therefore able to predict risks and react to dangers more quickly than humans.¹³

Eventually, autonomous cars will also produce an overall reduction of harms indirectly related to road circulation, *in primis* pollution: through the combined evaluation of data gathered from the surrounding environment, vehicles will be able to adjust their speed and consumption efficiently, reducing emissions and optimizing their overall environmental impact.¹⁴

C. Fully vs. Semi-Automated Vehicles: No Compromises

In designing our model, we chose to address the problem of tort liability for road accidents involving autonomous cars with exclusive attention to Highly and Fully Automated Vehicles.

According to our view, the most promising strategy is to focus primarily on investigating the risks involved in the circulation of “totally” automated cars where the human driver has no role, rather than focusing on already existent (or forthcoming) intermediate support technologies.

The evolution of software implementation in the automotive sector is proceeding on a “modular” basis, and vehicles’ autonomy increases with each technological innovation: semi-automatic driving systems where the human driver is entrusted with a mere supervisory role are already present on the market. In this system the driver is compelled to interfere with the HAV’s autonomous decisions only where an anomaly is detected.¹⁵

The National Highway Traffic Safety Administration (NHTSA) and the International Society of Automotive Engineers (SAE)¹⁶ acknowledged this standpoint by classifying automated vehicles according to six possible levels of automation: the initial state (L0) indicates non-automatized driving systems, where the human

12. ROAD SAFETY REPORT 2017, DEKRA 3–5 (2017), <http://www.dekra-vision-zero.com/downloads/dekra-roadsafety-report-2017-engl.pdf>.

13. See ARBIB & SEBA, *supra* note 5, at 62.

14. JAMES MANYIKA ET AL., MCKINSEY GLOB. INST., DISRUPTIVE TECHNOLOGIES: ADVANCES THAT WILL TRANSFORM LIFE, BUSINESS, AND THE GLOBAL ECONOMY 78–85(2013), https://www.mckinsey.com/~media/McKinsey/Business%20Functions/McKinsey%20Digital/Our%20Insights/Disruptive%20technologies/MGI_Disruptive_technologies_Full_report_May2013.ashx.

15. P. Morgan et al., *Handover Issues in Autonomous Driving: A Literature Review* 2–3, U. W. ENG. (2016), http://eprints.uwe.ac.uk/29167/1/Venturer_WP5.2Lit%20ReviewHandover.pdf.

16. The National Highway Traffic Safety Administration (NHTSA) is an agency of the Executive Branch U.S. government, part of the Department of Transportation. The Society of Automotive Engineers International is a professional association and standards developing organization for engineering professionals, focused on transport industries such as automotive, aerospace, and commercial vehicles. For an analysis of NHTSA’s powers and its role in HAVs regulation, see Jerry L. Mashaw & David L. Harfst, *From Command and Control to Collaboration and Deference: The Transformation of Auto Safety Regulation*, 34 YALE J. ON REG. 167 (2017).

driver is in total control of the vehicle,¹⁷ and the last one (L5) refers to a fully-autonomous system in which the HAV is expected to perform equally and better than a human driver in every scenario.¹⁸ Intermediate levels (L1-L3) relate to growing degrees of assistance of the software in the activities of the vehicle (braking, speed management, etc.), even if the main conductor is still the human driver; lastly, Level 4 vehicles are those designed to perform all safety-critical driving functions and monitor roadway conditions for an entire trip, as long as it is within the operational design domain of the vehicle.¹⁹ L4 HAVs, in practice, do not cover every driving scenario or environmental condition.²⁰

As we already stated, our model is meant to operate in a system where only *Highly Automated Vehicles* (therefore, L4 and L5 ones) are present. This decision arises from two considerations, both essential and intertwined.

The first reason is that the perspective of a society where only fully automated cars exist is, considering the path of technological evolution in the automotive sector, certain *and* desirable. As a consequence, evaluating the normative implications of such an occurrence is opportune. Furthermore, the analysis of tort rules for completely autonomous cars can be addressed through a purely theoretical approach before such a technology enters the market, whilst a regulation for partially-automated vehicles is profoundly technology-dependent, being strongly affected by how driving software will concretely evolve.

The second reason for investigating the tort liability regime for only for L4 and L5 automated vehicles descends, on one hand, from the fact that auxiliary driving systems are to a certain degree already implemented in commercial cars (think about the anti-lock braking system), and on the other hand from the consideration that, with regards to semi-automated technologies, the need for a radical change in tort rules might be questionable. Even in the most evolved level of automation (L3), the human driver is always responsible for the supervision of the vehicle and is compelled to hand-over the control of the HAV whether requested by the software. In such systems, the main concern is not re-framing the rules allocating liability in case of an accident, but creating adequate rules in order to guarantee that the driver is able to obtain the control of the car immediately and avoid possible dangers.²¹

17. See Damien A. Riehl, *Car Minus Driver: Autonomous Vehicle Regulation, Liability and Policy*, 73 *BENCH & B. MINN.* 25, 25 (2016).

18. *Id.*

19. *See id.*

20. *See id.*

21. A review of the main literature on the topic reveals how the utility of this “hand-over” system is extensively debated amongst experts. Empirical studies suggest that the average reaction time of drivers to a hand-over request formulated by the driving software in case of danger is nearly seventeen seconds: such a lapse is clearly inadequate to guarantee that the driver’s supplementary intervention will be effective, considering that during that time a vehicle proceeding at forty MPH would cover almost 300 meters. André Tunc, *Fault: A Common Name for Different Misdeeds*, 49 *TUL. L. REV.* 279 (1975) (it is worth noting that André Tunc questioned whether even a “split-second distraction” might have been deemed sufficient to found the fault of the actor according to American tort law); *see also* Christian Gold et al., “TAKE OVER!” HOW LONG DOES IT TAKE TO GET THE DRIVER BACK INTO THE LOOP?, *PROCEEDINGS OF THE HUMAN FACTORS AND ERGONOMICS SOCIETY 57TH ANNUAL MEETING* (2013), <http://journals.sagepub.com/doi/pdf/10.1177/1541931213571433>. Furthermore, in automated driving conditions, the driver, having faith in the well-functioning of the system, will devote less attention to the road; as a consequence, his reactivity

On the contrary, if a vehicle is able to operate ordinarily without any intervention from the “human driver”, the situation changes radically. The integration *by design* of systems governing each aspect of the circulation of vehicles affects our understanding regarding the role of the driver. Although in most legal systems the driver is the one figure traditionally liable in case of road accidents, autonomous vehicles will not have a driver anymore, but only passengers. Imposing liability on a subject who is not operating the vehicle is, at least, questionable.

We, therefore, proceed to investigate the role and responsibilities of all potential “players” in HAVs’ circulation, in order to evaluate the preferable allocation of tort liability for accidents involving driverless vehicles.

III. POSSIBLE APPROACHES IN ALLOCATING TORT LIABILITY FOR HAVS’ ROAD ACCIDENTS

Four leading players have been traditionally considered—in the academic debate as well as in the regulatory proposals enacted by governmental and independent bodies—“potentially responsible” in case of road accidents involving HAVs:²² the driver of the car; its owner; the government (or, widely speaking, the general public) and the manufacturer of the vehicle.²³

A. Driver, Owner and Government

We already observed that the driver of the vehicle is traditionally considered the immediately responsible party for road accidents occurring while she is conducting the car; such a rule is—with slight variations on the burden of proof incumbent on the driver in order to demonstrate the concurrent liability of third parties, e.g. a mechanical defect of the vehicle—a common feature of road regulations both in civil and in common law systems.²⁴

The reason behind a driver-centered tort rule is intuitive: in traditional vehicles the driver is in full control of the car and is ultimately responsible for its actions. Even in the regulation of semi-automated (L1-L3) vehicles, this system finds its rationale on the basis of the aforementioned hand-over duties.

In a world where only HAVs circulate, though, this rule shall be substantially disputed and revised for (at least) two main reasons:

wherever he shall be demanded to regain the control of the vehicle in case of hand-over (i.e. of danger) will be low. The overall findings provided by cognitive analysis of individuals’ behavior in driving semi-automated cars suggest that, in the presence of a system that requires human intervention in case of emergency, the safest solution for the driver would be continuing to use the manual driving system! See NAT. HIGHWAY TRAFFIC SAFETY ADMIN., HUMAN FACTORS EVALUATION OF LEVEL 2 AND LEVEL 3 AUTOMATED DRIVING CONCEPTS (2015), https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/812182_humanfactorseval-l2l3-automdrivingconcepts.pdf; Morgan et al., *supra* note 15; M. S. Young & N. A. Stanton, *What’s Skill Got to Do with It? Vehicle Automation and Driver Mental Workload*, 50(8) ERGONOMICS 1324, 1324–39 (2007).

22. See Gary E. Marchant & Rachel A. Lindor, *The Coming Collision Between Autonomous Vehicles and the Liability System*, 52 SANTA CLARA L. REV. 1321 (2012).

23. *Id.*

24. PROSSER AND KEETON ON TORTS (W. Page Keeton et al. eds., 5th ed. 1999). For a prominent example in Europe see, e.g., art. 2054 of the Italian Civil Code. Codice Civile [C.c.] art. 2054 (It.).

The first one is that liability of the driver is always based on a judicial evaluation aimed at ascertaining her guilt (whether it may be in terms of simple fault, or negligence, depending on the specific provision considered).²⁵ Accordingly, a driver is granted immunity from liability if she demonstrates that she did everything she could to avoid the occurring of the harmful event. It is clear, though, that no investigation of the driver's duties is *de facto* possible in the context of autonomous vehicles—apart from minor hypothesis, such as an active intervention on the car's software in terms of *hacking* or negligence in downloading mandatory updates for the HAV's software—since she does not play any form of participation in the control of the vehicle. With the lack of an active role of the driver, it is ontologically impossible for human conduct to cause the vehicle error. Furthermore, the development of automation technologies seems to point towards the implementation of software that will permit HAVs to circulate even in the total absence of *any human* on board.²⁶ In this hypothesis, any evaluation regarding a supposed “driver” liability appears incongruous.

A second reason to be considered arises from an evaluation of liability rules according to a law and economics perspective, in terms of allocation of risk and incentives. The current formula is economically inefficient in the driverless car world, imposing the cost of accidents on a subject that is not incentivized (*rectius*, able) to reduce the likelihood of the event.²⁷ As we can undisputedly observe, the driver is “twice impotent” before the HAV: on one hand, she is not able to modify the conduct of the vehicle; on the other hand, she is devoid of the specific competencies to improve the circulation software. As a result, imposing a liability burden on her has no effect in terms of promoting the highest grade of safety.²⁸

The irrelevance of the driver in the new dynamics of HAV regulation calls for a re-definition of the traditional rules in order to reach a solution able to achieve, on one side, compliance with the underlying principles of each legal system and, on the other one, an efficient allocation of the cost of accidents.

25. RICCARDO MAZZON, *LE AZIONI A TUTELA DEL DANNEGGIATO DA CIRCOLAZIONE STRADALE* (2011).

26. Tesla recently announced the implementation of its car-sharing service, named “Tesla Network”: Tesla users will be able to contact any Tesla car in the surroundings, and then the vehicle will autonomously reach them and transport them to their desired destination. See Fred Lambert, *Tesla Network: Elon Musk Elaborates on Autonomous Ride-Sharing, Says Will Eventually Be Cheaper Than Public Transport*, ELECTREK (May 1, 2017), <https://electrek.co/2017/05/01/tesla-network-elon-musk-autonomous-ride-sharing-vision/>. Furthermore, Uber already announced in 2015 that by 2030 its whole fleet will be driverless. Paul Goddin, *Uber's Plan for Self-Driving Cars Bigger Than its Taxi Disruption*, MOBILITY LAB (Aug. 18, 2015), <https://mobilitylab.org/2015/08/18/ubers-plan-for-self-driving-cars-bigger-than-its-taxi-disruption/>.

27. The primary benchmark for this evaluation is the notorious book by Guido Calabresi, *THE COST OF ACCIDENTS: A LEGAL AND ECONOMIC ANALYSIS* (1970). See also ROBERT COOTER ET AL., *IL MERCATO DELLE REGOLE: ANALISI ECONOMICA DEL DIRITTO CIVILE* (2006) (offering an evaluation of the academic debate on the issue).

28. Someone may argue that the driver still plays an active role in terms of “activity risk,” since she is still responsible for choosing whether to actually move *by car* or by other means (public transport, or on foot). According to what other scholars already underlined, we believe that such a role is not significant enough to justify, at least, the identification of the driver as the *main* responsible party in case of a road accident. See Robert L. Rabin & Kenneth S. Abraham, *Automated Vehicles and Manufacturer Responsibility for Accidents: A New Legal Regime for a New Era*, 105 VA. L. REV. (forthcoming Dec. 2019), <https://law.stanford.edu/publications/automated-vehicles-manufacturer-responsibility-accidents-new-legal-regime-new-era/>. This article is currently unpublished and a Draft version was presented at the workshop *Driverless Cars: The Legal Landscape* held on June 14, 2017, at the George Washington University Law School. The implications of Abraham and Rabin's work are widely discussed in Part IV.

The problems we observed regarding the drivers' liability are mostly valid also for the owner of the vehicle.

Even if in those legal systems where the owner of the vehicle is held responsible in case of a road accident,²⁹ such liability (assuming her non-involvement in the harmful event) is justified in terms of subsidiarity to the driver's one, performing a *deep-pocket* function.³⁰ The driver is, subsequently, still the main responsible party for compensation. If we assume that the introduction of wholly automated driving systems radically "wipes out" drivers' liability in case of a road accident, it is difficult to promote a rule according to which the sole responsible party is the owner of the vehicle: she is equally unable to impact the behavior of the car or to improve the software performances.

The inadequacy of the owner as the main target for liability rules is supported by a second consideration related to the socio-political environment that is accompanying the development of the driving sector. We are referring to the prevalence of the *sharing economy* phenomenon in the automotive industry and, in particular, to the diffusion of *car-sharing* systems in the main urban communities.³¹

Car-sharing entails significant benefits for society (e.g. reduction of road traffic and lowering of pollutions) and should consequently be incentivized. The widespread use of car-sharing might have substantial impact on the proprietary assets of vehicles: if car-sharing services are provided, for example, by public administrations, acquiring the cars and then making them available to users, the immediate consequence of a rule imposing liability on the owner would be the allocation of the cost of road accidents on that same public administration—indirectly on the citizenry.

Imposing an indirect liability duty on the general public is not a satisfactory remedy either. With the lack of a concurrent remedy apt to govern the conduct of those who are actually able to affect the functioning of driverless cars, the only result of such a provision would be stimulating free-riding behaviors, without providing solutions able to orientate conducts.

Neither the driver, nor the owner of the vehicle, be it a private individual or the general public, seem to ultimately represent optimal resources to allocate liability for HAV road accidents. This consideration leads us to the analysis of the role of the manufacturer of the vehicle—the car company.

B. The Role of the Manufacturer and the Consequences of Liability Rules on R&D

In light of the sub-optimal condition of the first three "players" we considered, the last figure called into consideration is the manufacturer. It is intuitive, in fact, that those who are responsible for the development and the commercialization of

29. See, e.g., C.c.art. 2054, n. 3 (It.).

30. See Gary T. Schwartz, *The Hidden and Fundamental Issue of Employer Vicarious Liability*, 69 S. CAL. L. REV. 1739, 1744 (1996).

31. See Guido Smorto, *I Contratti della Sharing Economy* IL FORO ITALIANO (2015) (It.), <https://iris.unipa.it/retrieve/handle/10447/127476/190589/2015.%20contratti%20sharing%20economy.pdf>; Tim Higgins, *The End of Car Ownership*, WALL STREET J. (June 20, 2017), <https://www.wsj.com/articles/the-end-of-car-ownership-1498011001>.

an unsafe product must be subsequently liable for potential harms caused by its use. On the basis of this assumption, the vast majority of the literature on the topic³² concedes the manufacturer is, actually, the sole reasonable figure that should be held responsible for autonomous car accidents.

The leading operators in the automotive sector are vehemently opposed to this position, adducing various arguments that should justify a more moderate understanding of their role in the autonomous car industry.

Firstly, a traditional position³³ advocating for the exclusion of tort liability is based on the idea that the increase of the costs related to potential litigation and compensation after accidents would impact the overall costs sustained by the manufacturers, as well as their investments in R&D, ultimately delaying the introduction in the market of a technology that—even in its “imperfect” form—is suitable to reduce the accident rate and save human lives.³⁴ The most “extreme” version of this argument even advocates in favor of a complete immunity of manufacturers from so-called “development risks” on the basis of the benefits that autonomous cars bring to society.³⁵

A second objection involves the fact that car manufacturers are not always responsible for the *in-house* development of their circulation software, having the option to delegate to specialized third parties for its creation and improvement.³⁶

Neither of these two objections is strong enough to shatter the idea that manufacturers are the most proper target for liability.

The first argument reproduces policy positions that might have had some relevance in the early days of industrial development, but that are hardly acceptable now. Furthermore, we should consider that such a position is vitiated by a sort of circular paradox in its most extreme version: once provided with immunity, car manufacturers would be exempted from tort liability arising from harms caused by their products and would actually have *fewer* incentives to develop better products.³⁷

The second argument, based on the potential delocalization/deverticalization of the circulation software to third parties is equally inadequate. Whether the

32. Apart from many contributions mentioned in the present work, such a position is also endorsed by studies conducted by governmental agencies in their consultation. See PATHWAY TO DRIVERLESS CARS: CONSULTATION ON PROPOSALS TO SUPPORT ADVANCED DRIVER ASSISTANCE SYSTEMS AND AUTOMATED VEHICLES, CTR. FOR CONNECTED & AUTONOMOUS VEHICLES 11–12 (2017), https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/581577/pathway-to-driverless-cars-consultation-response.pdf.

33. For an overview of the main positions on the argument, see Omri Ben-Shahar, *Should Car-makers Be Liable When A Self-Driving Car Crashes?*, FORBES: OPINION (Sept. 22, 2016), <https://www.forbes.com/sites/omribensshahar/2016/09/22/should-carmakers-be-liable-when-a-self-driving-car-crashes/#7c5dcb848fb2>. “If the self-driving capacity increases liability [of suppliers of safer products], it might distort the choice between old and new technology, weaken the incentive to innovate, and ultimately hurt the car users that the liability regime sought to protect.” *Id.*

34. *See id.*

35. *Id.*

36. Cf. Steven Wittenberg, *Automated Vehicles: Strict Products Liability, Negligence Liability and Proliferation*, ILL. BUS. L.J. (Jan. 7, 2016), https://publish.illinois.edu/illinoisblj/2016/01/07/automated-vehicles-strict-products-liability-negligence-liability-and-proliferation/#_ftn14.

37. *See generally* Guido Calabresi & Alvin K. Klevorick, *Four Tests for Liability in Torts*, 14 J. LEGAL STUD. 585, 622 (1985) (observing that only those whose conducts are analysed on the basis of a test considering all the information gathered after an accident “will arguably see greater payoff to learning more now, as opposed to finding out only later with perhaps quite dire financial consequences.”).

development of the software is operated in-house, this option does not find any space; even if the software is created by third parties, though, it is reasonable to hypothesize that the producer of the autonomous vehicle shall compensate victims of accident on the basis of a *culpa in eligendo* criterion (also considering the interest for a quick restoring of the injured party). The car manufacturer will then be in charge of proving that the casualty was provoked by a scripting error in the driving algorithm in order to seek recourse against the creator of the software.

Despite the fact that both the arguments are not sufficient to impose liability on car manufacturers, it is nonetheless opportune to observe that both of them underline a common rationale: manufacturers' accountability in cases of road accidents is an additional cost that the producer must internalize (e.g. through an increase in the price of the product on the market). This might lead to reduced investments in R&D, higher prices of the driverless cars, and subsequently to a net welfare loss caused by the lack of reduction in fatalities if fewer cars are sold.

This bedrock calls for a further investigation to evaluate—within the general option of manufacturers' liability—which specific rule is, *de iure condito* or *de iure condendo*, preferable to conjugate safety and promotion of HAVs.

IV. PRODUCT LIABILITY AND STRICT LIABILITY

In considering possible rules to regulate manufacturers' liability we devote our attention to the analysis of the two most significant models in the legal debate on HAVs: on one hand, we consider the role that rules on *product liability* can play; on the other hand, we evaluate the impact of *strict liability* options. In particular, as for the latter, we want to confront the hypothetical system proposed by Kenneth Abraham and Robert Rabin (A&R) in their work "Automated Vehicles And Manufacturer Responsibility For Accidents: A New Legal Regime For A New Era": this formulation is, in our opinion, the best strict liability solution currently proposed for autonomous cars (and we will explain why).³⁸

However, A&R's solution is not entirely devoid of limits. After discussing it, we will present our personal proposal for regulating manufacturer duties according to a "corrected" strict liability rule. Our system shares significant features with A&R's, but it also encompasses relevant differences that, according to our view, make it ultimately preferable.

We will proceed with a brief overview of the product liability and A&R strict liability rules, underlining both systems' benefits and shortfalls.

A. The Case for Product Liability

In evaluating if current product liability rules might be a satisfying solution to regulate manufacturers' responsibility, the first aspect that must be observed is that the current rules on product liability differ by jurisdiction. We must, therefore, operate through a territorial-based approach. Furthermore, in the United States, there is no federal regulation, and the laws of each state determine the rules governing

38. See Rabin & Abraham, *supra* note 28.

liability for defective products. Nevertheless, there are many similarities amongst the various jurisdictions, since they are all orientated toward the general framework outlined in the Third Restatement.³⁹ According to our opinion, it is possible to provide a comprehensive overview of the product liability in the U.S. On the other side, the European Union regulation offers general rules for defective products within the territory of the Union,⁴⁰ lending itself to a unitary analysis.

According to U.S. law, in assessing a claim against manufacturer the claimant has to prove—in compliance with the specific requirements of the individual jurisdiction considered—the existence of a design or a manufacturing defect. We consider the third category encompassed by the Restatement—warning defects—in-significant in the case of HAVs, provided that the vehicle is not supposed to alert the driver since she is not able to take over control of the car. This means that the claimant must demonstrate that the product *per se* is not adapted to perform its expected activity (design defect) or that, even if the car is theoretically apt to carry out its function, the specific product sold was defective, and this caused the vehicle to behave abnormally (manufacturer defect).⁴¹

Both of these rules present significant issues in terms of the burden of proof in the case of HAVs' (as well as in innovative technologies in general) defects.⁴²

The proof of a design defect relies on the demonstration of the existence of no reasonable alternative designs that would have avoided the occurrence of the accident.⁴³ In the case of a road accident, the claimant must consequently prove that the circulation software of the vehicle could have been designed differently and that this modification could have prevented the harmful event.⁴⁴ It is intuitive, though, that such a burden of proof is extremely demanding for the *quibus the populo*: offering a reasonable alternative design for the sophisticated algorithm regulating autonomous cars—and proving that this alternative is actually preferable to the originally implemented one—is undoubtedly onerous, and the vast majority of the literature observes how the very concept of Reasonable Alternative Design is meant to become increasingly indeterminate in innovative technologies, subtracting this area to the rules of conventional analysis.⁴⁵

The proof of a manufacturer's defect is no simpler a task to be accomplished as well, since the claimant must demonstrate the existence of a defect of the product, a causal connection between the defect and the harmful event, and that the product was defective when it was provided by the manufacturer (the proof of a

39. RESTATEMENT (THIRD) OF TORTS: PRODUCTS LIABILITY (Am. Law Inst. 1998).

40. Council Directive 85/374/EEC of 25 July 1985 on the approximation of the laws, regulations and administrative provisions of the Member States concerning liability for defective products, EUR-LEX, <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:31985L0374>.

41. See RESTATEMENT (THIRD) OF TORTS: PRODUCTS LIABILITY, *supra* note 39.

42. See Wittenberg, *supra* note 36.

43. In determining reasonableness according to the *Third Restatement* the court may consider, among other things, the effect on production costs, durability, maintenance, and aesthetics. See RESTATEMENT (THIRD) OF TORTS: PRODUCTS LIABILITY, *supra* note 39. For a comment on this provision, see Scott Wilkov & Elisa Arko, *No Alternative Design: An Often-Overlooked Defense to Product Liability Claims*, FOR THE DEFENSE, Apr. 2017, at 47.

44. See Wilkov & Arko, *supra* note 43, at 53.

45. SAMIR CHOPRA & LAURENCE F. WHITE, A LEGAL THEORY FOR AUTONOMOUS ARTIFICIAL AGENTS 139 (2011).

defect in the product can be presumed in specific circumstances of the case—*in primis* if there are no other potential causes of the accident).⁴⁶

Once again, in high-technology sectors, the consumer will face extreme difficulties—provided the absence of a reversal of the burden of proof over the manufacturer—in demonstrating the existence of a defect in the circulation software algorithm *and* the fact that *that* particular error was determinant for the occurrence of the accident.⁴⁷

In the European framework, defective product regulation does not seem to offer better solutions: E.U. rules substantially request victims to fulfil the same burden of proof required in the U.S. to prove manufacturers' defects, and case law amongst the different Member States show an extensive heterogeneity in the interpretation of the elements necessary to fulfil the burden of proof related to the causality between the defect of a product and the harmful event.⁴⁸ Very different approaches oscillate between quasi-strict liability positions—inverting the burden of proof on the manufacturer—and opinions supporting the idea that the burden of proof should rely entirely on the claimant.⁴⁹ Recently the European Commission, evaluating the state of the art of defective products regulation, underlined how the current framework creates substantial obstacles for victims of injuries in the effective access to compensation.⁵⁰

Both U.S. and E.U. regulations present relevant shortcuts in offering effective protection in high-tech sectors. Furthermore, the current allocation of the burden of proof in trial raises concerns on the role (and relevance) of expert witnesses in the resolution of the dispute: since the judge is utterly incapable of evaluating the reliability of their findings, a technical expert's opinion is not a tool for the judge as *peritus peritorum*: it is, instead, a real oracle, and the sole option the court has is to abide by it in the defectiveness and causality evaluation.

B. Strict liability

In general terms, we can define a simple strict liability rule for car manufacturers as a system in which they are always responsible for harms caused by the vehicles they produce. This form of liability departs from any notion of fault and without any chance to avoid compensation. It is, indeed, essentially based on causation, without regard to whether a defendant's conduct is socially blameworthy.⁵¹

46. See RESTATEMENT (THIRD) OF TORTS: PRODUCTS LIABILITY, *supra* note 39.

47. *Id.*

48. See DUNCAN FAIRGRIEVE, PRODUCT LIABILITY IN COMPARATIVE PERSPECTIVE (2005); *cf.*, Case C-621/15 v. Sanofi Pasteur MSD SNC Et al. [EU Court of Just.] June 21, 2017.

49. A. PALMIERI & R. PARDOLESI, DIFETTI DEL PRODOTTO E DEL DIRITTO PRIVATO EUROPEO, IL FORO ITALIANO, IV c. 295 (2002).

50. C.F.R. EUROPEAN COMMISSION, FOURTH REPORT ON THE APPLICATION OF COUNCIL DIRECTIVE 85/374/EEC OF 25 JULY 1985 ON THE APPROXIMATION OF THE LAWS, REGULATIONS AND ADMINISTRATIVE PROVISIONS OF THE MEMBER STATES CONCERNING LIABILITY FOR DEFECTIVE PRODUCTS AMENDED BY DIRECTIVE 1999/34/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL OF 10 MAY 1999 (1999).

51. See *Rylands v. Fletcher* [1868] UKHL 1.

The core idea behind strict liability rules is that individuals should never bear a loss that they are not able to explain or avoid.⁵²

Several reasons are traditionally evoked in suggesting that the application of strict liability rules to autonomous vehicles would lead to optimal results.

The first reason is deeply rooted in a law and economics analysis: it is argued that, since it faces the total amount of costs arising from an accident, the manufacturer will have the maximum interest to minimize total accident costs. Under a strict liability regime, the total social costs of accidents are equal to the private costs. This, along with the certainty regarding the allocation of costs, would maximize the incentives for innovation. In substance, under a strict liability rule, the deterrence degree on the manufacturer is at its highest possible level.

Furthermore, strict liability rules lead to decentralization effects in the allocation of risk costs:⁵³ if the cost of optimizing the vehicle is different for each manufacturer (and considering that damages are expected to decrease with each additional unit of care) this will lead to a self-selection process, where (potential) tortfeasors with high per unit costs of care will exhibit a lower level of care than those with low unit costs of care. Through this method, “strict liability leads every individual [manufacturer] to reach the cost minimi[z]ing and socially optimal care level.”⁵⁴

A strict liability regime is also supposed to reduce transactions costs related to litigation. The first reason is that, since under strict liability it is not necessary to investigate the negligence of the car manufacturer, the probability of overall litigation is lower, making it easier to predict the outcome of a trial: this should lead to an increase of non-contentious solution and extra-proceedings transactions. A second reason is that—even if litigation actually arises—under strict liability courts are exonerated from the investigation concerning the optimal due care and the level of care actually taken by the manufacturer. These operations usually increase the costs and the length of the trial and would be eradicated under strict liability.

C. Abrahams & Rabin’s Model

A&R move from the abovementioned considerations in developing their strict liability proposal for regulating road accidents caused by autonomous vehicles. Their system is named “Manufacturer Enterprise Responsibility” (MER).

MER is supposed to operate in a world where the vast majority of vehicles are driverless (before reaching that point, A&R deem traditional product liability rules to be the most effective).⁵⁵ Directly speaking, MER is a capped fund regulated on the federal level that is responsible for compensating all bodily injuries arising out of the operation of automated vehicles—including accidents involving two or more

52. David C. Vladeck, *Machines Without Principals: Liability Rules and Artificial Intelligence*, 89 WASH. L. REV. 117, 146 (2014).

53. ROBERT COOTER & THOMAS ULEN, *LAW AND ECONOMICS* 388 (6th ed. 2004).

54. Hans-Bernd Schäfer & Frank Mueller-Langer, *Strict Liability Versus Negligence* 17 (German Working Papers in Law & Econ., 2008), https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2062787.

55. See Abraham & Rabin, *supra* note 28.

HAVs—except for damages caused by the HAV owner’s own negligence.⁵⁶ MER payments include full compensation of medical expenses and lost wages until a specific cap (hypothesized by A&R in \$1 million), and property damages are not covered. The HAV owner is therefore supposed to purchase a traditional auto insurance in order to cover damages to her vehicle.

MER should operate as the exclusive remedy in case of an accident since a concurring instrument (such as product liability claims) would imply—according to A&R—problems related to the concept of joint causation in distinguishing accidents caused by the autonomous vehicles *per se* and those caused by other features of the car.⁵⁷ The only exceptions to the exclusive nature of MER would encompass punitive damages claims (whereas parties deem that the manufacturer error has been particularly gross) and suits against third parties for concurring liability.

The MER funding cost is entirely placed on the car manufacturer. A&R argues that, in the first period of implementation of the MER, the allocation of expenses amongst manufacturers should be presumptive and based on their market share, then gradually shifting towards a mechanism based on the actual frequency of accidents caused by each manufacturer’s HAV.⁵⁸

As for the administration and claim-processing of the MER, A&R hold that insurers issuing the damage coverage for the vehicles will be responsible for submitting injurer’s claims in case of an accident, receiving a fixed commission by the MER in exchange for the execution of this service.⁵⁹ After receiving the documentation related to the request, MER will pay in full, in part, or deny the claim, and special Administrative Law Judges (ALJ) located in each state will decide if MER is entitled to pay only in part in case of dispute. Appeals will be admitted just in case of arbitrary and capricious judgment by the ALJ.⁶⁰

D. Evaluation of the MER System: Advantages and Shortcomings

Before proceeding to the illustration of our proposal, we want to offer an overview of, according to our view, the essential strengths and weaknesses in A&R’s model.

We agree with A&R that a strict liability system is, in principle, preferable to a traditional negligence evaluation and to current product liability rules: the uncertainty related to the assessment of defects and, more in general, the inconvenience of the rules on the burden of proof called for the introduction of a more objective approach.

In the general context of strict liability, we also believe that A&R’s choice of creating an *ad hoc* fund—rather than holding the manufacturers directly liable in

56. *Id.* at 12. This is the case, for example, of the forceful modification of the circulation software by the owner of the vehicle. The burden of proving that the injuries were caused by the driver’s (or owner’s) negligence will be incumbent on the MER. *Id.*

57. *Id.* at 16.

58. *Id.* at 23.

59. *Id.* According to their opinion, “the process would be roughly analogous to making a workers’ compensation claim through an employer, to the employer’s insurer.” *Id.* at 50.

60. *Id.* at 24.

case of an accident—should be welcomed. We already prospected—without developing rules regarding its mechanisms—the implementation of such a solution in a previous co-authored work;⁶¹ the use of a fund has, in fact, some significant advantages.

Firstly, a fund creates an exclusive respondent for road accident claims, and it subsequently provides to victims a clear expert entity responsible for the compensation. Therefore, it promotes certainty and easier access to compensation.

Secondly, devolving the liability duties to a fund avoids the risk of creating incentives to lower the relevance of damages in a very concentrated market like the HAV one. Without a fund, as a matter of fact, if two HAVs produced by different manufacturers crash and each one must reimburse the driver of the other car (according to insurance mechanisms for damages caused to third parties), manufacturers might have incentives to free-ride on other companies' precautions, since their priority will be protecting their own driver, rather than avoiding the accident in general (e.g. if a car produced by X is extremely fragile, while a car produced by Y is particularly resistant and safe—provided that both satisfy rules governing product safety for commercialization—if an accident occurs, Y might be required to pay a higher amount than X, since X car's driver suffered more injuries). An analogous situation might arise even in the presence of a fund if the cost of its creation and maintenance were to be equally split amongst all the manufacturers; A&R correctly address this concern by promoting a division of the funding on the basis of the accident rate of each manufacturer.

The MER system, though, has some significant shortcomings that might curtail its effectiveness.

Our fundamental concern regarding A&R's system arises from the fact that—fund or not—it is a *pure* strict liability system and, as such, it is susceptible to create "*chilling effects*" on the introduction and diffusion of new technologies on the market.

This is because the MER model takes into account only one side of an issue (the governance of HAVs' production and diffusion in the society) that is actually multi-faceted. On one hand, there is the interest in the protection and safety of the user and, on the other hand, there is the incentive to increase the adoption of a technology safer than the human driver.

The tension between these two goals, and the rules that should guide their balance, is well expressed by a recent article by Ryan Abbott⁶² advocating for the adoption of a negligence standard in computer-generated torts. In particular, Abbotts argues that, once computers—in our case, circulation software—become safer than people, the principal reduction in accident rates should arise from automation rather than from incremental improvements in product safety. As a consequence, it is preferable to promote measures in favor of the adoption of the technology (lowering its cost) rather than imposing significant burdens to ensure an

61. Antonio Davola & Roberto Pardolesi, *In Viaggio Col Robot: Verso Nuovi Orizzonti della R.C. Auto ("Driverless")?*, DANNO E RESPONSABILITÀ 616, 627 (2017).

62. Ryan Abbott, *The Reasonable Computer: Disrupting the Paradigm of Tort Liability*, 86 GEO. WASH. L. REV. 1 (2018).

almost total level of safety.⁶³ Such a conclusion can be justified also on the basis of those same considerations that—according to the Third Restatement—legitimize an exemption from strict liability rules every time that a product is “unavoidably unsafe” and yet promotes public safety.⁶⁴

Under pure strict liability rules, a manufacturer might wait to commercialize autonomous cars until they are certain to be able to calculate the potential harm caused by the car and internalize the cost of accidents by projecting it on consumers. This might ultimately delay the entrance to the market of vehicles that are (already) safer than a human driver.⁶⁵

Furthermore, since the costs related to compensation for HAVs accidents will be likely internalized in the overall price of the product, if the absolute liability that strict rules impose raises the cost of HAVs over a specific threshold, consumers will not buy them: if driverless cars are luxury products, they will need more time to diffuse in society.

In order to mediate between these concurring needs, the proper regulation of autonomous cars should hold the manufacturer liable for harms caused by autonomous vehicles and, at the same time, reduce the likelihood that the liability regime affects the investment in R&D or increases the costs of the product. In our opinion, A&R only consider one of these two aspects.

Another element that A&R seem to overlook pertains to a traditional objection raised against strict liability rules, that is the absence of a connection between the seriousness of the defect that caused the accident and the compensation due

63. *Id.* at 22. The author provides a simple example in order to illustrate his position:

[I]magine that with current technology a computer driver would be ten times safer than a human driver. In this case, it would be better that *one* human driver is replaced by a machine than that the same machine becomes *100 times* safer than a human driver. To see why that is so, assume a closed system with only two vehicles, where the risk of injury for a human driver is one fatality per 100 million miles driven and the risk of injury for a computer driver (model C-A) is one fatality per 1 billion miles driven. C-A is ten times safer than a person. Over the course of ten billion miles driven by the person and C-A, there will be an average of 110 fatalities.

Now imagine that we are able to improve C-A an additional ten-fold such that its risk of causing injury is reduced to one fatality per 10 billion miles (C-A+). Then, over the course of 10 billion miles driven by the person and C-A+, there will be a total of 101 fatalities. If, however, instead of focusing our efforts on improving C-A we simply replace the human driver with another C-A, then over the course of 10 billion miles driven by C-A & C-A there will be a total of 20 fatalities. Once computers become safer than people, and particularly once computers become substantially safer than people, very significant reductions in accident rates will be gained by automation. Therefore—at some point—it is preferable to weaken the incentive to gain incremental improvements in product safety to increase the adoption of safer technologies.

Id. at 22–23.

64. See RESTATEMENT (SECOND) OF TORTS § 402 cmt. k (AM. LAW INST. 1997). For an analysis of the implication of the Comment in the autonomous vehicle area, see Mark A. Geistfeld, *A Roadmap for Autonomous Vehicles: State Tort Liability, Automobile Insurance, and Federal Safety Regulation*, 105 CALIF. L. REV. 1611, 1667 (2017).

65. The presence of potential chilling effects is also present in the case of application of current product liability rules. See Maurice Schellekens, *Self-driving Cars and the Chilling Effect of Liability Law*, 31 COMPUTER L. & SECURITY REV. 506, 506–517 (2015).

by the manufacturer: since the compensation is determined only on the basis of the personal injury suffered by the victims, there is no causal connection between the magnitude of the manufacturer's error and its duty to compensate them.⁶⁶ Whether the defect of the product is caused by an unusually gross mistake by the manufacturer, A&R claims that the presence of claims for punitive damages will be sufficient.⁶⁷ In the opposite case, though—when the error was caused by a very minor defect and was reasonably unpredictable (also considering the elevated level of technical complexity of HAVs)—the manufacturer has no way to reduce her exposition towards the victim.⁶⁸ The underlying assumption behind this choice relies most probably on the idea that a software built more negligently will cause more accidents, and carelessness will be punished by the market. Since, though, the amount of compensation is determined not by the frequency of crashes, but by the harm they cause—and this aspect is influenced by many circumstances in the concrete cases—it is difficult to reach certain conclusions on the issue.

What is certain is that A&R design a system that has sticks, but no carrots: whether an accident occurs, it is not crucial whether the manufacturer was particularly diligent or not in building the HAV. She will have to pay (at least) the whole personal injury suffered by the victim.

In exchange for the sacrifice of the substantive attention towards the manufacturer's conduct, A&R's system is supposed to impact the general welfare in terms of reduction of the litigation costs by avoiding the assessment of the manufacturer's negligence. An in-depth analysis of the MER system highlights though that, under A&R solution, the negligence assessment is out of the door but then immediately back through the window, as a consequence of the need to replenish the fund. In case of accidents involving two cars produced by different manufacturers, after the MER has compensated for the physical injuries of the victims, each manufacturer must replenish the fund on the basis of the damages it caused (immediately or, according to A&R, every year): in the hypothesis of potential concurrent responsibility—but even if the accident was caused by only one of the two cars, it is not clearly evident which one—an assessment of the facts will be nonetheless necessary in order to appraise which manufacturer should pay, and in which proportion.

The two main aspects that, according to A&R, make the negligence evaluation so inadequate to regulate road accidents involving HAVs—the proof of the defect and the demonstration of its causal connection to the harmful event⁶⁹—will still continue to exist. Furthermore, even if A&R does not address this aspect, it is reasonable to expect that, if the assessment of responsibility is conducted by the fund directly (or even by that same ALJ that should evaluate funds' opposition to

66. It goes without saying that since strict liability, in its "pure" form, does not take into account the subjective element, the intentional gross negligent, negligent or reckless nature of the conduct does not play a role in assessing who is responsible for compensation (it can, at most, have a function in the determination of possible punitive damages). See Steven Shavell, *Strict Liability Versus Negligence*, 9 J. LEGAL STUD. 1 (1980).

67. Abraham & Rabin, *supra* note 55, at 36–37.

68. Shavell, *supra* note 66. See also R. POSNER, *ECONOMIC ANALYSIS OF LAW* 130 (2d ed. 1977)

69. Abraham & Rabin, *supra* note 55, at 43–47. On the general problem of assessing causality in accidents involving self-driving cars, see Roeland de Bruin, *Autonomous Intelligent Cars on the European Intersection of Liability and Privacy: Regulatory Challenges and the Road Ahead*, 7 EUR. J. RISK REG. 485, 490–501. (2016).

compensations) manufacturers will be able to challenge the officer's findings, if they believe that the allocation of liability has been apportioned wrongly. The only element that will actually disappear from the investigation will be the analysis of the *rate* of negligence related to the error.

The ultimate result of MER will not be the elimination of the litigation in general: even if the specific part of the negligence evaluation will be avoided—since the level of care will not be a relevant parameter—some degree of assessment will be nonetheless necessary, in order *a)* to quantify the amount of damage and *b)* to allocate the damage responsibility on manufacturers involved in the event (if two cars have an accident, who has caused what damage?) in order to determine the amount that each of them shall use to replenish the fund. If, furthermore, a manufacturer will be able to challenge the AHS findings regarding this repartition, it is not unlikely to hypothesize manufacturer vs. fund litigation. Whether the sum of these elements might ultimately lead to the substantial diminishing of litigation costs as A&R hypothesize is uncertain.

Lastly, we submit one concluding remark: on the procedural aspects, the general contestation mechanism of the fund proposed by A&R is not clear, with particular reference to the basis that should legitimate the fund to compensate only in part the victims of an accident.⁷⁰ According to the pure strict liability rule governing the overall system, it is plausible that the MER should be entitled to pay in part only if the injured party asked for too high a compensation (e.g. for an amount over the \$1 million cap) or if a third party concurred in the event. Claiming that the fund should be able to oppose compensation on the basis of a marginal causality between the malfunctioning of the HAV and the event, or asserting that the accident is due to a minor negligence, would represent an intimate contradiction within the system, since A&R's perspective in designing a pure strict liability system does not provide manufacturers any way out based on causality or culpability evaluations.

V. OUR PROPOSAL: A FUND WITH REWARDING FUNCTION AND A TWO-STEP LIABILITY ASSESSMENT

After laying the groundwork through the analysis of previous solutions for regulating tort liability in accidents caused by Highly Automated Vehicles, and after underlining how none of them are entirely satisfactory, we move to propose our own system for allocating risks in the driverless car world.

What we propose is a two-step liability regime, based on a negligence evaluation and on a participated fund, subsidized for 50% by manufacturers—on the basis of the number of accidents caused—and for 50% through public resources (e.g. by means of a federal tax). The 50% paid by manufacturers will be divided amongst them—similarly to what A&R proposed—according to their respective market share only in the first period of enforcement of the system. As soon as data regarding the accident rates are available, the contribution will be calculated on the basis of the damages caused by each manufacturer.

70. Abraham & Rabin, *supra* note 55, at 50: "The MER Fund would then pay in full, pay in part, or deny the claim."

In the occurrence of an accident, injured parties will file their claim against the fund, and an individual ALJ will oversee evaluating whether the crash was caused by negligence, in the terms that we will soon illustrate. If the ALJ finds the manufacturer's negligence, the latter will pay the whole compensation to the victim of the accident. Conversely, if the accident was not caused by negligence, the fund will reimburse the victim. In both cases—and differently from what A&R suggest—the compensation mechanism will compensate harms to people *and* objects involved in the casualty, without distinguishing amongst physical and material damages.

The negligence evaluation shall be performed by the ALJ through assessing the existence of (at least one of) two circumstances:

a) the error in the software that caused the vehicle to behave abnormally is easy to identify and solve, on the basis of the data that the HAV provides;

b) the technology used by the manufacturer is considered inadequate with respect to the current technological state of the art in the autonomous car industry.

If one of these two conditions is satisfied, the manufacturer is considered negligent and therefore held fully liable for the accident.

In our view, this solution will lead to better results than the A&R proposal in terms of general social welfare for consumers, whilst simultaneously promoting a significant diffusion of HAVs in society. In the following paragraphs, we will briefly investigate the main benefits that our two-step system provides.

A. Increased Transparency and Perceived Fairness of the Evaluation

Assessments of negligence do not only pursue a goal of efficiency in the allocation of liability but also in terms of substantive justice and legitimation of the manufacturers' responsibilities towards the society. This is particularly relevant in the field of emerging technologies, where social trust is difficult to achieve, and consumers need to perceive the active role of courts in promoting their rights (in this specific case, the access to safe products). Since—as we observed—conducting an investigation on the weight of each manufacturer's responsibility is an inevitable task that ALJs will have to carry on, using it as a way of modulating the compensation (through the obligation of restoring entirely the victim or the access to the fund) will increase the transparency of the whole liability allocation system and foster the message that a manufacturer who does not accomplish her activity correctly is *directly* liable for injuries she causes. It could be argued – in contrast to this consideration – that a pure strict liability rule might be considered more transparent, in the sense of promoting a univocal rule regarding the responsible actor in case of accidents. We believe, though, that our system achieves such a result as well, considering that (from the perspective of the victim) the manufacturer will always be liable for the harm caused; in addition, it provides a specific analysis of the degree of negligence adopted in the development of the product, providing further information on its quality to the market and consumers.

B. Incentives for Manufacturers to Invest In R&D and Improve Their Products

The provision of a double compensation system will provide manufacturers with constant incentives for innovation. On one hand, a manufacturer will be incentivized to continue development of their technology due to the pure strict liability

rules. On the other hand, they will be incentivized to invest in R&D in order to avoid being considered negligent and to access to the premium mechanism of the fund. Furthermore, since one parameter to evaluate the negligence will be the production of *up-to-date* vehicles consistent with the most advanced degree of technology present in the sector, each producer's improvement will have driving effects toward competitors, since their liability will be evaluated by comparing it with alternative technologies already present on the market.

C. Overall Lower Price of the Products on the Market Due to the Fund

The presence of a governmental support to the fund will permit manufacturers to reduce their costs, reducing the overall amount that they need to internalize (i.e. transpose on consumers), provided that they are able to access to the fund. Autonomous cars will become cheaper, and this will foster their diffusion, with a subsequent increase of the social wealth connected to the overall reduction of road accidents. In relation to this aspect, the central element to investigate concerns the type of tax that to use to sustain the fund. The most intuitive approach—considering that tax regulation varies widely amongst jurisdictions⁷¹—would be a general income tax. Such a solution would, in fact, spread the general amount required by the fund on the general public, imposing the least possible *pro-capite* contribution. An essential concern related to this solution is the fact that, through this approach, those citizens who have a HAV and those who do not have one, would be equally forced to contribute to the common expense for a commodity that is not of first necessity (and that not everyone might be willing to purchase). In order to address this concern, the usage of a sales tax should be considered as the main alternative. The central critical aspect of sales taxes is, however, that consumers pay them *una tantum*, at the moment of purchase, whereas the fund must be systematically replenished.

The technological developments related to the HAVs sector might provide different and better solutions apt to connect a tax paid by consumers to their actual utilization of the vehicle and to charge it periodically. One option worthy of further investigation is the introduction of a mileage-tax, through which each user will be charged a specific amount on the basis of her actual use of the car.⁷² HAVs will be able to monitor the specific route of each driver and calculate the number of miles she travels. The adoption of this tax will reach three positive goals at once: a) each driver will pay a specific amount related to how much she drives; b) the fee will not be tied to the ownership of the vehicles (and, subsequently, will not be subject to possible issues related to the development of car-sharing activities); and c) the contribution from each driver to the fund will be proportional to the activity risk she entails for the circulation.

71. VICTOR THURONYI ET AL., *COMPARATIVE TAX LAW* (2d ed. 2016).

72. Some states in the U.S. already hypothesized the implementation of this solution. See Danielle Muoio, *Massachusetts Might Tax Self-Driving Cars to Prevent the Rise of 'Zombie Cars'*, BUS. INSIDER (Mar. 4, 2017), <http://www.businessinsider.com/massachusetts-law-proposal-tax-self-driving-car-per-mile-2017-3>.

D. Direct Correspondence Between the Level of Negligence and the Overall Price Paid By the Manufacturer in Consequence of Accidents

The last consequence of introducing a two-step evaluation is, indeed, that the reduction of costs will apply, not to every producer on the market, but only to those who are able to avoid negligent errors in the development of their products.

This happens because our system gives less relevance—connecting them to the governmental support system—to non-negligent errors by acknowledging that, even in a strict liability system, the complete avoidance of unexpected events is a difficult task to accomplish in high-tech sectors: therefore, the condemnation for those errors that are not due to a superficial activity of the manufacturer should be at least partially tolerated (even if compensation according to victims is always entire). The ultimate result of such a system is to foster the diffusion of the technology and favor those who do not commit grave errors in the development of new products.

VI. CONCLUSIONS AND ALTERNATIVE FRAMEWORKS CONSIDERED IN THE DEVELOPMENT OF OUR SYSTEM

In the light of the different positions animating the debate on liability rules for HAVs, we promote the adoption of a system that could conjugate the need for safety, incentives for R&D *and* promote the diffusion of autonomous vehicles. According to our analysis, a “corrected” strict liability system is the best way of achieving all of these goals.

Considering the risk that a pure strict liability system might ultimately hinder innovation, the application of a criterion to evaluate if the circulation software was manifestly inadequate—on the same wavelength as Calabresi’s *ex post Learned Hand Test*⁷³—allows us to partially circumscribe the full liability of the manufacturer only to those hypotheses in which its error was coarse and inexcusable.

Before concluding our remarks, we would like to illustrate two alternative frameworks we considered in the development of our two-step system, and briefly explain why we discarded them.

a) In evaluating possible parameters for the court to assess the manufacturers’ negligence, we hypothesized to refer to standards created by an independent agency (e.g. NHTSA) as a benchmark. We decided, though, to leave aside this solution due to the fact that a substantial uncertainty seems to govern the development of the driverless car.⁷⁴ As a consequence, rather than requiring an *ex ante* setting of technical standards for the main aspects involved in the creation of the circulation software—and, generally, in the development of the vehicle—we currently deem it preferable to operate *ex post* assessment of the manufacturer conduct, that could take into account the most *up-to-date* achievements in the field and equip a court with a more flexible tool.

b) In our system, 50% of the fund is subsidized by the government. A plausible alternative would be having the owners of autonomous vehicles directly pay for this

73. See Calabresi & Klevorik, *supra* note 37.

74. Matthew U. Scherer, *Regulating Artificial Intelligence Systems: Risks, Challenges, Competencies, and Strategies*, 29 HARV. J.L. & TECH. 353, 354 (2016); see generally Andrew Tutt, *An FDA for Algorithms*, 69 ADMIN. L. REV. 83 (2017).

portion, through a car insurance system. Such a solution has the benefit of allocating the cost of the fund on those people who avail themselves of autonomous vehicles, rather than on the whole community. We deemed preferable to opt for the government solution substantially in consideration of two aspects: on one hand, the diffusion of HAVs might radically modify the proprietary approach to vehicles (we already mentioned the issue of *car-sharing* services); on the other hand, the impact that the development of driverless cars might have on the insurance market is equally unclear, and strictly dependent on the effective accident rate that autonomous vehicles will have. In light of these two elements of uncertainty, we deemed that a public contribution by the government would be the most appropriate solution. Furthermore, it is possible—as we already observed—that the implementation of a *mileage-tax* will allow, in the future, the government to impose the burden of the fund only on those who actually avail themselves of autonomous vehicles.

Regardless of these two alternatives, the core elements of our system still remain: on one hand, manufacturers will have incentives to responsibly develop better and better products for commercialization (with a subsequent benefit for society); on the other hand, the limitation of full liability exposition only for cases of gross negligence will avoid the risk of discouraging firms from quickly introducing innovations in the field. In any case, victims of road accidents involving HAVs will be fully compensated (whether entirely by the manufacturer or with the partial governmental contribution).

Maybe in the future we will find an even better solution to deal with the uncertainty that currently shapes the autonomous vehicles' world. The compromise solution we advanced, though, bears the responsibility of keeping in balance the many interests involved. Reaching such a goal is already, in our view, an excellent achievement.

APPENDIX

In relation to Section IV. D, the main effects of our proposal in comparison with A&R's one can be explained by an experiment.

We assume—for the sake of simplicity—that the HAVs market is very concentrated (four players) and that each player has the same market share (25%); furthermore, each manufacturer produces only one car at an aligned cost (8.000\$). On the basis of the allocation of costs on R&D in safety, each producer has a different probability of causing an accident. If (very optimistically indeed!) the fund is created for the year 2018 (and the cost is divided equally amongst the manufacturers), the contribution for the year 2019 will be based on the cost of accidents caused by each manufacturer.

Manufacturers	Damages Caused	
	Negligent	Non-Negligent
P1	\$ 400	\$ 600
P2	\$ 500	\$ 300
P3	\$ 0	\$ 400
P4	\$ 300	\$ 100

Table 1.1 Hypothetical damages caused by four manufacturers during the year 2018

According to A&R's model, the difference between Negligent and non-Negligent errors is not significant for the allocation of compensation; as a consequence, during 2018, each producer shall pay—through the MER—the entirety of damages she caused. If costs sustained for compensation are internalized by projecting their amount on the product, then for the year 2019, each producer will increase the sale price of her vehicle by the amount paid to victims of road accidents. As a consequence, the next year the cost of products will be \$9.000 (P1); \$8.800 (P2); \$8.400(P3) and 8.400(P4). A&R's system successfully provides compensation to victims and imposes on manufacturers additional costs in proportion to the damages caused. Nevertheless, since the MER does not distinguish on the basis of the gravity of the error, P3 and P4 are considered equally, even if P4's software was designed with less attention, and caused more "negligent" accidents.

By applying our system and distinguishing between Negligent and non-Negligent errors (subsidized for the 50% by the Government), the resulting cost of the HAVs for the year 2019 will be the following: \$8.700 (P1); \$8.650(P2); \$8.200(P3); \$8.350(P4).

Two main effects of our system are immediately observable: firstly, the overall price of each unit lowers due to the governmental support for non-negligent (therefore partially excusable) errors; as a consequence, each manufacturer can sell its vehicles at a more affordable price for consumers. Secondly, manufacturer P4, who created worse software, is forced to pay a higher amount than P3 even if the overall amount of damages caused by the two manufacturers was the same.