THE FUTURE OF AUTONOMOUS VEHICLES IN AMERICAN CITIES

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INTRODUCTION

From trolley cars to railways to the automobile, innovations in transportation have shaped the way our cities grow and develop. Urban economies rely on moving people and goods efficiently, and the most enduring cities have continuously adapted to embrace new transportation technologies. Today, one such technology—autonomous vehicles—may be on the verge of ushering in a new era in urban transportation. Major automakers such as General Motors (G.M.), Ford, Tesla, Fiat Chrysler, Audi, Mercedes-Benz, Volkswagen, Honda, Nissan, Toyota, and Volvo are racing to bring autonomous vehicles to market, as are tech companies like Waymo (Alphabet), Uber, Baidu, Zoox, and Lyft.[1]

1. *See, e.g.*, REG'L PLAN ASS'N, NEW MOBILITY: AUTONOMOUS VEHICLES AND THE REGION 6 (2017); Jessica S. Brodsky, Note, *Autonomous Vehicle Regulation: How an Uncertain Legal Landscape May Hit the Brakes on Self-Driving Cars*, 31 BERKELEY TECH. L.J. 851, 855–56 (2016); Adeel Lari et al., *Self-Driving Vehicles and Policy Implications: Current Status of Autonomous Vehicle Development and Minnesota Policy Implications*, 16 MINN. J.L. SCI. & TECH. 735, 745–49 (2015);

Moreover, it is growing increasingly likely that autonomous vehicles will be rolled out in American cities in the near future. Fifty-five cities around the world are currently hosting autonomous vehicle tests or have committed to doing so in the near future.[2] G.M. is seeking approval from the U.S. Department of Transportation (U.S. DOT) to begin deploying fully-autonomous vehicles in an urban ride-hailing service starting in 2019, and Ford and Volvo both expect to produce autonomous vehicles for use in ride-hailing services by 2021.[3]

Autonomous vehicles could change our society's relationship to vehicle travel and land use, bringing many potential benefits to cities, but also a variety of costs. Although the eventual adoption of autonomous vehicles is far from certain, cities should proactively prepare for the arrival of this new technology.[4] Rather than allowing industry alone to dictate how these vehicles will impact our urban landscape, governments can play an active role in ensuring the technology develops in a way that is most beneficial to city residents.

To guide policy decisions, this Note envisions a time when autonomous vehicles eventually supplant human-operated vehicles in American cities.[5] It then presents policy options that policymakers

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David Ticoll, *Driving Changes: Automated Vehicles in Toronto* 3–4 (Munk Sch. of Glob. Affairs, Univ. of Toronto, Discussion Paper), https://munkschool.utoronto.ca/ipl/files/2016/03/Driving-Changes-Ticoll-2015.pdf; Alex Davies, *Lyft Is Launching a Fleet of Self-Driving Cars in San Francisco*, WIRED (Sept. 7, 2017, 9:00 AM), https://www.wired.com/story/lyft-self-driving-cars-san-francisco-bay-area/; Guilbert Gates et al., *The Race for Self-Driving Cars*, N.Y. TIMES (June 6, 2017), https://www.nytimes.com/interactive/2016/12/14/technology/how-self-driving-cars-work.html; Ashlee Vance, *The First Look Inside Zoox's Mysterious Robo-Taxi*, BLOOMBERG TECH. (Nov. 28, 2017, 10:18 PM), https://www.bloomberg.com/news/articles/2017-11-29/the-first-look-inside-zoox-s-mysterious-robo-taxi. Waymo alone claims its fleet has already been test-driven over five million miles. *On the Road*, WAYMO, https://waymo.com/ontheroad/ (last visited Dec. 28, 2017). In addition, many self-driving features are already available on the market, such as collision avoidance, drifting warnings, blind-spot detectors, enhanced cruise control, lane changing, and self-parking. *See, e.g.*, Ticoll, *supra*, at 3; Gates et al., *supra*.

2. *Initiative on Cities and Autonomous Vehicles*, BLOOMBERG PHILANTHROPIES & ASPEN INST., https://avsincities.bloomberg.org/ (last visited Dec. 29, 2017). In the United States, this list includes Austin, Texas; Boston, Massachusetts; Detroit, Michigan; Las Vegas, Nevada; Pittsburg, Pennsylvania; San Antonio, Texas; San Francisco, California; San Jose, California; Tampa, Florida; and Washington, D.C. *Id.*

3. *See* REG'L PLAN ASS'N, *supra* note 1, at 7; Neal E. Boudette, *Ford Promises Fleets of Driverless Cars Within Five Years*, N.Y. TIMES, Aug. 17, 2016, at B2.

4. *See* Ticoll, *supra* note 1, at 3 ("City leaders, researchers and technologists increasingly agree that as vehicle automation transforms public, commercial, and consumer transportation, they will reshape urban life.").

5. There are various levels of automation, and most vehicles already have some autonomous features, such as cruise control. SAE International defines "levels of automation," which have been adopted by the National Highway Traffic Safety Administration (NHTSA). NAT'L HIGHWAY TRAFFIC SAFETY ADMIN., U.S. DEP'T

should consider to capture the benefits and limit the costs of these vehicles, with a specific focus on New York City. Although New York City is unique in many ways, most of the policy options presented in this Note regarding limiting congestion, and creating in-fill opportunities by reducing the need for car infrastructure, are applicable to cities across the country.

In particular, there are two overarching questions urban policymakers should consider. The first is the question of whether autonomous vehicles will be operated solely or primarily by ride-hailing fleets, or whether residents will instead opt to own their own autonomous vehicles in significant numbers. The second overarching question is whether autonomous vehicles run the risk of increasing residents' reliance on vehicle travel, increasing total vehicle-miles-traveled (VMT), exacerbating congestion, and ultimately siphoning riders off of public transit.

The answer to the first question—whether autonomous vehicles will primarily be used in shared fleets or whether they will be primarily privately-owned—could lead to radically different outcomes in American cities.[6] The shared-vehicles scenario has the potential to reduce the total number of cars in circulation, liberate vast amounts of urban space no longer needed for car infrastructure, and potentially allow for faster adoption of fuel-efficient technologies.[7] Under a private-ownership scenario, on the other hand, a significant number of residents and commuters would own their own autonomous vehicles and develop a higher tolerance for driving longer distances. This higher tolerance could cause more sprawl as residents and commuters choose to live farther and farther away from where they work.[8] Pursuing policies that encourage a future of shared vehicles rather than a future dominated by private ownership will be crucial to the endeavor of maximizing benefits as autonomous vehicles become increasingly common.

However, even the shared vehicle scenario could carry significant societal costs in the form of greater congestion and a reduction in pub-

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TRANSP., FEDERAL AUTOMATED VEHICLES POLICY: ACCELERATING THE NEXT REVOLUTION IN ROADWAY SAFETY 9 (2016). For the purposes of this Note, I will assume that autonomous vehicles achieving SAE Level 5 (i.e., able to perform all driving tasks absent any human intervention) will eventually overtake human-operated vehicles. *See id.*

6. *See, e.g.*, Robin Chase, *Will a World of Driverless Cars Be Heaven or Hell?*, CITYLAB (Apr. 3, 2014), https://www.citylab.com/transportation/2014/04/will-world-driverless-cars-be-heaven-or-hell/8784/.

7. *See infra* Section I.B.3.

8. *See* Chase, *supra* note 6.

lic transit ridership. In recent years, services like Uber and Lyft have increased vehicular travel and mileage in New York City.[9] Ridership on taxi and ride-hailing services is now growing faster than ridership on public transit in New York City, reversing a nearly quarter-century trend of transit-oriented growth.[10] Traffic speeds in Manhattan have also declined in recent years, at least in part due to the growth in ride-hailing mileage.[11] Congestion, in turn, carries significant economic and societal costs for cities—for example, by impeding the movement of goods and services, slowing down buses and taxis, and generally increasing the time and costs involved in traveling around the city.[12] Moreover, as will be explained in Section I.C, autonomous vehicles could even lower the costs of car trips, thus further incentivizing vehicle travel.[13]

This Note presents policy options aimed at playing a double role—incentivizing the adoption of shared autonomous vehicles (SAVs) relative to privately-owned vehicles, while also preventing the overuse of vehicle travel. Cities have long implemented policies to cut down on congestion, and New York City in particular has pursued policies to encourage people to use non-car modes of transportation. The policies described here do not depart from this longstanding trajectory: although they are specifically tailored to the goal of incentivizing a particular future for autonomous vehicles, the policies focus primarily on ensuring that people who travel by vehicle internalize the societal costs of their own vehicle use. By making car users internalize these costs, policymakers can encourage a future in which more residents choose to forgo personal car ownership in favor of shared vehicles, but also one in which vehicle usage is not over-incentivized relative to transit modes that carry fewer negative externalities, such as public transit.

The legal profession has only just begun to analyze the myriad implications of autonomous vehicles, and no legal author has yet analyzed how urban policymakers can create an optimal future for autonomous vehicles. The time is ripe for American cities to begin seriously considering policies related to autonomous vehicles. Given the rapid pace of innovation, as well as the major levels of investment from

9. Bruce Schaller, Unsustainable?: The Growth of App-Based Ride Services and Traffic, Travel and the Future of New York City 1 (2017) [hereinafter Schaller, Unsustainable?].

10. *Id.* at 1.

11. Bruce Schaller, Empty Seats, Full Streets: Fixing Manhattan's Traffic Problem 3 (2017) [hereinafter Schaller, Empty Seats].

12. *See, e.g.*, Schaller, Unsustainable?, *supra* note 9, at 18.

13. *See infra* Section I.C.1.

traditional automakers and tech companies, cities should prepare for autonomous vehicle technology to come to market sooner rather than later. The first years of autonomous vehicles' introduction could prove crucial for setting the trajectory of the technology's impact on vehicle travel and land use. Pursuing proactive policies now will help lock in benefits and minimize the potential costs.[14]

Of course, the future of autonomous vehicles is not guaranteed, and any number of stumbling blocks could prevent this new technology from ever being widely adopted.[15] However, because the policies proposed in this Note simply serve to help vehicle users better internalize the societal costs of their own vehicle use, it would be worthwhile for cities to pursue them even if autonomous vehicles never become a reality. By promoting better internalization of the costs of vehicle use, cities can optimally incentivize vehicle travel, thereby producing such benefits as lower VMT and reduced congestion.

Part I of this Note will discuss future potential scenarios for autonomous vehicles' impact on vehicle usage and land use. Part II will briefly discuss the current regulatory environment for autonomous vehicles at the federal, state, and city levels. Part III will discuss the rationale for policy interventions regarding autonomous vehicles. Part IV will introduce a variety of policy options to incentivize SAVs relative to individually-owned vehicles, and to make sure autonomous vehicles don't exacerbate congestion, increase VMT, or decrease transit ridership.

I.
Scenarios for the Development of Autonomous Vehicles

A. *Defining Shared Autonomous Vehicles (SAVs): Moving the Most People in the Fewest*

For purposes of this Note, I will define SAVs to include all for-hire autonomous vehicles.[16] This may include SAVs that offer sequential, or exclusive rides, to one customer at a time (analogous to today's

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14. *See* Clive Thompson, *No Parking Here*, Mother Jones (Jan. 20, 2016, 7:00 AM), http://www.motherjones.com/environment/2016/01/future-parking-self-driving-cars/ ("Most experts I spoke to said governments should set policies that make fleet-based ride-sharing more appealing than individual car ownership. . . . The bottom line is, if urban officials want to make sure these technologies benefit civic life, they need to start talking about them now.").

15. *See infra* notes 213–15 and accompanying text.

16. *See* Daniel J. Fagnant, Kara M. Kockelman & Prateek Bansal, *Operations of Shared Autonomous Vehicle Fleet for Austin, Texas, Market*, Transp. Res. Rec. No. 2536, at 98, 98 (2015) ("This new mode is the shared autonomous (or fully auto-

yellow taxis, UberX, or Lyft services). SAVs may also include vehicles that offer rides to multiple passengers simultaneously, or "pooled" rides (analogous to today's UberPool or LyftLine services).

Underlying my entire discussion of SAVs is the basic premise, however, that moving the most people most efficiently—and indeed in the fewest vehicles possible—is beneficial to cities.[17] Where incentivizing SAVs is a reasonable proxy for achieving the goal of moving the most people in the fewest vehicles, then policies that directly encourage the adoption of SAVs are appropriate. However, where technology enables governments to be more fine-tuned in their approach—such as with road pricing systems that can accurately measure the number of people in a car—then cities could approach the goal of moving the most people in the fewest vehicles more directly. In addition, although I define SAVs to include for-hire vehicles that serve customers one at a time and also "pooled" rides, I do assume a policy preference for higher-occupancy rides. Therefore, to the extent that governments are able to take a fine-tuned approach to incentivize higher-occupancy, such as pooled SAV rides over exclusive-passenger SAV rides, they should also consider doing so.

Finally, policies that are intended to incentivize the adoption of SAVs relative to privately-owned vehicles should not be read as also intended to incentivize the adoption of SAVs relative to public transit. SAVs will certainly serve a purpose in the urban transportation mix, just as vehicle travel serves an essential function now—for example, filling in the gaps in the public transit system, and providing trips that are expensive for public transit to provide (such as trips in lower-density areas, or late-night trips).[18] However, to the extent that public transit remains the most effective means of moving the most people from point-to-point in dense urban areas, it should be prioritized over SAVs.[19]

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mated) vehicle (SAV), combining features of short-term, on-demand rentals with self-driving capabilities: in essence, a driverless taxi.").

17. As will also be argued, however, simply moving more people in fewer vehicles may not be beneficial if SAVs end up contributing to greater VMT and congestion. Therefore, complementary policies should be put in place to encourage moving the most people in the fewest vehicles while also preventing a rebound effect in which vehicle use is over-incentivized. *See infra* Section I.C & Part IV.

18. *See infra* note 205 accompanying text.

19. *See, e.g.*, REG'L PLAN ASS'N, *supra* note 1, at 2 ("There is a lot of talk about how AVs will disrupt transit. But there is no AV technology that can carry the sheer volume of passengers taking the same point-to-point trips that are served today by our transit systems in high-density areas."); *Transit's Role in Environmental Sustainability*, FED. TRANSIT ADMIN., U.S. DEP'T TRANSP., https://www.transit.dot.gov/regulations-and-guidance/environmental-programs/transit-environmental-sus-

B. SAVs vs. Privately-Owned Autonomous Vehicles

1. SAVs Scenario

There are at least two very different scenarios for the development of autonomous vehicles and their impact on vehicle usage and urban land use patterns. The main differentiating factor between these two scenarios is the question of whether individual consumers—on average—will primarily use fleets of SAVs (analogous to today's ride-hailing services) or rather will choose to own their own autonomous vehicles.

Under the shared vehicle scenario, on-demand fleets of SAVs would offer the majority of vehicle trips to passengers. There are reasons to believe a future of fleets of SAVs may be the most likely outcome for autonomous vehicles, even without government intervention. Autonomous vehicles will be costly to produce when they are first introduced, and it is expected that the only autonomous vehicles that will be viable in the market will be vehicles that have high rates of utilization and profit.[20] For this reason, most companies that have announced timetables for the release of autonomous vehicles on the market have indicated that the autonomous vehicles will be used as part of ridesharing services.[21] In addition, rates of car ownership are already declining around the United States.[22] This trend is most apparent among millennials: the average number of vehicle miles traveled (VMT) by people ages sixteen to thirty-four decreased twenty-three percent between 2001 and 2009.[23] This age group is also much less likely than older generations to even be able to drive.[24] At the same time, younger generations are more likely to use on-demand rideshar-

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tainability/transit-role (last updated May 9, 2016) ("Public transportation can reduce the need for many separate trips by private vehicles in dense urban areas, replacing many separate emissions producing vehicles with fewer transit vehicles that generally emit less pollution on a per person basis.").

20. *See, e.g.*, *Difference Engine: The Long, Winding Road for Driverless Cars*, ECONOMIST (May 25, 2017), https://www.economist.com/news/science-and-technology/21722628-forget-hype-about-autonomous-vehicles-being-around-cornerreal-driverless-cars-will [hereinafter *Difference Engine*].

21. However, one company, Tesla, also envisions a future in which privately-owned personal vehicles could be used to offer for-hire rides when the owners are not using their car, thus generating revenue for the owners. Therefore, it is possible that some autonomous vehicles may end up being hybrids—both an SAV and a personal vehicle. *See* Jon Gertner, *Tesla's Dangerous Sprint into the Future*, N.Y. TIMES MAG. (Nov. 7, 2017), https://nyti.ms/2j5UkYx.

22. *See* Thompson, *supra* note 14.

23. BENJAMIN DAVIS, TONY DUTZIK & PHINEAS BAXANDALL, TRANSPORTATION AND THE NEW GENERATION 1, 2, 7 (2012).

24. *See* Thompson, *supra* note 14.

ing services—around seventy-percent of Uber's customers are under thirty-four years old.[25] The rapid growth of today's ridesharing services indicates a strong market for a potential fleet-based future.[26]

2. *Privately-Owned Autonomous Vehicle Scenario*

Although autonomous vehicles might be predominantly used in ridesharing services initially, if manufacturing prices come down, as it is expected they might,[27] individual ownership of autonomous vehicles may become eventually more viable on a mass consumer basis. At least one autonomous vehicles maker—Tesla—is expressly envisioning a future that features private ownership of autonomous vehicles.[28] Commentators warn that—for all the rosy predictions that SAVs will reduce car ownership and lead to greater urban density—privately-owned autonomous vehicles could actually have the opposite effect. If residents do choose to own their own autonomous vehicles, they might drive them even longer distances on a regular basis than they do now. One of the central promises of autonomous vehicles is that, instead of paying attention to driving, former-drivers will now be passengers, and thus able to devote their attention to other activities.[29] This ability to focus on alternative activities may increase com-

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25. *See id.* Uber itself certainly believes that ridesharing services are reducing the need for car ownership. *See* Kate Galbraith, *Are Uber and Lyft Helping or Hurting the Environment?*, GUARDIAN (Jan. 21, 2016, 7:00 PM), https://www.theguardian.com/environment/2016/jan/21/uber-lyft-helping-hurting-environment-climate-change ("Uber emphasizes that it is helping to reduce the need for personal car ownership. 'Uber helps use today's existing infrastructure more efficiently at no extra cost by getting more butts into the backseats of fewer cars,' a company spokesperson says.").

26. *See* COMM. FOR REVIEW OF INNOVATIVE URBAN MOBILITY SERVS., NAT'L ACADS. OF SCIS., BETWEEN PUBLIC AND PRIVATE MOBILITY: EXAMINING THE RISE OF TECHNOLOGY-ENABLED TRANSPORTATION SERVICES 13 (2015) ("The growth of [Transportation Network Companies (TNCs)] has been rapid, even meteoric . . . .").

27. *See* TODD LITMAN, VICTORIA TRANSP. POL'Y INST., AUTONOMOUS VEHICLE IMPLEMENTATION PREDICTIONS 7, 16 (2018) (predicting that autonomous vehicles will be available only at a large price premium in the 2020s, but will cheap enough so as to be available with a moderate price premium by the 2030s and a standard feature included in most new vehicles by the 2050s).

28. *See* David Dudley, *The Guy from Lyft Is Coming for Your Car*, CITYLAB (Sept. 19, 2016), https://www.citylab.com/transportation/2016/09/the-guy-from-lyft-is-coming-for-your-car/500600/.

29. *See* Matthew Gillespie, *Shifting Automotive Landscapes: Privacy and the Right to Travel in the Era of Autonomous Motor Vehicles*, 50 WASH. U. J.L. & POL'Y 147, 158 (2016) ("Further, even the time spent in AMVs would be more productive than time spent in manual vehicles, as users could read, use phones, or even use laptops without fear of jeopardizing their or others' safety.").

muters' tolerance for long commutes, encouraging them to live farther away from their workplaces and leading to more sprawl.[30]

Although there are reasons to believe that the SAVs scenario is most likely to occur within New York City, there is certainly cause for concern that the private ownership scenario could take hold. New York has the lowest rate of private car ownership among the thirty largest U.S. cities.[31] Less than twenty-three percent of households in Manhattan, and around forty-four and forty-one percent of households in Brooklyn and the Bronx, respectively, own at least one car.[32] This

30. *See* JAMES M. ANDERSON ET AL., RAND CORP., AUTONOMOUS VEHICLE TECHNOLOGY: A GUIDE FOR POLICYMAKERS xv (2016) ("AV technology . . . will likely decrease the cost of time in a car because the driver will be able to engage in alternative activities. Another effect of this may be to increase commuter willingness to travel longer distances to and from work. . . . AVs could lead to more dispersed and low-density patterns of land use surrounding metropolitan regions."); David Levinson, *Climbing Mount Next: The Effects of Autonomous Vehicles on Society*, 16 MINN. J.L. SCI. & TECH. 787, 804 (2015) ("As acceptable trip distances increase, we would expect a greater spread of origins and destinations (pejoratively, sprawl), just as commuter trains today enable exurban living or living in a different city."); Bryant Walker Smith, *Managing Autonomous Transportation Demand*, 52 SANTA CLARA L. REV. 1401, 1417 (2012) [hereinafter Smith, *Managing Demand*] ("Because of this lower time-cost, autonomous driving may nonetheless encourage suburban sprawl by increasing the acceptable commuting distance. . . . [I]f workers could sleep or work in their cars, they may be willing to live further from their jobs."); Allison Arieff, *Driving Sideways*, N.Y. TIMES: OPINIONATOR (July 23, 2013, 9:00 PM), https://opinionator.blogs.nytimes.com/2013/07/23/driving-sideways/?_r=0 ("[E]ndeavoring to make car travel so effortless feels like a gracious invitation to endless suburban sprawl. If you can read your iPad, enjoy a cocktail or play a video game while commuting, time spent in the car becomes leisure time, something desirable. Long commutes are no longer a disincentive."); Nick Bilton, *Disruptions: How Driverless Cars Could Reshape Cities*, N.Y. TIMES: BITS (July 7, 2013, 11:00 AM), https://bits.blogs.nytimes.com/2013/07/07/disruptions-how-driverless-cars-could-reshape-cities/ ("People might be more open to a longer daily commute, leading to even more urban sprawl."). In addition, some transportation experts fear that individually-owned autonomous vehicles could exacerbate congestion, in part because of the potential for "zero occupancy cars" clogging the streets—driving to pick up their owners or do errands. *See* Laura Bliss, *Even Shared Autonomous Vehicles Could Spell Traffic Disaster*, CITYLAB (May 10, 2017), https://www.citylab.com/transportation/2017/05/even-shared-autonomous-vehicles-could-spell-traffic-disaster/525951/.

31. OFF. OF THE MAYOR, CITY OF N.Y., FOR-HIRE VEHICLE TRANSPORTATION STUDY 1 (2016); Bernie DeGroat, *Hitchin' a Ride: Fewer Americans Have Their Own Vehicle*, MICH. NEWS (Jan. 23, 2014), http://ns.umich.edu/new/releases/21923-hitchin-a-ride-fewer-americans-have-their-own-vehicle (describing a 2014 analysis conducted by Michael Sivak of the University of Michigan Transportation Research Institute (UMTRI)).

32. *See* LAWRENCE D. BURNS ET AL., EARTH INST., COLUMBIA UNIV., TRANSFORMING PERSONAL MOBILITY 21 (2013); *New Yorkers and Cars*, N.Y.C. ECON. DEV. CORP.: STATSBEE'S BLOG (Apr. 5, 2012) [hereinafter NYCEDC], https://www.nycedc.com/blog-entry/new-yorkers-and-cars.

compares to ninety-two percent of households nationally.[33] Nonetheless, once accounting for Queens and Staten Island—which both have much higher car ownership rates—nearly half (over forty-five percent) of New York City households own at least one car.[34] As Nate Silver and Reuben Fischer-Baum point out, "[c]ar ownership is not as uncommon in New York as you might infer from media portrayals of life in Manhattan or well-off neighborhoods of Brooklyn."[35]

	Number of households	**Percent car ownership**	**Number of car-owning households**
Bronx	490,740	41%	201,970
Brooklyn	938,803	44%	414,389
Manhattan	753,385	23%	171,285
Queens	779,304	63%	487,324
Staten Island	166,014	83%	137,047
Total	3,128,246	45%	1,412,015

* Source: HOUSEHOLD SIZE BY VEHICLES AVAILABLE: 2012–2016 AMERICAN COMMUNITY SURVEY 5-YEAR ESTIMATES, U.S. CENSUS BUREAU (2016).

TABLE 1

Perhaps the most significant promise of autonomous vehicles is greater safety due to the elimination of human error: automated vehicles are expected to get into far fewer accidents.[36] With fewer colli-

33. *See* NYCEDC, *supra* note 32.

34. *See infra* Table 1; Nate Silver & Reuben Fischer-Baum, *Public Transit Should Be Uber's New Best*, FIVETHIRTYEIGHT (Aug. 28, 2015, 6:30 AM), https://fivethirtyeight.com/features/public-transit-should-be-ubers-new-best-friend/ ("[A]lmost half of New York households own a car . . . .").

35. Silver & Fischer-Baum, *supra* note 34.

36. The most frequently touted benefit for autonomous vehicles is safety. There are 34,000 annual deaths from car accidents in the United States (out of 1.24 million deaths globally) and ninety percent of them are caused by human error. *See* Lari et al., *supra* note 1, at 750–52; Brodsky, *supra* note 1, at 852. In economic terms, the annual cost of all crashes—fatal or otherwise—is estimated to be around $300 billion. DANIEL J. FAGNANT & KARA M. KOCKELMAN, ENO CTR. TRANSP., PREPARING A NATION FOR AUTONOMOUS VEHICLES 3 (2013) [hereinafter FAGNANT & KOCKELMAN ENO 2013]. Autonomous cars carry the promise to cut down on accidents caused by human factors, such as distraction, drowsiness, drunkenness, and driver error. *See* Gillespie, *supra* note 29, at 158; Adam Thierer & Ryan Hagemann, *Removing Roadblocks to Intelligent Vehicles and Driverlesscars*, 5 WAKE FOREST J.L. & POL'Y 339, 352 (2015). In terms of quantifying the total economic benefits from autonomous vehicles, the Eno Center for Transportation ("Eno") estimates that autonomous vehicles—at ten percent market penetration—would save 1000 lives per year. FAGNANT & KOCKELMAN ENO 2013, *supra*, at 30. In economic terms, Eno estimates that autono-

sions, it is likely that car insurance rates will decrease.[37] For the same reason, cars will need fewer repairs throughout their product-lives, which will reduce maintenance costs.[38] Tesla's Chief Executive Officer is also expecting that owners of autonomous vehicles could also send their cars to pick up for-hire passengers when they are not using the vehicle themselves, thus generating revenue and defraying the costs of purchasing a car. Autonomous vehicle technology could therefore reduce the overall costs of car ownership, which would further incentivize the use of privately-owned vehicles. The implication for New York City is that, by lowering the overall costs of car ownership, autonomous vehicles could induce more New Yorkers to purchase their own vehicles and actually increase the rate of car ownership.[39]

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mous technology could save the U.S. economy $25 to $450 billion annually (depending on market penetration), and a significant proportion of the savings would surely be attributed to improved vehicle safety. *Id.* at 17; *see also* NAT'L HIGHWAY TRAFFIC SAFETY ADMIN., *supra* note 5, at 5 ("For DOT, the excitement around highly automated vehicles (HAVs) starts with safety. . . . [A]utomated driving innovations could dramatically decrease the number of crashes tied to human choices and behavior."); Ticoll, *supra* note 1, at 24 ("Generally the literature predicts 50–90% safety improvement from AVs—rising with the level of adoption."). However, recent events like a fatal crash in Arizona involving an autonomous vehicle operated by Uber provide a sober reminder that autonomous driving is still a developing technology, and that it might be years until we realize the safety benefits touted by industry leaders. *See* Troy Griggs & Daisuke Wakabayashi, *How a Self-Driving Uber Killed a Pedestrian in Arizona*, N.Y. TIMES (March 21, 2018), https://www.nytimes.com/interactive/2018/03/20/us/self-driving-uber-pedestrian-killed.html.

37. *See* Lari et al., *supra* note 1, at 755 ("SDVs could also have important implications for the operating costs of vehicles. Most notably, car repairs and maintenance costs may go down as a result of fewer accidents and more appropriate and efficient vehicle operation. Safer vehicles and a safer U.S. fleet overall could put downward pressure on insurance prices if policies continue to be bought and sold as they are now."); Brodsky, *supra* note 1, at 866 ("Fundamentally, 'lower losses lead to [a] lower premium,' and if manufacturers of autonomous vehicles can achieve lower accident rates, insurance premiums should decrease, and consumers will happily pay lower costs.").

38. This is far from a trivial concern. Some commentators argue that the average person prefers the privacy and comfort of a car, and only uses other forms of transportation—like public transit—when they are clearly cheaper or faster. If the costs of car ownership decrease, and if there are realized gains to travel time from more efficient driving patterns, it is conceivable that car ownership will become more, not less, attractive to consumers. *See* Conor Dougherty, *Self-Driving Cars Can't Cure Traffic, but Economics Can*, N.Y. TIMES: THE UPSHOT, Mar. 8, 2017, at B1 ("[T]he average person prefers the privacy and convenience of riding in a car. Only when the drive is far enough or the traffic is bad enough—or a taxi costs enough—will more people choose to bike, car-pool, hop on a train or postpone a trip.").

39. Another potential development—but not the focus on this Note—is that countervailing forces at work in urban cores and the surrounding areas could lead to greater use of shared vehicles in urban cores and greater use of privately-owned vehicles in the surrounding regions. Outside the urban core, residents could decide to live

3. *Benefits of SAVs*

Although vehicles undoubtedly confer benefits on their users, car ownership and usage also carry significant societal costs that are largely external to individual drivers, including environmental damage from vehicle emissions, and the foregone value of land dedicated to vehicle infrastructure and parking.[40] SAVs have the potential to mitigate some of these costs by reducing the total number of cars in circulation, reducing the environmental costs of car travel, and creating significant "infill" opportunities due to a reduction in the need for car parking and infrastructure.[41]

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farther and farther away from work due to a greater tolerance for longer commutes—thus increasing sprawl. At the same time, inside the city, a reduction in the need for parking could lead to greater density as urban space is reclaimed for more housing. *See* ANDERSON ET AL., *supra* note 30, at xv–xvi.

40. *See* Brodsky, *supra* note 1, at 851–52 ("[T]he enormous social utility of automobiles comes with a surprisingly large societal cost. . . . Vehicle emissions take a huge toll on our environment. Our cities are . . . far less walkable. . . . [T]raffic accidents cost American households $836 billion every year, and traffic jams alone cost $124 billion."); *see generally Transportation Costs & Benefits*, VICTORIA TRANSP. POL'Y INST. TDM ENCYCLOPEDIA, http://www.vtpi.org/tdm/tdm66.htm (last updated Feb. 27, 2017).

41. Note that I am only discussing the benefits of SAVs *relative* to individually-owned autonomous vehicles, and I am not discussing benefits of autonomous vehicles that would accrue with either shared or privately-owned vehicles. Therefore, and importantly, this Note will not discuss potential labor reductions due to autonomous vehicles. However, it is crucial for policymakers to keep in mind the potential disruption to the labor market that could be caused by autonomous vehicles. Thompson, *supra* note 14 ("[M]illions of taxi, delivery, and long-haul trucking jobs that traditionally have gone to new immigrants and low-education workers could vanish within a few years. Labor activists and economists are understandably alarmed at the prospect."). The need for drivers will clearly be reduced—including truck and delivery drivers, which, according to Census Data, is the most common job in twenty-nine states. *See* Quoctrung Bui, *Map: The Most Common* Job in Every State*, NAT'L PUB. RADIO: Planet Money (Feb. 5, 2015, 3:31 PM), http://www.npr.org/sections/money/2015/02/05/382664837/map-the-most-common-job-in-every-state; Olivia Solon, *Self-Driving Trucks: What's the Future for America's 3.5 Million Truckers?*, GUARDIAN (June 17, 2016 7:00 PM), https://www.theguardian.com/technology/2016/jun/17/self-driving-trucks-impact-on-drivers-jobs-us. Moreover, jobs in industries less-visibly tied to the current automobile market may similarly be significantly impacted, including, for example, the car insurance industry. *See* Jamie Lincoln Kitman, Opinion, *Google Wants Driverless Cars, but Do We?*, N.Y. TIMES, Dec. 19, 2016, at A21 ("Millions of truck and taxi drivers will be out of work, and owing to the rise of car-sharing and app-based car services, people may buy fewer vehicles, meaning automakers and their suppliers could be forced to shed jobs."). In addition, a primary benefit of autonomous vehicles—safety—is not discussed at length, because it would likely be realized under any scenario of autonomous vehicles. Similarly, this Note also does not discuss the prediction that automated driving technology could be a benefit to mobility-impaired individuals, such as youth, elderly, and disabled individuals. *See, e.g.*, ANDERSON ET AL., *supra* note 30, at xv.

i. Land Use and City Planning Benefits of SAVs

a. Cutting the Number of Cars in Circulation

Under the scenario in which SAVs dominate the vehicle mix, the total number of cars on New York City roads could dramatically decrease. In a model of Lisbon, Portugal, conducted by Organization for Economic Cooperation and Development (OECD), researchers predict that in a scenario where the transportation mode includes fleets of ridesharing autonomous vehicles combined with high-capacity public transport, ninety percent of cars could be removed from the streets without changing the level of mobility.[42] A model conducted based on conditions in Austin, Texas predicts that each SAV could replace almost twelve traditional vehicles.[43] A model of Singapore predicts that, if SAVs replace the entire current private vehicle stock in Singapore, there could be a two-thirds reduction in the number of vehicles for the same total number of trips.[44] Finally, a similar model of Toronto predicts a sixty-five percent reduction in the number of cars entering the city if eighty percent of privately-owned vehicles are replaced by autonomous taxis.[45]

Even under the ownership scenario, it is still possible that the total number of vehicles in circulation could decrease, because a household could use a single car to serve multiple household members throughout the day. For example, an autonomous vehicle could drop one household member off at work, drop another off at school, return home to drive a third household member to do errands, and even pick

42. INT'L TRANSP. FORUM, ORG. FOR ECON. COOPERATION & DEV., URBAN MOBILITY SYSTEM UPGRADE: HOW SHARED SELF-DRIVING CARS COULD CHANGE CITY TRAFFIC 19 (2015) [hereinafter OECD]; Thompson, *supra* note 14.

43. *See* OECD, *supra* note 42, at 9; Fagnant, Kockelman & Bansal, *supra* note 16, at 98 (finding, in a modeling of Austin, Texas, that fleet-based autonomous vehicles could "replace about nine conventional vehicles . . . while still maintaining a reasonable level of service"); Thompson, *supra* note 14.

44. OECD, *supra* note 42, at 10 (citing Kevin Spieser et al., *Toward a Systematic Approach to the Design and Evaluation of Automated Mobility-on-Demand Systems: A Case Study in Singapore*, *in* ROAD VEHICLE AUTOMATION (Gereon Meyer & Sven Beiker eds., 2014)).

45. Ticoll, *supra* note 1, at 21 (finding that 650,000 fewer cars would enter Toronto daily under a fleet-based system than under an ownership-based system). Models of non-autonomous ridesharing have also found similar car-reduction results. For example, a modeling of non-autonomous ridesharing in Boston predicts that a ten percent adoption rate of ridesharing among car drivers and non-car-drivers would result in around two percent fewer cars on the road. Lauren P. Alexander & Marta C. González, Assessing the Impact of Real-time Ridesharing on Urban Traffic Using Mobile Phone Data 7 (Aug. 10, 2015) (unpublished manuscript), http://www2.cs.uic.edu/~urbcomp2013/urbcomp2015/papers/Real-time-Ridesharing_Alexander.pdf.

up for-hire passengers.[46] However, even if the number of cars per household were to decrease, the ownership scenario would likely not match the reductions in the total number of vehicles predicted under the SAVs scenario.

Reductions in the number of vehicles in circulation could have a significant impact on land use in New York City. Even though New York has lower overall rates of car ownership than any other major U.S. city, its significantly greater urban density means that New York City has a greater *concentration* of vehicles than cities like Los Angeles and Houston: New York City has nearly 6100 vehicles per square mile, compared to 4300 in Los Angeles, and 1900 in Houston.[47] Lowering the number of vehicles in New York City could therefore be quite impactful, and the benefits could include reducing the amount of space needed for vehicle infrastructure and parking.

b. Reduced Need for Parking

As explained above, one of the greatest consequences of a reduction in car ownership and in the total number of vehicles on the road would be a corresponding reduction in the need for parking.[48] If fewer people own cars, and there are fewer total cars in circulation, we would expect the need for parking to decrease.[49] This shift could be drastic, however, if we also consider that—in the SAV scenario—the cars that *are* in circulation will remain more or less consistently in motion as they move from passenger to passenger, and will therefore rarely need to park. To the extent that the shared vehicles do need to park, they could drive themselves to a centralized location on the out-

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46. *See* Lari et al., *supra* note 1, at 754–55 ("With the SDV's ability to direct itself to different locations[ ] . . . idle hours could become useful to others. These others might be within the family, reducing the number of cars per household . . . ."); Dudley, *supra* note 28.

47. *See* VICKI BEEN ET AL., N.Y.U. FURMAN CTR. & INST. FOR AFFORDABLE HOUSING POL'Y, SEARCHING FOR THE RIGHT SPOT: MINIMUM PARKING REQUIREMENTS AND HOUSING AFFORDABILITY IN NEW YORK CITY 7 (2012).

48. *See, e.g.*, Lari et al., *supra* note 1, at 758 ("If SDVs can use the idle time or park themselves away from city centers, there might be less need for parking spaces in urban areas. An increase in available space due to a reduction in parking could free up space for other purposes, like housing or commerce. In this case, SDVs would combat urban sprawl and provide more useful land for living spaces.").

49. Ticoll, *supra* note 1, at 6 ("Mobility services may lead to a dramatic decline in vehicle ownership. Simulation models suggest that most road and off-road parking may eventually disappear."); Thompson, *supra* note 14 ("[M]any urbanists predict that fleets of robocars could become so reliable that many, many people would choose not to own automobiles, causing the amount of parking needed to drop through the floor.").

skirts of the city to do so.[50] Individuals would therefore not require parking where they lived or at their destinations if SAVs were the dominant vehicle-mode.

Combined, these factors should free up a tremendous amount of space within our cities. Under some estimates, a range of eight to eleven parking spaces could be eliminated per SAV.[51] To give some context, it is estimated that the total area of the one billion parking spaces in the United States is bigger than the state of Connecticut.[52] Thirty-one percent of commercial downtown cores in the United States are paved over for parking.[53] In New York City, there are around 102,000 parking spaces in Manhattan below 60th Street, representing 18.4 million square feet.[54] Needless to say, this is extremely valuable land in a growing city.[55] The extra space achieved from reclaiming parking infrastructure could serve as a major boon and lead to the development of additional housing, schools, and parks—sometimes referred to as "infill" opportunities.[56] This could in turn lead to greater density within urban cores, especially if the extra space is converted into more housing units.[57] The increased housing supply could

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50. Thompson, *supra* note 14.

51. *See* Daniel Fagnant & Kara M. Kockelman, *The Travel and Environmental Implications of Shared Autonomous Vehicles, Using Agent-Based Model Scenarios*, 40 TRANSP. RES. 1, 8 (2014) [hereinafter Fagnant & Kockelman 2014]; Fagnant, Kockelman & Bansal, *supra* note 16, at 105; OECD, *supra* note 42, at 9 ("Each SAV would . . . lead to the elimination to [sic] 11 parking spaces per SAV in operation.").

52. *See* Thompson, *supra* note 14.

53. *See id.*; Bilton, *supra* note 30 ("Harvard University researchers note that as much as one-third of the land in some cities is devoted to parking spots.").

54. Thompson, *supra* note 14.

55. *See, e.g.*, Evan Bindelglass, *How Much Is All of the Land In Manhattan Worth?*, CURBED N.Y. (Jan. 7, 2016, 12:45 PM), http://ny.curbed.com/2016/1/7/10849000/how-much-is-all-of-the-land-in-manhattan-worth; C.J. Hughes, *The Dirt on NYC's Soaring Land Values*, REAL DEAL (Apr. 1, 2015, 11:58 AM), https://therealdeal.com/issues_articles/486631/.

56. *See, e.g.*, Levinson, *supra* note 30, at 805 ("[S]paces now devoted to cars can be repurposed. Garages can become accessory dwelling units. Gas stations and parking lots and structures can see a new higher and better use."); Bilton, *supra* note 30 ("Inner-city parking lots could become parks."); Thompson, *supra* note 14 ("[A]ll that paved-over space suddenly freed up for houses and schools, plazas and playgrounds, or just about anything.").

57. *See* ANDERSON ET AL., *supra* note 30, at xvi ("In metropolitan areas, however, it may lead to increased density as a result of the decreased need for proximate parking. . . . [F]ewer parking spaces would be necessary and would permit greater development of cities."); Lari et al., *supra* note 1, at 758 ("[S]everal reports and studies note the percentage of time that vehicles spend parked and the percentage of urban landscapes taken up by parking spaces, lots, and ramps. . . . An increase in available space due to a reduction in parking could free up space for other purposes, like housing or commerce. In this case, SDVs would combat urban sprawl and provide more useful land for living spaces."); *see also* REG'L PLAN ASS'N, *supra* note 1, at 5

bring down the overall price of housing.[58] In addition, the clear lack of a need for minimum parking requirements in cities' zoning codes could lead policymakers to eliminate these requirements altogether. This could bring down the cost of residential development, which would be passed onto consumers in the form of lower rents.[59] For example, an analysis of the Seattle housing market concluded that an oversupply of parking undermined housing affordability, and calculated that at least fifteen percent of housing developers' costs came from the need to build parking.[60] Not only would the housing supply likely increase with the extra space afforded by fewer parking spaces, but developers' overall costs might decrease as well. Both factors would place a downward pressure on the average price of housing in the city.

Either scenario for autonomous vehicles would possibly result in some reduction in the need for space devoted to parking. Even in an ownership scenario, rather than owners needing to park their cars themselves in a parking lot or on the street, they could depart the vehicles at their destinations, and then have their cars park themselves, most likely in centralized locations.[61] Without the need to let out a passenger at the centralized parking location, the cars could also park themselves closer together. These efficiency gains could result in a

("[Parking lots] will become available for alternative use [and] development once AVs are fully established. Governments should reclaim this space to help relieve the housing affordability crisis in our region by adding housing and requiring mixed-income developments."). Note that economists such as Edward Glaeser argue that there are economic and environmental benefits attendant to greater density and urban agglomeration. *See, e.g.*, Edward L. Glaeser, *Demand for Density?: The Functions of the City in the 21st Century*, BROOKINGS (June 1, 2000), https://www.brookings.edu/articles/demand-for-density-the-functions-of-the-city-in-the-21st-century/; *see generally* EDWARD L. GLAESER, TRIUMPH OF THE CITY: HOW OUR GREATEST INVENTION MAKES US RICHER, SMARTER, GREENER, HEALTHIER, AND HAPPIER (2011). However, greater density could lead to more cong estion absent concurrent policies to reduce VMT and promote efficient transportation modes. For a discussion of such policies, see *infra* Part IV.

58. *See* Bilton, *supra* note 30 ("Some city planners expect that the cost of homes will fall as more space will become available in cities.").

59. *See, e.g.*, Yonah Freemark, *Will Autonomous Cars Change the Role and Value of Public Transportation?*, TRANSPORT POLITIC (June 23, 2015), http://www.thetransportpolitic.com/2015/06/23/will-autonomous-cars-change-the-role-and-value-of-public-transportation/.

60. JESSE LONDON & CLARK WILLIAMS-DERRY, SIGHTLINE INST., WHO PAYS FOR PARKING?: HOW THE OVERSUPPLY OF PARKING UNDERMINES HOUSING AFFORDABILITY 1 (2013).

61. *See* Thompson, *supra* note 14.

reduction in parking needs overall.[62] Nevertheless, privately-owned autonomous vehicles would still need to park; shared vehicles—which would rarely, if ever, need to park—would lead to much greater reductions in the need for parking infrastructure.

ii. Environmental Benefits

As discussed *infra* in Section I.C.1, total vehicle miles travelled (VMT) may increase with the adoption of SAVs relative to today's levels. However, even assuming this increase in VMT, researchers have predicted that there may still be environmental benefits to SAVs.[63] For example, in a model of a mixed environment of shared autonomous and traditional non-autonomous vehicles in Austin, TX, Fagnant and Kockelman determined that although overall distance traveled would increase by eleven percent under an SAV scenario, there would still be 5.6% fewer greenhouse gas emissions.[64] The environmental gains are typically attributed in part to predictions that autonomous vehicles in general may exhibit more fuel-efficient driving patterns.[65] In addition—specifically in the SAVs scenario, because of more extensive use per vehicle—it is predicted that SAVs will have a shorter lifespan, such that they may need to be replaced every few years.[66] The greater amount of travel per vehicle will also cause oper-

62. *See id.* ("Since nobody would need to get in or out of [the vehicles] after they parked, they could position themselves as snugly together as Tetris bricks, fitting far more cars into our existing parking lots and garages.").

63. For example, Greenblatt and Saxena hypothesize that factors such as greater adoption of fuel-efficient technologies (i.e., battery-electric technology) and "right-sizing" of vehicles (i.e., a two-person trip would require a two-person vehicle), would lead to substantial greenhouse gas emissions reductions. *See* Jeffery B. Greenblatt & Samveg Saxena, *Autonomous Taxis Could Greatly Reduce Greenhouse-Gas Emissions of US Light-Duty Vehicles*, 5 NATURE CLIMATE CHANGE 860, 860 (2015) ("[Autonomous taxis] could enable [greenhouse gas] reductions even if total VMT, average speed and vehicle size increased substantially.").

64. OECD, *supra* note 42, at 10 (citing Fagnant & Kockelman 2014, *supra* note 51).

65. *See* Bryant Walker Smith, *How Governments Can Promote Automated Driving*, 47 N.M. L. REV. 99, 126 (2017) [hereinafter Smith, *Governments Promoting*] ("Automated driving could conceivably increase fuel efficiency by reducing crashes, smoothing speeds and flows, and enabling drag-reducing platoons."); Fagnant & Kockelman 2014, *supra* note 51, at 11 (describing that in their model, "[shared autonomous vehicles] were assumed to be relatively fuel-efficient vehicles"); Levinson, *supra* note 30, at 805–06 ("Fuel costs . . . should be lower, as autonomous vehicles are likely to be more efficient, . . . due to . . . more optimized driving styles (ranging from smoother acceleration to various hypermiling techniques like drafting to reduce drag)."); Greenblatt & Saxena, *supra* note 63, at 861 ("AVs could reduce energy use per vehicle . . . from platooning, efficient traffic flow[, etc.]").

66. *See* Levinson, *supra* note 30, at 808 ("Obtaining better capital utilization out of our surface transportation fleet (like the airlines have achieved with planes that are in

ating costs, including fuel, to "dominate total ownership cost," creating a "powerful financial incentive favouring energy efficient vehicles."[67] The combination of a pressure to lower operating costs and a quicker rate of replacement per vehicle could mean that newer, fuel-efficient technologies spread quickly throughout fleets of SAVs.[68] If this cost-incentive results in the fleets becoming electric-powered, then the environmental benefits will be even more enhanced.[69] One model predicts that if all cars become electric and autonomous, we will see a ninety percent decline in car-related greenhouse gas emissions.[70]

Finally, it is possible that SAVs will be smaller than current vehicles, both because they will be safer and therefore can be built lighter, and because they may be "right-sized" to each trip. For example, because the cars will be fleet-based rather than privately owned, no one will be tied to a single car-type; when someone travels alone, he or she will require only a one-person-sized vehicle. Two people will require a two-person-sized vehicle, and so on. As of 2009, the average vehicle occupancy in the United States was 1.63 passengers, and sixty-two percent of total VMT involved only one passenger. Although efforts should be made to encourage higher-occupancy trips, if more of these lower-occupancy trips were "right-sized," there could be a prevalence of smaller, lighter vehicles on the road, which in turn could lead to additional fuel savings.[71]

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motion as much as possible) through [shared autonomous vehicles] will reduce the lifespan of cars by using fewer vehicles more intensively, and wearing them out sooner. Thus, [shared autonomous vehicles] will on average be newer than today's fleet.").

67. Greenblatt & Saxena, *supra* note 63, at 861 ("[Shared autonomous vehicles], like conventional taxis, are estimated to travel annually roughly three to six times farther than [conventionally driven vehicles], resulting in operating expenses (fuel, maintenance, insurance) that dominate total ownership cost. The consequence is a powerful financial incentive favouring energy-efficient vehicles.").

68. The theory why each successive fleet would be more fuel efficient than the prior fleet is that SAVs will be in motion for nearly all their lifespans, and operating costs will be a huge portion of the total ownership cost. Therefore, there will be an even greater incentive than there is now to develop fuel efficient technologies to lower these operating costs. This pressure to drop operating costs, plus a shorter lifetime of vehicles (and thus the ability to replace older vehicles more quickly with new vehicles equipped with newer, more fuel-efficient technology) is why some analysists believe that fuel efficient technologies will be more quickly spread throughout SAV fleets. *See* OECD, *supra* note 42, at 10; Greenblatt & Saxena, *supra* note 63, at 861. Note, however, that the faster rate of vehicle replacement and manufacture could lead to higher emissions levels during the production of autonomous vehicles, perhaps mitigating some of the emission reductions of the more fuel-efficient vehicles.

69. *See* OECD, *supra* note 42, at 10.

70. *See* Thompson, *supra* note 14 (citing Greenblatt & Saxena, *supra* note 63).

71. Greenblatt & Saxena, *supra* note 63, at 860–61.

C. The Danger of Increased VMT, Greater Congestion, and Declining Transit Ridership

Although SAVs may have benefits relative to privately-owned vehicles, they could also—absent policy intervention—lead to significant societal costs in the form of more total vehicle miles traveled, greater congestion, and a reduction in public transit ridership.[72]

1. Increased VMT

Many theoretical models and commentators predict that overall VMT may increase with the adoption of autonomous vehicles, with estimates ranging from modest to major increases.[73] For example, the OECD modeling of Lisbon estimated that with SAVs that offer "pooled" rides and the retention of high-capacity public transit, total VMT would increase by nine percent despite a significant reduction in the total number of vehicles in circulation.[74] On the flip side, OECD found that a combination of sequential-passenger SAVs and *no* high-capacity public transit would increase total VMT by 103%.[75] In another simulation of SAVs in a mid-sized U.S. city (Ann Arbor, MI), researchers found that although there would be an eighty-five percent reduction in the number of cars needed, the overall vehicle miles would increase relative to today's levels due to the need to detour and reposition vehicles for drop-offs and pick-ups.[76]

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72. *See, e.g.*, REG'L PLAN ASS'N, *supra* note 1, at 3 (stating that "smart policies" for autonomous vehicles should "allow for innovations but also control for negative externalities, such as sprawl, congestion, and reduced public transportation ridership").

73. *See, e.g.*, Fagnant, Kockelman & Bansal, *supra* note 16, at 98, 101 (predicting that "as [shared autonomous vehicles] preemptively move to better serve current unserved and future anticipated demand (thus reducing traveler wait times), the total amount of unoccupied (empty vehicle) VMT grows, meaning that more relocation results in lower wait times but also in higher VMT"); Smith, *Managing Demand*, *supra* note 30, at 1402 ("[A]utomation could significantly increase motor vehicle travel . . . ."). For example, some commentators do predict that, with a reduction in the need for parking, the amount of "cruising" that individual car owners must now do to find parking spaces will decrease. Thompson, *supra* note 14. However, even this reduction in cruising may be overshadowed by the extra vehicle miles added from the need for shared fleets to reposition themselves and pick up and drop off new passengers.

74. OECD, *supra* note 42, at 5.

75. *Id.*

76. *Id.* at 11 (citing BURNS ET AL., *supra* note 32, at 7) ("[T]he shared fleet could provide near instantaneous access to a vehicle servicing [residents'] request, but with only 15% of the vehicles currently needed to carry out these trips. However, overall travel would increase due to the need for repositioning vehicles."); *id.* at 9 ("After each trip, the [Shared Autonomous Vehicle] moves on to the next traveller or reposi-

Moreover, recent data on ride-hailing services—precursors to a potential future of SAVs—should give cause for concern. A 2017 national survey conducted by researchers at the Institute of Transportation Studies at the University of California, Davis, found that a majority (sixty-one percent) of ridesharing trips would not have been made at all if not for services like Uber or Lyft, or would have been made by walking, biking, or transit.[77] This finding suggests that ridesharing services may be adding to VMT nationally by expanding the number of trips taken by vehicles. Locally at the New York City level, ridesharing services have demonstrably added to VMT on city streets: from 2013 to 2016, ridesharing produced a net increase of 31 million vehicle trips and an additional 600 million miles of vehicular travel.[78] Moreover—and relevant to the discussion about SAVs—the increase in VMT has occurred even as ridesharing companies have promoted pooled options, such as UberPool and LyftLine, which were predicted (by the companies themselves) to decrease total VMT.[79]

Moreover, SAVs are expected to ultimately bring down the costs of operating ridesharing services: savings on labor expenses are expected to eventually outweigh vehicle costs (which will be higher than today's conventional vehicles, at least initially).[80] Indeed, these expected cost savings are undoubtedly one of the reasons ridesharing companies are investing so heavily in autonomous vehicle technology. In addition, some scholars suggest that, with the high numbers of vehicle miles traveled per SAV, there would be an even stronger economic incentive (on average) to bring down overall operating costs through the adoption of fuel-efficient technologies.

If these predictions come true, then some of the cost savings could translate into a downward pressure on the price of ridesharing

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tions itself to a more favourable location for lower cost parking and faster future passenger service.").

77. REGINA R. CLEWLOW & GOURI SHANKAR MISHRA, U.C. DAVIS INST. OF TRANSP. STUDIES, DISRUPTIVE TRANSPORTATION: THE ADOPTION, UTILIZATION, AND IMPACTS OF RIDE-HAILING IN THE UNITED STATES 26 (2017).

78. SCHALLER, UNSUSTAINABLE?, *supra* note 9, at 1.

79. *See id.* at 1 ("Since mid-2015 TNCs have offered and heavily promoted 'pooled' options such as UberPool and LyftLine. TNC mileage nonetheless continues to grow rapidly . . . ."); *id.* at 11 ("Mileage increases have occurred even with TNCs offering shared ride (or 'pooled') options that were designed to reduce overall vehicle mileage."); Galbraith, *supra* note 25.

80. *See, e.g.*, SCHALLER, EMPTY SEATS, *supra* note 11, at 18 ("[O]nce the costs of operating shared autonomous vehicles drops below the cost of human-driven TNC operations (taking into account higher vehicle costs but the absence of a driver in autonomous vehicles), fares are also likely to drop. Declines in fares will spur further growth, with impacts on both traffic volumes and transit ridership.").

services.[81] Lower fares for SAVs could thus potentially giving a boost to the already fast-growing industry of ridesharing fleets.[82] If this happens, we run the risk that more people will start to use vehicles as their default transit mode, thus increasing VMT.[83] This future risk may be even greater in New York City, where the fleet-based concept is more likely to be effective than in more dispersed areas because of shorter response times and greater variety of the nearby vehicle pool.[84]

However, other factors could depress the total miles traveled, specifically within the SAV scenario. For people who previously used to own and drive their own cars, SAVs could comparatively decrease the individual costs of driving by freeing up drivers' time to do other activities.[85] However, in the fleet-based model, the costs of taking a vehicle trip—just like the costs of using a taxi today—will become "variable and visible" for these former drivers. This price pressure could serve to cabin some of the increase in VMT.[86]

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81. *See* Greenblatt & Saxena, *supra* note 62, at 861.

82. *See* REG'L PLAN ASS'N, *supra* note 1, at 2 ("The expansion of AVs will continue to accelerate the adoption of transportation network company (TNC) services such as Uber, Lyft, and Chariot, by lowering the cost of providing these services."); Bliss, *supra* note 30 ("For customers, pooled rides mimic the automated experience—you summon the car, meander along an algorithm-generated route, and hop out—except that automated version will be cheaper.").

83. *See, e.g.*, SCHALLER, UNSUSTAINABLE?, *supra* note 9, at 5 ("Combining low fares and fast trip-making, shared autonomous vehicles could attract transit users, negating the congestion benefits."); Bliss, *supra* note 30 ("But what if this shared-and-automated future arrives, with its low cost and convenience, is so appealing that it becomes the default mode? Transit ridership could plummet. Riders who weren't driving at all before, whether by choice or by circumstance, could jump into backseats en masse.").

84. *See* Levinson, *supra* note 30, at 802 ("[Shared autonomous vehicles] will work better in urban areas than rural areas, as the response time will be shorter and size and variety of the nearby vehicle pool will be greater."). This dynamic is perhaps already playing out in the greater popularity and usage of ridesharing apps in urban areas versus rural or suburban areas. *See* COMM. FOR REVIEW OF INNOVATIVE URBAN MOBILITY SERVS., *supra* note 26, at 16 ("A greater percentage of those living in urban areas (about 8 percent) than of those living in suburban (4 percent) or rural (3 percent) areas reported frequent use of ridesharing applications."). However, some of this phenomenon could also be explained by lower rates of car ownership in cities, and thus a more consistent demand for ridesharing and taxis generally. *See* Silver & Fischer-Baum, *supra* note 34.

85. *See* ANDERSON ET AL., *supra* note 30, at 5 ("By reducing the time cost of driving, AVs may encourage greater travel and increase total vehicle miles traveled (VMT), which could lead to more congestion."); Lari et al., *supra* note 1, at 756 ("With less effort required to execute a trip, individuals may choose to take more trips.").

86. Lari et al., *supra* note 1, at 757 ("If the ownership model changed into that of a fleet, then most of the trip cost becomes variable and visible. . . . This may have a downward impact on vehicle miles traveled (VMT)."); *see* Levinson, *supra* note 30, at 802–03 ("While the average cost of car ownership, now a quite significant share of

2. *Congestion*

Some proponents of autonomous technology claim that, by increasing efficiency and capacity on our roads, autonomous vehicles will improve congestion, reduce traffic, and reduce travel times. For example, autonomous technology will enable vehicles to drive closer together with lower rates of accidents, thereby expanding the number of cars that can safely be on the same road at a single time.[87] However, increasing capacity on our roads has been held up before as a cure for traffic, and more roads and more lanes have only increased the demand for driving and invited more drivers to clog them up.[88] According to what has some writers have dubbed the "fundamental law of road congestion," people often choose to drive more when road capacity increases. The reason is that expanding the space available for driving—i.e., the supply of roadways—reduces the average cost of driving, thereby further increasing demand for driving.[89] Moreover, if SAVs increase the overall demand for vehicle travel—as it is suggested they might in Section I.C.1—then an increase in VMT could

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household expenses, goes to zero for those who join [a fleet-based] system, the out-of-pocket marginal cost per trip rises quite significantly. The implication is that there will be fewer trips once people give up on vehicle ownership. People paying by the minute or the mile will want to reduce trip distances.").

87. *See* Smith, *Managing Demand*, *supra* note 30, at 1422 ("In the near or long term . . . some of these benefits [of autonomous vehicles], such as a lower time-cost of travel and a higher vehicle capacity on some highways, may actually increase certain costs associated with congestion, emissions, and sprawl."); Levinson, *supra* note 30, at 796–97 ("Because they are safer, autonomous vehicles can have shorter headways[,] follow each other at a significantly reduced distance[, and] stay within much narrower lanes with greater accuracy. . . . Thus, capacity at bottlenecks should improve, both in throughput per lane and the number of lanes per unit road width."). Note that even though capacity is expected to increase, some predict that increased demand for driving will outpace gains to capacity. *See* Smith, *Managing Demand*, *supra* note 30, at 1409 ("Absent other phenomena, the total cost of motor vehicle travel is likely to decrease, and demand for that travel is likely to increase faster than corresponding capacity.").

88. *See supra* Section I.C.2; *see also* Dougherty, *supra* note 38 ("[H]istory gives us reasons to be skeptical. Decades' [sic] worth of studies show that whenever cities add roads, new drivers simply fill them up. This is not because of new development or population growth—although that's part of the story—but because of a vicious cycle in which new roads bring new demand that no amount of further roads can satisfy."); Bilton, *supra* note 30 ("'The future city is not going to be a congestion-free environment. That same prediction was made that cars would free cities from the congestion of horses on the street . . . .'" (quoting Bryant Walker Smith)).

89. Gilles Duranton & Matthew A. Turner, *The Fundamental Law of Road Congestion: Evidence from US Cities*, 101 AM. ECON. REV. 2616, 2618, 2619 (2011); *see also* Levinson, *supra* note 30, at 807 ("Generally, as the cost of travel declines, travel increases."); Adam Mann, *What's Up With That: Building Bigger Roads Actually Makes Traffic Worse*, WIRED (June 17, 2014, 6:30 AM), https://www.wired.com/2014/06/wuwt-traffic-induced-demand/.

entirely offset any gains in road capacity and lead to an overall increase in congestion.[90]

Increased congestion would carry a variety of familiar costs to cities. These include decreased economic efficiency as people, goods, and on-site services take longer to travel across the city, as well as increased fuel consumption and emissions.[91] The costs of congestion are felt even by people who don't use vehicles—the increased costs of moving goods and on-site services are passed onto consumers, and traffic congestion delays the movement of public buses and emergency vehicles, and impacts the safety of cyclists and pedestrians. Moreover, in New York City, traffic congestion is becoming an increasing concern as traffic speeds in Manhattan south of 60th Street declined twenty-three percent from 2010 to 2017, with an especially sharp drop in 2015 that coincided with a period of accelerated growth for ridesharing services.[92]

Although the future is uncertain with regards to the impact on VMT and congestion, policymakers should be mindful that SAVs could lead to greater VMT and congestion, and plan accordingly by implementing policies that ensure vehicle users internalize the costs of their own vehicle use.[93]

3. *Diminished Viability of Public Transit*

If SAVs lower the costs of vehicle travel,[94] and offer convenient and comfortable services, then they could siphon off riders who previously used public transit. To give an indication, today's ridesharing services may already be having a detrimental effect on public transit. A 2017 University of California, Davis national survey found that, after using ridesharing services, respondents reported a net six percent

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90. *See* SCHALLER, UNSUSTAINABLE?, *supra* note 9 at 5 ("Combining low fares and fast trip-making, shared autonomous vehicles could attract transit users, negating the congestion benefits.").

91. *See* VICTORIA TRANSP. POL'Y INST., *supra* note 40, at 11 ("Congestion costs consist of the incremental delay, stress, vehicle operating costs and pollution that results from each additional vehicle added to the traffic stream. . . .
[E]stimates indicate that total U.S. annual congestion costs, probably average about $100 billion.").

92. BRUCE SCHALLER, EMPTY SEATS, *supra* note 11 at 2–3 (2017); SCHALLER, UNSUSTAINABLE?, *supra* note 9, at 16 ("Manhattan traffic speeds dropped sharply in the spring of 2015, at the same time that Uber greatly accelerated its growth."); *see* Jim Dwyer & Winnie Hu, *Driving a Car in Manhattan Could Cost $11.52 Under Congestion Plan*, N.Y. TIMES, Jan. 18, 2018, at A1 ("The iPhone, released in 2007, led to an explosion of Uber and ride-hail cars that jam streets in Midtown and Lower Manhattan.").

93. *See infra* Part IV.

94. *See supra* notes 80–84 and accompanying text.

reduction in their use of public transit.[95] In New York City, ridesharing services became the leading source of growth in non-personal-car travel in 2015, effectively ending a period of transit-based growth dating back to 1990.[96] Subway ridership also declined in New York City in 2016 for the first time since 2009, and bus ridership declined for the third year in a row.[97] At the same time, ridership on ride-hailing services tripled between June 2015 and fall of 2016, and the total number of ridesharing vehicles and taxis in Manhattan south of 60th Street increased by fifty-nine percent from 2013 to 2017.[98]

The popularity of ridesharing services is just one factor likely contributing to a decline in transit ridership in New York City—the well-publicized woes of the subway system is surely another.[99] However, the concurrent rise in ridesharing ridership and the decline in public transit ridership suggests that at least part of the decline in transit ridership may likely be attributed to the rise in such ridesharing services.[100] This problem will only be compounded if the price of ridesharing services comes down any further with the introduction of SAVs.

Lower ridership levels could ultimately result in underinvestment in transit. Such an underinvestment could have detrimental effects on cities. Transit remains the most efficient means of moving the most people taking the same point-to-point trips, and it is also the most affordable of transportation for low-income residents.[101] Any worsening of transit service would raise serious equity concerns, as it would disproportionally impact lower-income riders who must rely on public

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95. *See* Clewlow & Mishra, *supra* note 77, at 27.

96. Schaller, Unsustainable?, *supra* note 9, at 1–2, 17.

97. *See id.* at 18; Emma G. Fitzsimmons, *Subway Ridership Declines in New York. Is Uber to Blame?*, N.Y. Times, Feb. 23, 2017, at A23. Moreover, some analysts also theorize that autonomous vehicles pose the risk of displacing public bus ridership almost entirely. In the OECD Lisbon study, researchers drew this conclusion based on the fact that average bus occupancy was already low, and they theorized that passengers would be better served by fleets of autonomous vehicles than by the bus system. OECD, *supra* note 42, at 20.

98. *See* Schaller, Empty Seats, *supra* note 11, at 6; Schaller, Unsustainable?, *supra* note 9, at 1.

99. For example, when survey respondents in the University of California, Davis study were asked "why one might substitute ride-hailing for public transit," the most popular response was that "services are too slow." *See* Clewlow & Mishra, *supra* note 77, at 25.

100. *See* Fitzsimmons, *supra* note 97.

101. *See generally* Jonathan Mahler, *The Case for the Subway*, N.Y. Times Mag., (Jan. 3, 2018), https://www.nytimes.com/2018/01/03/magazine/subway-new-york-city-public-transportation-wealth-inequality.html.

transit.[102] In addition, emissions costs of public transit are lower than for vehicle travel, because the efficiency gains of transit limits the emissions costs per passenger,[103] and because transit can lead to denser development patterns, which in turn lowers the distances that the average person needs to travel to get from origin to destination.[104]

Because of the importance of public transit—and the potential for ridesharing and SAVs to diminish the viability of our transit system—policymakers should take steps to ensure that vehicle travel is not over-incentivized relative to transit, and that transit continues to provide quality services that can compete for customers with ridesharing fleets.[105]

II.
Current Regulatory Environment for Autonomous Vehicles

The current regulatory environment for autonomous vehicles in the United States is characterized by an increasing level of intervention and guidance at both the federal and state levels. Two years ago, the federal government issued guidelines for autonomous vehicle technology, a move that was praised by the autonomous vehicle industry.[106] An Op-Ed penned by then-President Obama highlighting the potential safety benefits of autonomous technology was released the same day.[107] In September 2017, the House of Representatives passed the SELF DRIVE Act with bipartisan support, which creates a federal framework for autonomous vehicle regulation.[108] The House bill expressly preempts state and local governments from enacting their own regulations with regard to the design, construction, or performance of

102. *See* Reg'l Plan Ass'n, *supra* note 1, at 3 ("Governments need to guard against the risk that transit services are undermined by new AV shared-ride services which could siphon off wealthier riders, leaving lower-income residents with underfunded and diminished service options.").

103. *See* Fed. Transit Admin., *supra* note 19 ("National averages demonstrate that public transportation produces significantly lower greenhouse gas emissions per passenger mile than private vehicles.").

104. *See id.* ("Transit can also reduce greenhouse gas emissions by facilitating compact development, which conserves land and decreases the distances people need to travel to reach destinations.").

105. *See infra* Section IV.C.2.

106. Nat'l Highway Traffic Safety Admin., *supra* note 5.

107. *See* Barack Obama, Opinion, *Self-Driving, Yes, But Also Safe*, Pittsburgh Post-Gazette (Sept. 19, 2016, 8:00 PM), http://www.post-gazette.com/opinion/Op-Ed/2016/09/19/Barack-Obama-Self-driving-yes-but-also-safe/stories/201609200027.

108. *See* Aarian Marshall, *Congress United (Gasp) to Spread Self-Driving Cars Across America*, WIRED (Sept. 6, 2017, 4:33 PM), https://www.wired.com/story/congress-self-driving-car-law-bill/.

autonomous vehicles.[109] However, the bill expressly does *not* preempt state and local governments from enacting regulations regarding registration, licensing, emissions restrictions and "congestion management of vehicles."[110] A Senate version of the bill—the AV START Act—also expressly preempts state and local regulations regarding the design, construction, and performance of autonomous vehicles.[111] However, it removes language in the House bill that expressly allows states and local governments to enact regulations regarding traffic and congestion.[112] Therefore, it is unclear on the face of the Senate bill whether the legislation would preempt local traffic and congestion regulations. The Senate bill was approved by the U.S. Senate Committee on Commerce, Science, & Transportation on October 4, 2017, and was placed on the Senate Legislative Calendar on November 28, 2017, but at the time of this writing it has yet to be called for a full vote on the Senate floor.[113] Of course, if it the Senate bill is approved, it will

109. SELF DRIVE Act, H.R. 3388, 115th Cong. § 3(b)(1) (2017) ("No State or political subdivision of a State may maintain, enforce, prescribe, or continue in effect any law or regulation regarding the design, construction, or performance of highly automated vehicles, automated driving systems, or components of automated driving systems unless such law or regulation is identical to a standard prescribed under this chapter.").

110. *Id.* § 3(b)(3)(A); *see also* Timothy B. Lee, *House Passes Law to Accelerate Adoption of Self-Driving Technology*, ARS TECHNICA (Sept. 6, 2017, 1:55 PM), https://arstechnica.com/cars/2017/09/house-passes-law-to-accelerate-adoption-of-self-driving-technology/ ("At the same time, the legislation preserves state authority over a long list of traditional state functions that are not directly implicated by self-driving technology: registration, licensing, driving education and training, insurance, law enforcement, crash investigations, safety and emissions inspections, and congestion management—subjects that shouldn't hamper the development of self-driving car technology.").

111. AV START Act, S. 1885, 115th Cong. § 3(a)(3)(A) (2017); *see also* S. Rep. No. 115–187, at 6 (2017).

112. *Compare* H.R. 3388 § 3(b)(3)(A) ("Nothing in this subsection may be construed to prohibit a State or a political subdivision of a State from maintaining, enforcing, prescribing, or continuing in effect any law or regulation regarding registration, licensing, driving education and training, insurance, law enforcement, crash investigations, safety and emissions inspections, congestion management of vehicles on the street within a State or political subdivision of a State, or traffic unless the law or regulation is an unreasonable restriction on the design, construction, or performance of highly automated vehicles, automated driving systems, or components of automated driving systems."), *with* S. 1885 § 3(a)(3)(C) ("Nothing in this paragraph may be construed to prohibit a State or political subdivision of a State from maintaining, enforcing, prescribing, or continuing in effect any law or regulation regarding the sale, distribution, repair, or service of highly automated vehicles, automated driving systems, or components of automated driving systems by a dealer, manufacturer, or distributor.").

113. *See* Press Release, U.S. Senate Comm. on Commerce, Sci. & Transp., Senate Commerce Approves AV START Act, Other Bills and Nominations (Oct. 4, 2017), https://www.commerce.senate.gov/public/index.cfm/pressreleases?ID=BA5E2D29-

need to be reconciled with the House bill before receiving final congressional approval.

Multiple states and the District of Columbia have also enacted legislation regarding autonomous vehicles, many of them legalizing testing and trials.[114] Moreover, seventeen U.S. cities are currently (or will be in the near future) hosting tests of autonomous vehicles, and another sixteen U.S. cities are performing studies on autonomous vehicles but have not yet begun hosting tests and trials.[115] Autonomous vehicle initiatives have also received government support in many other countries, including Australia, China, France, Japan, Korea, the Netherlands, and Singapore.[116]

A. *Regulatory and Governmental Context in New York City*

In April 2017, New York state lawmakers voted to include in the 2017 state budget a provision allowing testing of autonomous vehicles on New York state highways. All tests must occur under state police supervision, a licensed driver must be in the cars when they are on the road, and companies will have to apply to the Department of Motor Vehicles for approval before testing. Autonomous vehicle testing will only be permitted until April 2018, and the DMV and the State Police must compile a report on their findings.[117] One company—G.M., through its autonomous vehicles subsidiary Cruise Automation—has applied to test autonomous vehicles in Manhattan in early 2018.[118]

Thanks to an initiative led by the U.S. Department of Transportation, New York City is also one of three jurisdictions in the country that have received federal funding to install and pilot vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) technologies.[119] The

2BF3-4FC7-A79D-58B9E186412C; *S.1885—AV START Act*, CONGRESS.GOV, https://www.congress.gov/bill/115th-congress/senate-bill/1885/all-actions-without-amendments (last visited April 6, 2018).

114. For a full list of state legislation, see Gabriel Weiner & Bryant Walker Smith, *Automated Driving: Legislative and Regulatory Action*, STAN. CTR. INTERNET & SOC'Y, http://cyberlaw.stanford.edu/wiki/index.php/Automated_Driving:_Legislative_and_Regulatory_Action (last visited May 15, 2017).

115. *See* BLOOMBERG PHILANTHROPIES & ASPEN INSTITUTE, *supra* note 2 and accompanying text.

116. *See* Ticoll, *supra* note 1, at 8.

117. Jon Campbell, *NY to Approve Self-Driving Car Tests*, DEMOCRAT & CHRON. (Apr. 5, 2017, 8:31 AM), http://www.democratandchronicle.com/story/news/politics/albany/2017/04/05/ny-budget-approves-self-driving-car-tests/100056236/.

118. *See* Sarah Maslin Nir, *Self-Driving Cars Could Come to Manhattan*, N.Y. TIMES, Oct. 18, 2017 at A23.

119. Press Release, U.S. Dep't of Transp., U.S. Department of Transportation Announces up to $42 Million in Next Generation Connected Vehicle Technologies (Sept. 14, 2015), https://www.its.dot.gov/press/2015/ngv_tech_announcement.htm.

technologies will enable vehicles "to share and communicate anonymous information with each other and their surroundings in real time."[120] The City is planning to install the V2V capabilities in up to 8000 vehicles (including some MTA buses and yellow taxis), as well as V2I technology throughout the middle of Manhattan and along a road segment in Brooklyn. This will include V2I-enabled traffic signals on First, Second, Fifth, and Sixth Avenues between 14th Street and 66th Street in Manhattan.[121] If the pilot goes successfully, New York City will be well poised for the introduction of autonomous vehicles.

In October 2016, the New York City Council conducted a hearing on autonomous vehicles, during which some of the councilmembers expressed openness to preparing for a future of autonomous vehicles. However, some voiced well-founded concerns about the impact of the new technology on labor.[122] In addition, New York City's Department of Transportation Deputy Commissioner for Policy, Michael Replogle, was fairly cautious about the future of autonomous vehicles. Replogle warned of several potential downsides of autonomous vehicles, including increased congestion and traffic caused by "ghost vehicles"—privately-owned autonomous vehicles that circle the area while their owner is shopping or at work in order to avoid parking costs.[123] He also expressed concerns about the safety of these vehicles in the dense and chaotic urban environment of New

120. *Id.*

121. *See* Press Release, N.Y.C. Dep't of Transp., NYC DOT Advances to Phases Two and Three of Federal Connected Vehicle Pilot Program (Sept. 28, 2016), http://www.nyc.gov/html/dot/html/pr2016/pr16-094.shtml; *NYC Connected Vehicle Project for Safer Transportation*, N.Y.C. DEP'T TRANSP., https://cvp.nyc/ (last visited Jan. 19, 2018).

122. Transportation Committee Chair Ydanis Rodriguez said that "New York City must be ready to embrace a future that is all but imminent . . . ." *See* Stephen Miller, *Will Self-Driving Cars Ruin New York?*, VILLAGE VOICE (Oct. 31, 2016), http://www.villagevoice.com/news/will-self-driving-cars-ruin-new-york-9288862. Councilman Daniel Garodnick tweeted during the hearing (and before the State had passed its bill allowing for AV testing), that "NYC will miss [sic] chance to lead on autonomous cars if our laws do not even allow us to test them on city streets in a safe and controlled way." Alfred Ng, *Self-Driving Cars Face Massive Roadblocks in New York City*, ROADSHOW BY CNET (Oct. 28, 2016, 3:26 PM), https://www.cnet.com/roadshow/news/self-driving-cars-nyc-face-massive-roadblocks/. Councilman Antonio Reynoso was generally positive about autonomous vehicles, but also warned that "[t]his is gonna [sic] be a fight regarding jobs," and stated that "[f]or us that want to be supportive of this movement," the industry is "going to have to have a response to that." Miller, *supra*.

123. Ng, *supra* note 122.

York City.[124] Ultimately, Replogle was not opposed to testing autonomous vehicles in New York City, but recommended that City policymakers have a high degree of input in the process to ensure that the technology is tested and developed safely and responsibly for New York City's uniquely dense urban environment.[125]

III.
Rationale for Policies to Incentivize SAVs Relative to Privately-Owned Autonomous Vehicles

A. Public Benefit of SAVs Outweighs the Private Incentive

Many of the benefits achieved by SAVs would be positive externalities not internalized by individual vehicle users.[126] Use of these vehicles will reduce the number of cars in circulation, decrease urban space needed for parking, and allow reclamation—or infill—of that space for housing or parks.[127] These benefits are felt by society as a whole more than they are internalized to the individual vehicle user who decides to forgo car ownership and use SAVs instead. Therefore, there is an imbalance between the private benefit and the public benefit of SAVs, such that individuals might not be adequately incentivized to adopt shared vehicles over personal vehicles. Policy interventions may therefore be justified to make up for the difference in the public benefit and the private incentives, and thus properly incentivize the adoption of SAVs.

B. Public Costs of Privately-Owned Autonomous Vehicles Outweigh Private Costs

Although automobiles have helped shape much of our modern economy and have delivered significant benefits, car ownership and usage also carry a large societal cost, including environmental damage and the value of land devoted to car parking.[128] Drivers do experience costs that can lead them to forgo car ownership—up-front payments,

124. Emma Whitford, *NYC Is Having Serious Conversations About Driverless Cars*, Gothamist (Oct. 28, 2016, 3:47 PM), http://gothamist.com/2016/10/28/driverless_cars_nyc_debate.php.
125. *Id.*
126. *See* Anderson et al., *supra* note 30, at 135 ("[Autonomous vehicle] technology is likely to generate many positive externalities—benefits to those other than the purchasers. Since they do not accrue to the purchasers, these positive externalities will not be incorporated in economic demand for this technology. The result may be a market failure and the potential for a less than socially optimal outcome.").
127. *See supra* Section I.B.3.
128. *See* Brodsky, *supra* note 1, at 851–52.

financing, fuel, parking, insurance, and the time-cost of needing to pay attention at the wheel while driving.[129] However, many other costs associated with vehicle ownership and usage are not internalized by drivers, which further disincentives the switch to an ownerless system. According to estimates from the Victoria Transport Policy Institute, over one quarter of the total costs of driving are general costs to society not internalized by individual drivers. These costs take the form of non-residential off-street parking, crash damages, roadway costs, congestion, environmental costs, roadway land value, fuel externalities not borne by the driver, and traffic services.[130] Moreover, some costs that are already internalized by the driver—particularly related to the time-cost of driving—are expected to be reduced with autonomous vehicles, further *widening* the gap between the public costs and private costs of driving.[131]

Even if there is a switch to SAVs, greater internalization of the cost of driving may still be needed in order to cut back on an increase in vehicle miles traveled that may be caused by the adoption of these vehicles.[132] Both scenarios therefore pose the risk that consumers will underprice their vehicle trips, and autonomous technology may even further lower the internalized cost of driving.[133]

Because many of the costs of vehicle ownership and usage are not internalized by the individual consumer under either scenario, the government would be justified in implementing policies to ensure that public costs and private costs are better aligned.[134] As will be discussed further, these policies could include—at the local level—such initiatives as road pricing and parking fees.[135]

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129. Burns et al., *supra* note 32, at 3.

130. Victoria Transp. Pol'y Inst., *supra* note 40; Smith, *Managing Demand*, *supra* note 30, at 1414.

131. *See* Anderson et al., *supra* note 30, at 24 ("AVs should reduce the opportunity cost of travel time by freeing a driver to engage in other productive or enjoyable activities while driving . . . .").

132. *See supra* Section I.C.1; *see also* Smith, *Managing Demand*, *supra* note 30, at 1402 ("[T]he law can help manage [the potential effects of increased VMT on rural and urban land use] by better internalizing the costs and benefits of motor vehicle travel.").

133. *See* Smith, *Managing Demand*, *supra* note 30, at 1414 ("[D]rivers tend to underprice their trips, a problem that could be exacerbated by the lower cost of an autonomous vehicle trip.").

134. *See id.* at 1421 ("[P]olicymakers should seek to maximize the share of motor vehicle travel costs that are internal and variable as opposed to external or fixed. . . . [I]n the near term it could include variable tolling [and] management of on-street parking . . . .").

135. *See id.* at 1416–17 ("[T]olling (of highways, bridges, tunnels, lanes, or urban zones) . . . . offer[s] the potential to internalize more of the costs of driving . . . ."

C. Industry May Not Be Properly Incentivized

Currently, many entrants into the autonomous vehicles market are planning on deploying their first autonomous vehicles in ride-hailing fleets.[136] However, it is difficult to predict how industry incentives will adapt over the long run in the era of autonomous vehicles. Today, carmakers clearly have an incentive to sell as many cars as possible to maximize profits. It is possible that, as the cost of manufacturing autonomous vehicles decreases, the economics of the car market will remain such that the best way for many companies to maximize profits will be to sell as many vehicles as possible. If so, this will encourage companies to try to maintain or increase current rates of car ownership, and to market their autonomous vehicles as individually-owned products.

On the other hand, today's traditional automakers like G.M. or Ford may determine that it would be profitable to offer subscription services, in which former purchasers of a single vehicle would instead sign up for a menu of on-demand options.[137] For example, with a G.M. subscription, a single user could reserve a one-person vehicle to take her to work each morning, but a five-person vehicle to take her family on a vacation over Memorial Day weekend.[138] Automakers would therefore be incentivized to sell the most subscriptions as opposed to the most privately-owned vehicles.

Although the future market incentives remain uncertain, because there is a possibility that automakers will continue to market and sell privately-owned vehicles, cities may be justified in intervening to increase the likelihood that SAVs—and all their benefits—take hold in the market relative to privately-owned autonomous vehicles.

D. Rationale as Applied to Specific Policies

The policy initiatives contained in this Note aim to incentivize a future of SAVs relative to privately-owned vehicles, but also to cabin any potential rises in total VMT and congestion. Although the initiatives will be detailed in Part IV, one is outlined briefly below for the purpose of illuminating the economic rationale behind the policies.

(internal quotation omitted)); *id.* at 1420 ("Cities, if so empowered, might use tolling or parking fees to manage any increased demand generated by these vehicles.").

136. *See supra* note 3 and accompanying text.

137. *See* Arieff, *supra* note 30.

138. *See id.*

1. Road Pricing

Road pricing schemes generally charge fees for vehicles using certain roads or entering certain areas—such as the £11.50 daily fee charged to drivers entering much of Central London.[139] Section IV.A runs through a variety of options for how to structure a road pricing scheme, but a common thread throughout all the options is charging privately-owned vehicles a higher fee relative to SAVs.

As discussed in Section III.B, drivers generally do not internalize the full societal costs of their vehicle travel. This includes costs in the form of crash damages, roadway costs, congestion, environmental costs, roadway land value, and fuel externalities not borne by the driver. Rather, these costs are borne by society as a whole without a significant impact on the individual driver. The net result is to artificially depress the individual costs of driving and effectively subsidize vehicle travel.

Congestion fees correct some of this market imbalance by making drivers internalize more of the overall costs of their vehicle travel. For instance, in the heavily trafficked area of Central London, each additional driver on the road exacerbates congestion and increases the likelihood of an accident. The additional driver does not internalize these full costs; thus—absent a congestion fee—her driving is effectively subsidized within the Central London area. The congestion fee takes away the driver's effective subsidy, brings her internalized costs in line with the total societal cost of driving, and thus corrects the market imbalance.

With regard to autonomous vehicles, shared vehicles will carry greater benefits than those that are privately owned. There will be fewer cars in circulation, and they will hardly ever need to park, thus freeing up urban space for housing or other alternative uses.[140] As described in Section III.A, the full benefits of shared vehicles—including denser urban development—are not internalized by the individual user, and individuals therefore might not be properly incentivized to use shared vehicles relative to privately-owned vehicles.

Charging privately-owned vehicles a higher road fee relative to shared vehicles will help vehicle users better internalize the costs of driving privately-owned vehicles; likewise, charging a lower fee to users of shared vehicles will help them better internalize the benefits

139. *See Congestion Charge*, Transport for London, https://tfl.gov.uk/modes/driving/congestion-charge (last visited May 15, 2017).

140. *See supra* Section I.B.3.i.

of driving shared vehicles. A regulatory environment with zero congestion fees for all vehicles would still effectively subsidize, and thus artificially prop up demand for, vehicle travel in general. Moreover, because privately-owned vehicles carry greater costs that are not internalized to the user, it would perpetuate a particularly stark market imbalance with relation to privately-owned vehicles and thus artificially prop up demand for consumers to purchase their own autonomous vehicles. By charging higher congestion fees for privately-owned vehicles and comparatively lower fees for shared vehicles, governments could guide residents away from an ownership-based future and towards a future of shared fleets.

IV. Proposed Policies: Incentivizing SAVs Relative to Privately-Owned Vehicles, While Also Preventing a Rise in VMT and Congestion

The policies proposed below aim to incentivize the adoption of SAVs relative to individually-owned autonomous vehicles, while also not over-incentivizing car usage overall. Many of these policy proposals contained below should already be largely familiar to urban policymakers, though they are tailored both to disincentivize privately-owned vehicles and to incentivize shared vehicles.

A. Road Pricing

Road pricing is a concept frequently promoted by economists and urban planners as an effective means of limiting congestion and inducing commuters to use non-automobile transit modes. The concept is currently in practice in London,[141] Singapore,[142] and Stockholm.[143] Although there are a variety of ways to administer a road pricing scheme, the basic idea is that automobiles are charged a fee for driving within a certain area of the city. As the cost of driving goes up, we can expect rates of car use to go down, and for people to travel by other means.

Road pricing has a somewhat rocky history in New York City. The concept was promoted by Mayor Michael Bloomberg between

141. London's congestion pricing scheme includes an exemption for ridesharing vehicles. *See* Thompson, *supra* note 14.

142. *See* Matthew Chayes, *De Blasio: Charging Drivers to Ease Congestion 'Not Part of My Vision'*, NEWSDAY (Feb. 14, 2017, 7:36 PM), http://www.newsday.com/news/new-york/de-blasio-no-support-for-charging-to-drive-in-manhattan-1.13124865.

143. *See* Dougherty, *supra* note 38.

2007 and 2008. Under the final draft of Bloomberg's plan, the City would have imposed an eight-dollar fee on cars traveling on city streets in Manhattan south of 60th Street. The funds collected from the fees were then expected to be allocated toward improving public transit. Bloomberg touted the plan as a means of improving the public transit system and achieving environmental benefits caused by lower rates of car usage.[144] Although Bloomberg's congestion pricing plan ultimately passed the New York City Council by an unusually slim margin,[145] it failed in the New York State Assembly in 2008.[146] Following the showing of lack of support in Albany, the federal government, which had been poised to give New York City roughly $350 million to launch the program and make public transit improvements, announced that it would instead grant the money to projects in Chicago and Los Angeles that were unrelated to congestion pricing.[147]

In recent months, against a backdrop of a widening subway crisis, New York Governor Andrew Cuomo again floated congestion pricing as a means to limit congestion and pay for subway improvements. He appointed a panel to study congestion pricing and report its

144. Nicholas Confessore, *$8 Traffic Fee for Manhattan Gets Nowhere*, N.Y. TIMES (Apr. 8, 2008), http://www.nytimes.com/2008/04/08/nyregion/08congest.html?hp.

145. Diane Cardwell, *City Council Approves Fee to Drive Below 60th*, N.Y. TIMES (Apr. 1, 2008), http://www.nytimes.com/2008/04/01/nyregion/01congestion.html?ref=nyregion.

146. Confessore, *supra* note 144. By coincidence, the spring after the congestion pricing plan stalled in the State Assembly, a surge in oil prices appears to have resulted in a significant decline in congestion and a rise in public transit ridership in New York City, demonstrating in a real-world experiment the effects of higher driving costs on congestion in Manhattan. *See* William Neuman, *Politics Failed, but Fuel Prices Cut Congestion*, N.Y. TIMES (July 3, 2008), http://www.nytimes.com/2008/07/03/nyregion/03congest.html?ref=nyregion. Critics of the congestion pricing plan cited a variety of concerns, including that the flat eight-dollar congestion pricing fee was essentially a regressive and elitist tax: because rich people could better afford the fee, they could better afford driving in Manhattan under the proposed regime. In addition, then-Assembly Speaker Sheldon Silver expressed concerns about increased congestion in the areas immediately surrounding the proposed congestion fee zone, and cast doubt on the plan's potential air-pollution and health benefits. Moreover, politicians from areas surrounding New York City were alarmed that the car commuters among their constituents would bear some of the brunt of the proposed fee but receive none of the benefits. The Bloomberg administration sought to address some of these concerns, including by putting in place a low-income tax credit to balance out the regressive nature of the fee. However, these efforts ultimately proved unsuccessful in achieving enough support in Albany. *See* Bruce Schaller, *New York City's Congestion Pricing Experience and Implications for Road Pricing Acceptance in the United States*, 17 TRANSPORT POL'Y 266, 266, 270–71 (2010), [hereinafter Schaller, *Congestion Pricing*]; Cardwell, *supra* note 145; Confessore, *supra* note 144.

147. *See* Schaller, *Congestion Pricing*, *supra* note 146, at 269.

findings by the end of 2017.[148] In January 2018, the Governor's task force—called "Fix NYC"—released the first major congestion pricing proposal since Mayor Bloomberg's efforts in 2008.[149] Under the proposal, vehicles entering Manhattan south of 60th Street would have paid variable rates depending on the vehicle-type: trucks would have paid $25.34, personal vehicles $11.52, and for-hire vehicles would have seen a surcharge of two to five dollars.[150] Mayor de Blasio voiced openness to the proposal, pending a full review of the details of the plan.[151] However, other than a surcharge on for-hire vehicles operating south of 96th Street in Manhattan, the plan did not make it into the budget approved by state legislators in March 2018.[152]

Governor Cuomo's proposal took a reasoned approach in charging higher fees for personal vehicles than for shared, for-hire vehicles. In the context of autonomous vehicles, the ideal road pricing system would similarly charge a higher fee for privately-owned autonomous vehicles. Such a fee for privately-owned vehicles would force car users to properly internalize the societal costs of privately-owned vehicle ownership and usage, as elaborated in Section III.D.1.

How to treat SAVs under the road pricing scheme, however, is a more complicated question. Cities could (1) charge a lower congestion fee for SAVs than for privately-owned vehicles, or (2) start with no fee for SAVs but then phase in a reduced fee for shared vehicles over time.[153]

A lower fee for shared vehicle modes would reflect the lower societal costs of shared vehicles, while acknowledging that these vehicles will still incur congestion costs. The second option—phasing in a lower fee for shared vehicles over time—might be the most advantageous from a policy perspective, however. Initially exempting shared vehicles from congestion fees would incentivize their use relative to

148. *See* Kirstan Conley, *Cuomo Appoints Panel to Study Congestion Pricing*, N.Y. POST (Oct. 5, 2017, 4:30 PM), https://nypost.com/2017/10/05/cuomo-appoints-panel-to-study-congestion-pricing/.
149. *See* Dwyer & Hu, *supra* note 92.
150. *See id.*
151. *See* William Neuman, *In a Shift, Mayor Voices Openness to Congestion Pricing*, N.Y. TIMES, Jan. 19, 2018, at A1.
152. *See* Winnie Hu, *Congestion Pricing Falters in New York, Again*, N.Y. TIMES, Apr. 1, 2018, at A21.
153. In addition, note that any road pricing scheme would also need to calibrate a fee-level for trucks—similarly to Governor Cuomo's most recent congestion pricing plan. *See* Dwyer & Hu, *supra* note 92. Another option could be to charge an identical congestion pricing fee for privately-owned vehicles and SAVs, but tax privately-owned vehicles more heavily at the point of purchase. This could achieve the goal of disincentivizing privately-owned vehicles relative to SAVs without having to create a bifurcated congestion pricing scheme.

privately-owned vehicles. Policymakers could then maintain this fee exemption at least until they felt confident that SAVs had prevailed in the market relative to privately-owned vehicles. Many of the benefits from SAVs (including reduced parking needs and more available urban space) would be captured by that time, and cities could then phase in a lower fee to limit the congestion and VMT costs of SAVs and ensure that vehicle travel was not over-incentivized relative to other, more efficient transit modes, such as mass transit.[154] The temporary subsidy (the initial free pricing period) would be justified by the fact that many of the positive externalities of SAVs are not internalized to individual car users. The phased-in fee would be justified by the fact that many of the negative externalities of SAVs are *also* not internalized. The initial free phase would therefore serve to lock in the benefits of SAVs, while the subsequent, phased-in fee would serve to limit the costs of these same vehicles.[155]

B. Parking Initiatives

Parking subsidies are a quintessential example of the misalignment between the private and public costs of vehicle travel.[156] Our society frequently makes parking free or subsidizes parking, which lowers one of the primary marginal costs of car travel and thus over-incentivizes car ownership and use. For example, researchers have estimated that free and available street parking increases car ownership rates by nearly nine percent in the New York metropolitan area.[157]

Most of the costs of driving are borne by the public in the form of greater congestion, more emissions, and other related externalities. Moreover, as UCLA Professor Donald Shoup and others have illuminated, the costs of providing parking get passed on to consumers, te-

154. The fee for shared vehicles would still be lower than the fee for privately-owned vehicles to reflect their lower congestion and emissions costs relative to privately-owned vehicles.

155. One risk of this phase-in approach could be that—as Dougherty suggests—people are less resistant to paying for something new, and more resistant to paying for something that they are used to getting for free. Dougherty, *supra* note 38. Residents might grow accustomed to not being charged a congestion fee for using shared vehicles, and they could mount political opposition once policymakers seek to phase in the lower fee.

156. *See* Smith, *Governments Promoting*, *supra* note 65, at 128 ("Reducing parking subsidies is [a] way that governments—particularly local governments—can better align the individual and social costs of motor vehicle travel. More precisely, many cities subsidize private vehicle ownership by providing free on-street parking (especially in residential areas) and by requiring new buildings to include more parking spots than the market demands. Cheap and plentiful parking encourages both vehicle ownership and vehicle usage.").

157. *See* BEEN ET AL., *supra* note 47, at 7.

nants, and workers in the form of higher consumer prices, higher rents, and lower wages. Because the driving population tends to skew older, whiter, and richer on average, the hidden costs of parking also raise distributional and social equity concerns: free parking is in many ways a subsidy for older, richer, whiter drivers paid disproportionately by the younger, poorer, and non-white non-drivers.[158]

Initiatives aimed at eliminating free or subsidized parking would end this subsidy, and could help lower rates of car ownership and usage. Research suggests that a ten percent increase in the price of parking decreases the likelihood of owning a car from between four and ten percent.[159]

Moreover, in the context of autonomous vehicles, parking initiatives are uniquely tailored to specifically disincentivize privately-owned autonomous vehicles relative to SAVs,[160] because, as described in Sections I.B.1.i–ii, SAVs will have a reduced need for parking than privately-owned vehicles. Parking policies will therefore primarily target privately-owned autonomous vehicles. Policymakers could speed up or delay the adoption of SAVs relative to privately-owned vehicles depending on how they decide to approach the problem of parking.

1. Dynamically-Priced Curb Parking

Mayor de Blasio and N.Y.C. Transportation Commissioner Polly Trottenberg have signaled that they are receptive to parking policy initiatives as a means of combating congestion.[161] It is unclear exactly what form this would take, but it could signal the rollout of dynamically-priced curbside parking (greater prices for curbside parking at high-demand locations and times).[162] Professor Shoup has championed this technique as a means of cutting down on car congestion and

158. *See Parkageddon: How Not to Create Traffic Jams, Pollution and Urban Sprawl*, ECONOMIST (Apr. 8, 2017), http://www.economist.com/news/briefing/21720269-dont-let-people-park-free-how-not-create-traffic-jams-pollution-and-urban-sprawl [hereinafter *Parkageddon*].

159. *See* BEEN ET AL., *supra* note 47, at 7.

160. *See Parkageddon*, *supra* note 158 ("In a radically driverless future, [one] could perhaps do away with many . . . parking spaces. But only if consumers decide to forgo car ownership—and whether they do is connected to parking. Where spaces are expensive, shared vehicles that need not be parked are highly attractive. They are less attractive in cities where parking is plentiful and free . . . .").

161. David Meyer, *De Blasio's Congestion Plan Will Tackle Deliveries and (Maybe) Parking*, STREETSBLOG NYC (Mar. 28, 2017), http://nyc.streetsblog.org/2017/03/28/de-blasios-congestion-plan-will-tackle-deliveries-and-parking/.

162. *Id.*

limiting the amount of time cars spend circling to find parking.[163] The rationale is that most curbside parking spots are either free or underpriced, and there is therefore an over-demand for curb parking. This superficially-inflated demand leads to street parking regularly filling to capacity and to cars circling to find spots.[164] In addition, the general underpricing of parking—not just curbside, but also off-street in residential and commercial locations—significantly lowers the costs of driving, which induces more people to use cars in the first place.[165] After raising the price of parking in popular locations and at peak times, only people who highly value parking during the peak hours will drive and park there and people who value it less will park in alternative, less-demanded locations. This could also induce fewer people to use cars by accurately pricing parking and therefore forcing car users to internalize more of the social costs of their car usage.

New York City has already launched a mobile app payment method for accepting parking payments: ParkNYC.[166] This mobile payment capability makes it easier for the City to implement smarter pricing schemes that could be updated dynamically based on demand and location. Commissioner Trottenberg has acknowledged that the mobile payment method "does open the door up to a smarter and more tailored parking policy in terms of rates and dynamic pricing."[167] However, it has not been reported whether Trottenberg or de Blasio have moved forward with such a plan.

If New York City does decide to implement dynamically priced parking, there is evidence to suggest that it could have a meaningful impact on car usage and ownership. For example, when Washington, D.C. opted to charge more for curb parking, it saw a six percent decline in new car registrations over a time period when the city's population grew by three percent.[168] Moreover, in San Francisco, a "large-scale controlled parking pricing experiment" helped achieve goals of

163. *See* DONALD SHOUP, THE HIGH COST OF FREE PARKING 14–15, 304–07 (2005).

164. *See id.* at 273–94.

165. *See id.* at 4.

166. *ParkNYC*, PARKMOBILE, https://parknyc.parkmobile.us/parknyc/ (last visited Apr. 19, 2017); David Meyer, *NYC Now Has a Smart Parking Payment App. When Will It Get Smart Parking Prices?*, STREETSBLOG NYC (Dec. 19, 2016) [hereinafter Meyer, *Smart Prices*], http://nyc.streetsblog.org/2016/12/19/nyc-has-a-smart-parking-payment-app-now-when-will-it-get-smart-parking-prices/.

167. Meyer, *Smart Prices*, *supra* note 166.

168. However, some of this decrease could also be caused by the rise in ridesharing services, as well as the general trend of younger generations owning fewer cars. *See* Thompson, *supra* note 14.

sixty to eighty percent occupancy rates for metered parking and reduced cruising by fifty percent.[169]

New York City itself has piloted demand-based pricing for curb parking in limited parts of the city with its PARK Smart program. PARK Smart began with Greenwich Village and Park Slope in 2008 and 2009 respectively, and extended to include Jackson Heights (on Atlantic Avenue) in 2013.[170] In Park Slope—where the program charged base parking meter rates of one dollar per hour from eight a.m. to noon, and peak rates of two dollars per hour from noon to seven p.m.—drivers reduced the length of their parking stays by twenty percent, which, in turn, enabled more vehicles to utilize the parking spaces. In all, the total number of vehicles parking in the pilot parking spaces increased by eighteen percent.[171] Moreover, the added circulation of parking (and thus, of customers) proved popular enough with local businesses that the local Community Boards voted to make the programs permanent in Greenwich Village in 2009 and in Park Slope in 2010.[172]

With the successes of the PARK Smart program and the implementation of mobile payment capabilities for curb parking, New York City is well-positioned to implement dynamic pricing on a broader scale.

2. *Reduce or Eliminate Minimum Parking Requirements*

Since the 1940s and 1950s, cities across the United States have enacted requirements for developers to provide a minimum number of parking spaces for new developments.[173] The minimum parking re-

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169. *See* Millard-Ball et al., *Is the Curb 80% Full or 20% Empty? Assessing the Impacts of San Francisco's Parking Pricing Experiment*, TRANSP. RES. PART A: POL'Y & PRAC. 76, 76 (May 2014).

170. *See* David Meyer, *Parking Reforms Cut Congestion, So When Will DOT Get Serious About Them?*, STREETSBLOG NYC (Jan. 27, 2016), http://nyc.streetsblog.org/2016/01/27/parking-reforms-cut-congestion-so-when-will-dot-get-serious-about-them/. In addition, Mayor Michael Bloomberg proposed implementing demand-based prices for curb parking in order to increase turnover of parking spots when he first ran for mayor in 2001. *Untangling Traffic: Bloomberg's Promises*, STREETSBLOG NYC (July 11, 2001) [hereinafter *Bloomberg's Promises*], http://nyc.streetsblog.org/bloombergs-promises/.

171. N.Y.C. DEP'T OF TRANSP., PARK SMART 2.0, at 6 (2014), http://www.nyc.gov/html/dot/downloads/pdf/2014-10-park-smart-road-show.pdf.

172. *Id.*

173. *See* Thompson, *supra* note 14; INGRID GOULD ELLEN ET AL., MANHATTAN INST. FOR POLICY RESEARCH, THE NEXT URBAN RENAISSANCE: HOW PUBLIC-POLICY INNOVATION AND EVALUATION CAN IMPROVE LIFE IN AMERICA'S CITIES 4 (2015) ("Nearly every U.S. city mandates that developers include a minimum number of parking spaces in their developments.").

quirements generally depend on the development type—for example, two parking spots per household might be required for a residential development, or enough parking to satisfy peak demand for a commercial development.[174]

These minimum parking requirements generally tend to overestimate the demand for parking, thereby artificially increasing the costs of new development and creating an oversupply of parking. One study of Seattle found that thirty-seven percent of residential parking spots remained empty during peak nighttime hours;[175] analyses of the New York City housing market have similarly found that minimum parking requirements likely artificially inflate the amount of parking provided by developers.[176]

Eliminating or reducing minimum parking requirements may not negatively hamper urban growth or housing markets, but may instead allow the market to accurately calibrate the demand for parking spaces. When London abolished minimum parking requirements in 2004, the parking supply on new residential blocks fell sharply, from 1.1 average parking spaces per apartment to 0.6, indicating that the minimum parking requirements had been causing developers to oversupply parking and that the market was now recalibrating.[177] In the United States, several cities have taken steps to eliminate or rollback minimum parking requirements without experiencing detrimental effects, and Buffalo, New York, recently eliminated the requirements entirely.[178]

The added development costs from the oversupply of parking are ultimately passed down to consumers in the form of higher rents.[179] More importantly for the purposes of this Note, minimum parking requirements also reduce the costs of car ownership by oversupplying and subsidizing car parking, and thus lead to greater car usage.[180] An

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174. Thompson, *supra* note 14.

175. LONDON & WILLIAMS-DERRY, *supra* note 60, at 1, 6.

176. *See* BEEN ET AL., *supra* note 47, at 11 ("Overall, the data suggest that parking requirements cause developers to build more parking spaces than they otherwise would based on what they believe their prospective tenants or buyers demand.").

177. *See Parkageddon*, *supra* note 158.

178. *See id.*; Linda Poon, *Buffalo Becomes First City to Bid Minimum Parking Goodbye*, CITYLAB (Jan. 9, 2017), http://www.citylab.com/housing/2017/01/buffalo-is-first-to-remove-minimum-parking-requirements-citywide/512177/; *see also* BEEN ET AL., *supra* note 47, at 12 ("San Francisco . . . has eliminated minimum parking requirements in much of the city and imposed limits on the construction of new spaces in several neighborhoods.").

179. *See Thompson*, *supra* note 14.

180. *See* Simon McDonnell, Josiah Madar & Vicki Been, *Minimum Parking Requirements and Housing Affordability in New York City*, 21 HOUS. POL'Y DEBATE 45 (2011).

effort to disincentivize individual car ownership and usage therefore should focus on eliminating this subsidy.

New York City is already further along than many U.S. cities with regard to minimum parking requirements. Rather than minimum parking requirements, the City has set maximum parking requirements for residential development throughout much of Manhattan since 1982.[181] In addition, it eased minimum parking requirements in 2016 for affordable housing developments in "Transit Zones" (i.e., areas with good access to public transit), and to a more limited extent outside of Transit Zones.[182] Decreasing minimum parking for affordable housing is a laudable means of reducing the costs of these developments. However, there is still more the City could do to reduce or eliminate minimum parking requirements broadly.[183] For example, it could follow in the footsteps of San Francisco, which did away with minimum parking requirements in much of the city,[184] or scale the approach taken in Manhattan to other parts of the city.[185] Doing so will end effective subsidies for vehicle owners, thereby better incentivizing consumers to adopt shared vehicles relative to privately-owned vehicles.

3. *Parking Placard Reform*

Studies have shown that the cost and availability of parking is one of the main factors determining whether commuters choose to drive into Manhattan or use public transit (or other modes).[186] For years, New York City has grappled with a phenomenon that artificially lowers the costs of car travel for tens of thousands of commuters each day, thus inducing more people to drive: free parking placards issued to government employees and fraudulent parking placards that

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181. Manhattan serves as another data point showing that the elimination of parking requirements does not hindering rates of urban growth. *See* BEEN ET AL., *supra* note 47, at 12 (describing a Department of City Planning study that found that the revised parking regulations "have proven to be compatible with a growing, successful Manhattan Core").

182. *See* N.Y.C. DEP'T OF CITY PLANNING, HOUSING NEW YORK: ZONING FOR QUALITY AND AFFORDABILITY OVERVIEW 58–62 (June 2016); *see also Policy Minute: Minimum Parking Requirements*, N.Y.U FURMAN CTR: THE STOOP (Oct. 14, 2015), http://furmancenter.org/thestoop/entry/policy-minute-minimum-parking-requirements.

183. *See* BEEN ET AL., *supra* note 47, at 12 ("The most straightforward type of reform would be a general reduction or elimination of the requirements in more of the [C]ity.").

184. *Id.*

185. *See supra* note 181.

186. *See Free Parking, Congested Streets: The Skewed Economic Incentives to Drive in Manhattan*, SCHALLER CONSULTING, http://www.schallerconsult.com/pub/freeparking.htm (last visited Apr. 20, 2017).

evade traffic enforcement. As of 2016, it was reported that there were approximately 104,000 valid free parking placards currently issued to government employees.[187] In addition to the valid parking placards, there have been numerous reports over the years suggesting that there are an unknown number of fraudulent or expired parking placards that frequently enable the placard holders to park in illegal parking spots or to illegally park for free in paid parking spots.[188]

The availability of this free parking greatly impacts commuting decisions. A 2006 study found that twenty-seven percent of government employees working south of 59th Street in Manhattan commuted by car, as compared to only fourteen percent of private sector employees.[189] The study's author—Bruce Schaller—suggested that free parking for government employees was a main factor explaining why the government workers were nearly twice as likely to drive to work, and that this amounted to a $35 million perk to City employees in the aggregate.[190] Strikingly, Schaller found that ninety-five percent of the government employees commuting into Manhattan by car from Brooklyn or Staten Island came from neighborhoods where most of their neighbors commuted by public transit, suggesting that these same government workers had access to non-car modes of transit.[191]

The City has tried to tackle the placard issue before, and sustained efforts should continue in order to stop artificially inducing thousands of daily car trips. Mayor Bloomberg first proposed placard reform during his inaugural 2001 mayoral campaign,[192] and in January 2008 he launched an effort to reduce the total number of placards by at least twenty percent, centralize parking placard issuance within the New York Police Department (NYPD) and New York City Department of Transportation (N.Y.C. DOT), and create a new enforcement

187. David Meyer, *NYPD Still Resisting Attempts to Reform Parking Placard Abuse*, STREETSBLOG NYC (Jan. 15, 2016), http://nyc.streetsblog.org/2016/01/15/nypd-still-resisting-attempts-to-reform-parking-placard-abuse/.

188. *See, e.g.*, Alex Katz & Erin Einhorn, *Park Anywhere with Fake Placard*, N.Y. DAILY NEWS (June 22, 2011), http://www.nydailynews.com/new-york/bogus-parking-placard-advocacy-group-park-new-york-city-single-ticket-article-1.128164; Noah Kazis, *Want the Best Deal on Parking? Get Yourself a Police Surgeon Placard*, STREETSBLOG NYC (June 15, 2010), http://nyc.streetsblog.org/2010/06/15/want-the-best-deal-on-parking-get-yourself-a-police-surgeon-placard/.

189. Aaron Naparstek, *The $46 Million Parking Perk*, STREETSBLOG NYC (June 16, 2006), http://nyc.streetsblog.org/2006/06/16/the-46-million-parking-perk/.

190. *Id.*

191. *Id.*

192. *Bloomberg's Promises*, *supra* note 170.

unit within NYPD to ensure compliance and prevent placard abuse.[193] Within four months, the City reported significant reductions in parking placards—including roughly 20,000 fewer for the Police Department, and 2000 fewer for the Fire Department.[194] However, the City has since issued an additional 50,000 parking placards to Department of Education employees.[195] In addition, the reports of misuse of placards and use of fraudulent placards persist.[196] In developing anti-congestion plans, the City should consider backing sensible placard reform efforts. This could include limiting the number of official placards issued, and—to cut down on fraudulent placards—potentially requiring the placards to contain barcodes that can be scanned.[197]

C. Additional Policies

Cities could pursue a wide array of other policies to incentivize the adoption of SAVs relative to privately-owned vehicles. This Note has focused primarily on two of these methods: road pricing and parking initiatives. Below is a brief list of some additional policies that cities could consider: dedicated lanes for high-occupancy vehicles, improving public transit to better complement shared vehicles, and VMT taxes.

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193. Aaron Naparstek, *City Hall to Reduce Parking Placards and Centralize Control*, STREETSBLOG NYC (Jan. 3, 2008), http://nyc.streetsblog.org/2008/01/03/city-hall-reduces-parking-placards-20-centralizes-control/.

194. Ben Fried, *25,000 Fewer (Official) Parking Placards for City Employees*, STREETSBLOG NYC (May 1, 2008), http://nyc.streetsblog.org/2008/05/01/25000-fewer-official-parking-placards-for-city-employees/; Adam Lisberg, *Thousands of Cops Lose Parking Permits*, N.Y. DAILY NEWS (Apr. 30, 2008, 11:03 PM), http://www.nydailynews.com/new-york/thousands-cops-lose-parking-permits-article-1.331215; William Neuman, *New York, True to Mayor's Promise, Slashes City Parking Permits*, N.Y. TIMES (May 1, 2008), http://www.nytimes.com/2008/05/01/nyregion/01parking.html.

195. *See* Brad Aaron, *De Blasio Administration Volunteered to Hand Out Tens of Thousands of New Parking Placards*, STREETSBLOG NYC (May 12, 2017), http://nyc.streetsblog.org/2017/05/12/de-blasio-administration-volunteered-to-issue-tens-of-thousands-of-new-parking-placards/; Brad Aaron, *Reversing Bloomberg Reforms, City Will Reissue Tens of Thousands of Teacher Parking Placards*, STREETSBLOG NYC (May 11, 2017), http://nyc.streetsblog.org/2017/05/11/reversing-bloomberg-reforms-city-will-reissue-tens-of-thousands-of-teacher-parking-placards/comment-page-1/; Carl Campanile et al., *De Blasio Grants Thousands of Parking Permits to DOE Workers*, N.Y. POST (May 12, 2017, 1:12 PM), http://nypost.com/2017/05/12/de-blasio-grants-thousands-of-parking-permits-to-doe-workers/.

196. For example, a Twitter handle that posts and retweets photos of illegal placards is very active and at the time of this writing had nearly 5000 followers. @placardabuse, TWITTER, https://twitter.com/placardabuse (last visited Mar. 30, 2018).

197. Noah Kazis, *NYPD Opposes Bill to Curb Placard Abuse as Total Soars to 118,000*, STREETSBLOG NYC (June 22, 2011), http://nyc.streetsblog.org/2011/06/22/nypd-opposes-bill-to-curb-placard-abuse-official-placards-back-on-the-rise/.

1. Dedicated Lanes for High-Occupancy Vehicles

Implementing dedicated lanes for high-occupancy vehicles with variable pricing for rush hour periods could be an effective way to encourage the adoption of SAVs, while also not over-incentivizing vehicle travel.[198] Multiple states have already implemented high-occupancy toll lanes with variable pricing during rush hour periods—including California, Minnesota, and Texas—as a means of reducing congestion.[199] Such a policy could have multiple impacts in cities. First, dedicated lanes could incentivize more people to use higher-occupancy vehicles (such as SAVs) to achieve faster travel times. Second, by reducing the number of lanes previously available to lower-occupancy vehicles, cities could increase the costs of driving such vehicles, thereby lowering the demand and reducing the number of such vehicles on the road.[200] Third, by imposing pricing schemes for high-occupancy vehicles, cities could prevent an overall rise in VMT that has already been documented with the growth of ridesharing services.[201]

198. *See* INSURANCE TASK FORCE, KPMG, MARKETPLACE OF CHANGE: AUTOMOBILE INSURANCE IN THE ERA OF AUTONOMOUS VEHICLES 8 (2015) (stating that, to "promote . . . further usage" or autonomous vehicles, "high-occupancy vehicle (HOV) lanes may become autonomous vehicle exclusive," but without making a distinction between SAVs and privately owned vehicles); Smith, *Governments Promoting*, *supra* note 65, at 116, 116 n.80 (listing "high-occupancy vehicles lanes" as a tool governments could use to promote the adoption of automated driving, without making a distinction however, between SAVs and privately owned vehicles); Bliss, *supra* note 30 ("Shared AVs would add fewer vehicles to the road than private ones, but a shared model alone may not be enough to keep increased congestion at bay. The same 'carrots and sticks' used to manage other forms of car traffic could help. Establishing priority lanes for certain kinds of very high-occupancy AVs—i.e., buses or shuttles—might help keep transit options attractive.").

199. *See* Dougherty, *supra* note 38.

200. Transportation planners used to believe that the way to alleviate gridlock was to simply build more roads. In theory, this would spread the existing cars out across more space and thus reduce overall traffic. However, the new highways never seemed to reduce congestion for very long; they merely encouraged more people to drive on them. The highways created "induced demand"—by providing more space to drive and thus lowering the costs of driving, they actually spurred more people to drive in the first place, thus perpetuating gridlock. *See* Mann, *supra* note 89. Following these same principles, one way to reduce the number of cars on the road could simply be to reduce the number of routes available to vehicle traffic. This could have the opposite effect of induced demand: having fewer routes would increase the costs of driving, thereby lowering the demand and reducing the number of cars on the road.

201. *See* CLEWLOW & MISHRA, *supra* note 77, at 30 (stating that "it is critical that high-occupancy vehicles be prioritized on the roadways if they are carrying a sufficient number of passengers" in order to "address the issue of additional vehicle miles that ridehailing services contribute to cities (as well as those from personally-owned vehicles)– which can further erode high-capacity transit services").

2. *Improving Public Transportation to Better Complement Shared Vehicles*

A recent report prepared for the American Public Transportation Association (APTA) found that the same people who tended to use shared transit modes (such as ridesharing) were also likely to use public transit as well.[202] The report also found that shared modes tended to be used most extensively at times when public transit runs infrequently, such as social trips between ten p.m. and four a.m.[203] Moreover, in New York City, ridesharing and taxi users tend to already live in areas that have high levels of transit access, and for-hire vehicles and mass transit already complement each other because, combined, they offer an alternative to vehicle ownership.[204] These findings still strongly suggest that a shared fleet of autonomous cars could coexist well with public transit. Namely, SAVs could complement existing public transit by offering trips that would be more expensive for transit to provide—such as late-night trips or trips in lower-density areas.[205]

To encourage the use of SAVs over privately-owned vehicles, cities could work proactively to promote synergies between ridesharing and public transit. For example, transit agencies and ridesharing companies could seize on opportunities to discount or promote ridesharing as first or last mile connections on trips.[206] According to Uber, one-third of its trips begin or end at transit stations, so encouraging synergies with ridesharing could present a major opportunity.[207] This cooperation would be mutually beneficial for both cities and for ridesharing companies because, as Silver and Fischer-Baum argue, if properly coordinated, public transit and ridesharing combined could help wean New Yorkers off of vehicle ownership altogether. The rea-

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202. SHARED-USE MOBILITY CTR., SHARED MOBILITY AND THE TRANSFORMATION OF PUBLIC TRANSIT 3–7 (2016).

203. *Id.* at 10.

204. Silver & Fischer-Baum, *supra* note 34 ("[T]he combination of public transit and for hire vehicles is something that New Yorkers have been relying on for years. . . . Ubers, taxis and public transit are complements to one another instead of competitors.").

205. REG'L PLAN ASS'N, *supra* note 1, at 3 ("We should be looking at opportunities for AV technology to be applied today to transit trips that are very expensive to provide because they serve far lower volumes of people (lower density areas, overnight service) . . . . AVs should complement existing transit service, helping to connect people to trunk lines in lower density areas, providing overnight service where volumes are low and potentially paratransit service with the assistance of aides to help with boarding and disembarking.").

206. Thompson, *supra* note 14.

207. *Id.*

son is that a combination of ridesharing and public transit could simply become more affordable for individual consumers than car ownership.[208]

3. *Vehicle Miles Traveled (VMT) Tax*

One way policymakers could incentivize SAVs relative to privately-owned vehicles would be to impose a vehicle miles traveled (VMT) tax. As the name of the tax suggests, VMT taxes would impose a per-mile tax on vehicles, and would likely replace existing fuel taxes. This type of approach is already being piloted in Oregon, which is testing a per-mile charge for 5000 vehicles who volunteer to participate. Participants who sign up forego a gas tax in exchange for a VMT tax.[209] Oregon's reasons for adoption of this tax is to maintain state tax revenue in the face of vehicles' increasing fuel efficiencies (and thus a reduction in fuel tax revenues).[210] However, this same mechanism could also be used as a way to limit total VMT in the event that autonomous vehicles lead to greater congestion and an increase in VMT. As a New York State Department of Transportation (N.Y. DOT) report on VMT taxes suggested, "VMT fee rates can be set to modify behavior," such as by charging trucks (or other types of vehicles) a higher fee "to discourage their travel on certain segments of the network and to recapture their true infrastructure costs."[211] Higher fees could similarly be charged to privately-owned autonomous vehicles relative to shared vehicles in order to "recapture" their true societal costs and discourage their use. Moreover, autonomous vehicles might be particularly amenable to VMT taxes because they will likely be equipped with technology that enables them to communicate with state or city infrastructure and could therefore easily communicate their distances traveled for taxation purposes.[212] Policymakers should be mindful, however, that pursuing a VMT tax and a congestion pricing scheme simultaneously could lead to duplicative results; therefore, policymakers would be wise to choose between one or the other.

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208. Silver & Fischer-Baum, *supra* note 34.

209. *See Frequently Asked Questions*, MYOREGO, http://www.myorego.org/frequently-asked-questions/ (last visited Apr. 6, 2017).

210. *Id.* ("As average fuel efficiency increases over time, the result is a decline in fuel tax revenue. Inflation results in increased transportation system maintenance costs. OReGO is one option that can resolve this funding dilemma.").

211. *See* JEFFERY M. ZUPAN & RICHARD E. BARONE WITH JACKSON WHITMORE, REG'L PLAN ASS'N, MILEAGE-BASED USER FEES: PROSPECTS AND CHALLENGES 10 (2012).

212. *See supra* notes 119–121 and accompanying text.

CONCLUSION

This Note has made the assumption that fully autonomous vehicles will become widely adopted in American cities. However, this future—even if it does seem increasingly likely—is far from guaranteed. As James M. Anderson et al. write, "The history of technology in general—and transportation in particular—is littered with promising ideas that never achieved widespread adoption."[213] It could be that automakers are never able to reduce the costs of autonomous vehicles enough to make them viable to a broad consumer base.[214] Or it could be that engineers aren't able to adequately fix all the safety concerns that arise from autonomous vehicles. Or, even if the safety of autonomous vehicles does advance to the point where accidents are exceedingly rare, any tragic events that still do occur might make consumers and regulators less willing to embrace this new technology in significant numbers. Or perhaps autonomous vehicles will coexist poorly with traditional vehicles and so will not able to make it through the transitionary period in which autonomous and traditional vehicles have to share the road. For whatever reason, autonomous technology might hit a stumbling block that prevents widespread consumer adoption.[215]

Nevertheless, the policies presented here could be beneficial even if autonomous vehicles never even come to market, because they improve the alignment of the private and public costs of vehicle use, and help cities better manage their roads, a vital public resource. By making vehicle users better internalize the costs of their vehicle use, these policies will help to encourage optimal levels of VMT and limit congestion. Even outside the context of autonomous vehicles, the benefits of such policies are numerous, including reduced congestion, fewer greenhouse gas emissions, fewer collisions, increased ridership and revenue for public transit, and less space needed for car infrastructure and parking. For this reason, policymakers should continue or step up efforts to make car users internalize the costs of their car use, such as by pursuing policies like road pricing, parking pricing initiatives, or VMT taxes.

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213. ANDERSON ET AL., *supra* note 30, at 135.

214. The Eno Center for Transportation has predicted it will take five years after product introduction for prices to drop to allow for mass-market penetration. *See* FAGNANT & KOCKELMAN ENO 2013, *supra* note 36, at 1; REG'L PLAN ASS'N, *supra* note 1, at 7.

215. For a run-down of potential stumbling blocks that could derail a future of autonomous vehicles, see *Difference Engine*, *supra* note 20 ("Most carmakers have plans to start testing the market with Level 3 or possibly Level 4 autonomous vehicles around 2021.").

In addition to incentivizing one scenario over another, policymakers could also take a number of different approaches with regards to autonomous vehicles. They could decide that the potential benefits are great enough that they would actually like to encourage the adoption of autonomous vehicles generally. Cities may decide to do this, for instance, if they highly value the potential safety benefits of autonomous vehicles. Additional steps to speed up the adoption of autonomous vehicles could include continuing to invest in smart infrastructure, such as Intelligent Transportation Systems (ITS) improvements, Vehicle to Vehicle communication (V2V) technology, and Vehicle to Infrastructure communication (V2I).[216] Policymakers could also provide subsidies for users of autonomous vehicles, or even develop city-owned fleets of autonomous public transit vehicles as a means of improving the bus system.[217]

In addition, policymakers should work to address some of the overarching costs that might accompany autonomous vehicles. For example, it is crucially important that lawmakers prepare for potentially major labor disruptions due to autonomous vehicles.[218] They should also work to address concerns about affordability of shared vehicles. For example, it is unclear, absent policy interventions, whether fleets of autonomous vehicles will be affordable or accessible for people at a variety of income levels.[219] If current ridesharing apps are an indication, certain segments of the population are not able to use the services because the apps themselves require a credit card.[220] Just as importantly, taxis and ridesharing services are prohibitively expensive for many low-income residents.[221] Without the need for a driver, for-hire vehicle prices may come down.[222] However, to be on the safe side, policymakers should assume that affordability issues will continue with SAVs, just as they do with today's for-hire vehicles. Efforts

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216. *See* Lari et al., *supra* note 1, at 743, 745.

217. *See* Thompson, *supra* note 14.

218. *See supra* note 41.

219. Arieff, *supra* note 30 ("The issue of equity—particularly for those who are most often passengers today—is glaringly absent from discussions of driverless cars.").

220. *See* Katrina Wyman, *Taxi Regulation in the Age of Uber*, 20 N.Y.U. J. LEGIS. & PUB. POL'Y 1, 28, 28 n.69 (2017).

221. *See* Silver & Fischer-Baum, *supra* note 34 ("[P]assengers of [Uber and taxis] are highly concentrated in wealthier areas. . . . This is a reminder that a taxi or an Uber is a big expense.").

222. *See* Levinson, *supra* note 30, at 806 ("Labor is a significant share of costs in transportation, and that will diminish [as autonomous vehicles become increasingly common]. This lower cost benefits taxis, buses, and trucks, which had higher labor costs compared to their competitors: cars and trains.").

should therefore be made to subsidize services for lower-income residents, ensure that people who don't currently have credit cards can still pay, or simply maintain and improve affordable, effective transit options for all residents.[223]

Finally, because of the great opportunities attendant to utilizing the space freed up from reductions in parking needs, cities like New York could work proactively to capitalize on potential infill opportunities.[224] This could mean actively working to convert parking spaces to alternative uses, such as parks, housing, or schools.

As New York City Council Transportation Committee Chair Ydanis Rodriguez said at the 2016 Council hearing on autonomous vehicles, "New York City must be ready to embrace a future that is all but imminent."[225] Although the future is uncertain, autonomous vehicles could have a transformative effect on many aspects of society. Cities like New York should take action now so that they are ready to capture the benefits and minimize the costs of this new technology.

223. *See, e.g.*, REG'L PLAN ASS'N, *supra* note 1, at 5 ("Governments should consider subsidizing shared AV services to provide discounts for low-income residents, seniors and the disabled, similar to transit passes.").

224. *See* Lari et al., *supra* note 1, at 768–69 ("SDVs could eventually free up parking areas for alternate investment and development. Local governments should be ready to recapture these spaces for economic and social benefit.").

225. Miller, *supra* note 122.