Make way for the wealthy? Autonomous vehicles, markets in mobility, and social justice

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Abstract:

The development of a "mobility as a service" model for accessing urban transport via autonomous vehicles may be expected to have far-reaching implications for the economics of road transport. In particular, it would offer a new opportunity to price access to the roads in accordance with the principles of the free market. Once people are paying for mobility on the roads on a "per trip" basis, it will be possible to offer different levels of access — and service — at different prices. According to hegemonic ideas in the transport planning and economics literature the introduction of such a "market in mobility" would be an economically efficient way of allocating access to the scarce good of space on the roads. In this paper we draw attention to a number of ethical and political challenges to the appropriateness of the use of such a pricing mechanism in the context of urban mobility.

Keywords: Autonomous vehicles; driverless vehicles; ethics; transport; equity; mobility as a service; markets; social justice.

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The development of a "mobility as a service" model for accessing urban transport via autonomous vehicles may be expected to have far-reaching implications for the economics of road transport. In particular, it would offer a new opportunity to price access to the roads in accordance with the principles of the free market. Once people are paying for access to the roads on a "per trip" basis, it will be possible to offer different levels of access — and service — at different prices. According to hegemonic ideas in the transport planning and economics literature the introduction of such a "market in mobility" would be an economically efficient way of allocating access to the scarce good of space on the roads.

In this paper we draw attention to a number of ethical and political challenges to the appropriateness of the use of such a pricing mechanism in the context of urban mobility. After briefly describing, in Sections I and II, how the advent of autonomous vehicles could establish a "market in mobility", in Section III we argue that this would mean that the cars of ordinary consumers will be required to "make way for the wealthy". That wealthy people should have better access to mobility than poor people would hardly be unprecedented and in Section IV we highlight a number of precedents and analogies relevant to our discussion. In Section V we survey a number of important social costs of requiring driverless cars to make way for the wealthy, arguing that a market in mobility either challenges a democratic conception of how people should interact in public spaces or reveals how autonomous vehicles are likely to lead to the systematic enclosure of what was previously public space. We conclude, in Section VI by emphasising the significance of these social justice

considerations for future policy in relation to autonomous vehicles. Those who would like to realise the potential of these systems to cost road usage efficiently — as well as those who would resist such a proposal — need to begin considering these ethical and political questions.

I. Mobility as a service

The full implications of autonomous vehicles for the future of transport are still being debated (Anderson et al. 2014; Fagnant and Kockelman 2015; Fraedrich et al. 2015; Milakis et al. 2017; Schreurs and Steuwer 2015). However, a number of authors have argued that, as this technology matures, we will see rapid movement away from private ownership of motor vehicles and towards the provision and purchase of mobility as a service provided by third-party fleets (Fagnant and Kockelman 2018; Greenblatt and Shaheen 2015; Seba 2014; Spieser et al. 2014; Zimmer 2016). For reasons discussed elsewhere, we believe the successful commercialisation of driverless cars requires cars that can drive themselves from the beginning to the end of the journey, without human oversight, in large — if only, large, modern — cities in almost all weather conditions (Sparrow and Howard 2017). Once a car can drive itself then it becomes a valuable asset even when it is not being driven by its owner: while the owner is not using a car, the car can be earning money by transporting other people. Once any vehicle that one owns spends most of the time transporting other people — and once the streets are full of the vehicles of other parties offering the same service — it will make little sense for private citizens to own cars (Burns 2013). Instead, most people may simply enter into a contract with a provider of transport services in order to gain access to mobility when they require it (Arbib and Seba 2017; [Uber CEO] Travis

Kalanick cited in Newton 2014; Zimmer 2016). Providers will run fleets of autonomous vehicles and guarantee their customers a particular level of service at particular times of day. In all likelihood, consumers will interact with transport service providers using something like the mobile-phone-app-based interface pioneered by Uber and other rideshare services (Burns 2013). Thus "mobility as a service" (MaaS) (Jittrapirom et al 2017).

Whether driverless vehicle technology will ever realise its potential to facilitate a MaaS transport system of this sort remains controversial (Compare, for instance, Seba (2014) with Litman (2018)). For the purposes of this paper, we take the claims of those who believe that it will at face value in order to investigate an important set of ethical and policy issues that are likely to arise if they are right.

II. Markets in mobility

As Hannam et al. observe, increasingly "software… writes mobility" (2006). Should it eventuate, the consequences of a mobility as service model for urban transport using autonomous vehicles may be expected to be far-reaching and to include changes in patterns of road use as well as implications for the economics of transport, and for urban planning, which are beyond the scope of the current discussion (Arbib and Seba 2017; Milakis et al. 2017; Pangbourne et al. 2018). We have discussed some of these in Sparrow and Howard (2017): for a more sceptical account, see Litman (2018). Our focus in this section is on the new opportunity such a model would make available to price access to the roads in accordance with the principles of the free market: we will consider the implications of doing so for mobility justice in later sections. Once payment for use of the roads is made on a "per trip" basis it will be possible to charge different prices for different levels of access and

service. Thus, for instance, once customers have indicated the start point and end point of their desired journey, service providers could offer a range of different guaranteed maximum trip times at different prices. Establishing a "market in mobility" of this sort would allow the scarce good of space on the roads to be distributed in an "economically efficient" manner.

There are at least two means that could be used to allocate access to the road network and thus to offer reduced journey times those who are willing to pay more.

The first, and the more significant, would be a centralised, or cloud-based, system built for this very purpose (Buitelaar et al. 2007). In the simplest case, people might pay more in order to be picked up by an autonomous vehicle sooner than other people who requested a vehicle at the same time. However, a dynamic traffic management system might also monitor and shape the interactions between vehicles across the entire road network in order to provide people who had paid higher prices with shorter journey times (Cramton et al. 2017; Vasirani and Ossowski 2012). This might involve reserving certain advantageous routes for vehicles transporting those who had paid higher prices by allocating other vehicles to less advantageous routes. More ambitiously, a cloud-based system might shape individual interactions between vehicles so as to allow those who had paid higher prices to arrive at their destinations more swiftly (Mladenovic and McPherson 2016). For instance, as long as vehicles can communicate with each other (or can return accurate location details to, and receive instructions from, a central server) then the cars of those who had paid lower prices could be made to slow down and move aside in order to allow the cars of those who had paid higher prices to pass them.

If there are multiple providers of transport services then, in the absence of agreement on an infrastructure to allow differentiated access across the whole road network, many interactions between vehicles may be interactions between different providers, with the result that no provider may be able to do much to shorten journey times via either of these latter two mechanisms. However, there are independent reasons for governments to demand that all autonomous vehicles are able to communicate with each other in order to grant particular vehicles right of way.[1] These include the desirability of realising the benefits for efficient movement of vehicles rendered possible by networked vehicles, and of providing emergency service vehicles with priority access to the roads. Many of the potential traffic management benefits associated with AVs, such as "platooning" or "convoying", central route allocation, and increased intersection capacities also depend on "networking" AVs through vehicle-to-vehicle and vehicle-to-infrastructure communication (Fagnant and Kockelman 2015; Ferreras 2013; Sparrow and Howard 2017).[2]

The second means that might facilitate the development of markets in mobility on the roads involves interactions between vehicles at intersections.

Elsewhere, we have argued that it will be unethical to allow autonomous vehicles on the road until they are safer than the average driver and, moreover, that once they have reached this standard of performance governments should prohibit human beings from taking direct control of a vehicle on a public road (Sparrow and Howard 2017). This argument suggests that governments should encourage a very rapid transition to a fully autonomous vehicle fleet as soon as driverless vehicle technology matures. We acknowledge that, for political reasons, it may prove difficult for governments to rid the roads of vehicles with steering wheels in the short term and thus that traffic lights may

remain necessary for some time in order to allow human drivers to navigate intersections safely. Eventually, though, new driverless cars will make up a large majority of the vehicle fleet, at which point it should prove politically plausible for governments to prohibit human drivers on public roads. In the meantime, there may be particular roads, or networks of roads, reserved for the use of autonomous vehicles. If the only vehicles on the roads are autonomous, traffic lights (and give way signs) will become redundant (Ferreira et al. 2010).

Again, as long as all vehicles on the roads can communicate with each other – or with electronic infrastructure at each intersection — then it should prove possible to secure safe passage for all vehicles through an intersection by reaching an agreement between the vehicles regarding which vehicle should pass through the intersection at which time (Dresner and Stone 2004; Naumann et al. 1998). One — arguably the most efficient — way in which this negotiation might be conducted would be by means of an online auction wherein vehicles approaching an intersection would bid for the right to pass through it at some particular time and then these "slots" were allocated to the highest bidder (Carlino et al. 2013; Schepperle and Böhm 2007; Vasirani and Ossowski 2012). If the amount that vehicles have available to them to bid over the course of a particular trip is a product of the price the consumer has paid to travel then such a system would work to facilitate the development of an efficient market for use of the roads and thus to allow people to pay more to secure faster trip times.

These suggestions may seem fanciful given that some of the technologies required to realise them have yet to be demonstrated in practice or at scale (useful surveys of the current state of the art of intelligent vehicle technology are provided by Chen and Englund (2016) and Jimenez (2017)). However, prioritising the transport needs of those who have

paid more by moving them towards the top of the queue of people waiting for a vehicle is already eminently possible. Moreover, the logic of the free market, when unleashed on urban transport, points firmly to pricing journey times — and therefore access to space on the roads — in accordance with willingness, which presumes ability, to pay (Block 1996; Lindsey 2006; Roth 2017; Vanoutrive 2017; Vickrey 1963). As Vanoutrive and Zijlstra (2018) observe "There seems to be a general conviction among a considerable number of (transport) economists that market-based solutions for governments are preferable in general" (p.99). Unless governments intervene to prevent transport providers from offering it, then, we expect that pricing for differential access to the road system will swiftly be rolled out as soon as the technology allows (Cramton et al. 2017). This emergent new "mobile sociotechnical" system (Sheller and Urry 2006) – a hybrid of human desires, market forces, mobile phones, and "autonomous" vehicles – cries out for investigation by scholars of mobilities.

III. Making way for the wealthy

Although the proposal to use the opportunity presented by these new technologies to price transport on the roads on a *per* trip basis will appear unremarkable to readers with backgrounds in economics, marketing, or — some schools of — public policy, we believe that it would affront the vast majority of road users. If any of these mechanisms are adopted then road users will be required to "make way for the wealthy" when they use the roads. In some cases, the mobility privileges purchased by the wealthy will be all-too-obvious to the poor, as, for instance, when the cars carrying the poor automatically pull aside for cars carrying wealthier persons. In other cases, differential access to the road

network will be secured by systems that are invisible to road users (as, for instance, when some users are allocated less advantageous routes in order to facilitate the journeys of others, without being informed of the fact). As we shall see, at least some of the ethical and political issues raised by allocating road space according to the market are differently inflected depending on whether the mechanisms whereby the wealthier are privileged relative to the poorer on the roads are visible to the poorer parties. Regardless, the very idea that we should make way for the wealthy in either of these ways offends against a widely held intuition that public roads are for the public and should serve all drivers equally (Altshuler 2010; Mladenovic and McPherson 2016). Historically, although some people drive prestige cars and others drive "bombs", when members of each group met on the roads, they encountered each other as equals, with the same rights to the road and governed by the same laws.

The suggestion that the poor should make way for the wealthy, then, either challenges a democratic conception of how people should interact in public spaces or reveals how autonomous vehicles are likely to lead to a privatisation of what was previously public space. Whether concerns about "mobility justice" (Sheller 2018) provide grounds to try to resist the development of markets in mobility on the roads will be the topic of the remainder of our discussion.

IV. Precedents and analogies

Before we move to consider the ethical and policy issues raised by the development of markets in mobility on the roads, it may prove useful to acknowledge a number of relevant precedents and analogies, both contemporary and historical, elsewhere in the field of

transport and network policy. In particular, there are already many contexts and ways in which access to transport is distributed in accordance with willingness to pay. In this section we offer a short survey of several of these in order that we may draw upon lessons from each when we turn to our more substantive discussion of the introduction of markets in mobility provided by autonomous vehicles.

Vehicles, roads, and routes

Even if, as we suggested above was the case, drivers, for the most part, think of themselves as having equal rights to the road, the drivers of cars (and other vehicles) themselves are privileged when it comes to their ability to move through urban (and other) space.

In most countries around the world, poor people walk or cycle, or at least ride on the back of a truck or in buses, while wealthy people drive (or, indeed, are chauffeured). Mobility privilege, experienced by those with access to automobiles, manifests culturally and materially and is entrenched in the uneven development of the built environment, creating 'spatial patterns' that sustain inequality (Bartling 2006). The very existence of a road system that is accessible to private vehicles therefore already excludes significant numbers of people from large areas of the city, being the roads themselves (Sheller and Urry 2003; Gössling 2016; Mullen et al 2014). Moreover, roads tend to be built where there is an effective demand — either political or economic — for them, which means where those who are wealthy enough to afford cars want to go (Martens 2006). For this reason, road systems also privilege the wealthy as opposed to the poor when it comes to serving their needs for transport (Graham and Marvin 2001; Lucas et al. 2016). The link between the suburb, the automobile, and uneven mobility and social inequality is now widely

acknowledged in the larger mobilities literature (See Hine 2016; Urry 2000; 2007; Ling 2012 pp. 61-80). To a certain extent, then, the public accepted differential access to transport when cars were adopted as the main solution to urban transport.

Congestion taxes and toll roads

Distribution of access to roads on the basis of willingness — and thus ability — to pay also already exists within many road networks, to some extent at least (Wood and Graham 2006). Where private toll roads exist, they allow those who are willing and able to pay the toll a shorter journey time, while those who cannot afford to pay the tolls must travel by longer and more congested routes (Graham and Marvin 2001). Similarly, congestion taxes, which are increasingly being adopted for social and environmental reasons, mean that those who cannot afford to pay them have reduced access to roads in particular areas or leading to particular destinations (Baeten 2000; Bonsall and Kelly 2005).[3] While, again, these institutions demonstrate that markets already play a role in governing access to roads, it is also striking how unpopular both toll roads and congestion taxes often prove (Chronopoulos 2012; Frey 2003; Giuliano 1992; Oberholzer-Gee and Weck-Hannemann 2002).

"HOT" lanes

Astute readers will have already realised that a recent extension of the concept of toll roads and congestion taxes even more clearly raises many of the same issues with which we are concerned here. A number of cities around the world have begun using smart tolling technologies to allow the pricing of access to faster route times on major arterial roads (Altshuler 2010; Weinstein and Sciara 2006; Ye and Chen 2017). These systems reserve the use of particular lanes for drivers who are carrying some minimum number of passengers or

have paid a fee in order to avoid congestion elsewhere in the road system (thus HOT for High-Occupancy/Toll lanes): what distinguishes them from traditional toll roads is the ease with which drivers can purchase access rights on a *per* trip basis. Although the practice is as yet confined to particular arterial roads in each city, where these lanes exist, those who are unwilling or unable to pay to use them are already effectively required to make way for the wealthy (Graham and Marvin 2001; Rutten 2009).

Air travel

Another context in which people seem to have accepted — or at least put up with — people paying for privileged access to transport is air travel. When it comes to the price of a plane ticket, direct routes with shorter journey times are more expensive than slower and more physically demanding options. On board aeroplanes, space is allocated according to seat class and thus ticket price. In airport departure lounges, a bewildering range of levels of status and privilege have evolved to govern access to space and time, which are available for different prices. For that matter, the truly wealthy never appear in a departure lounge at all and are whisked between their limousines and their private jets at separate terminals designed for their convenience. Similar, if less dramatic, observations might also be made about rail and (to a lesser extent) bus travel. Given that consumers appear to have accepted markets in these contexts, one might wonder why the extension of the same principles to the use of the roads should prove any more controversial.

Make way for the King

A relevant historical example is the social expectation — in some places and in some periods backed by the force of the law — that commoners would make way for the nobility

when they encountered them in the streets. For instance, in feudal Japan, when commoners encountered processions of the "daimyo" (feudal lord) and his family on the roads they were required to step aside and make way for the party or risk being beaten – or even killed – by the lord's military retainers (Vaporis 2005). In Europe, members of the nobility – and later wealthy citizens – rode horses, or travelled in carriages, and commoners, who travelled by foot, were expected to get out of their way or risk being trampled (Amato 2004). While we hope that people will not be threatened with death if they fail to make way for the wealthy, the historical analogy is potentially illuminating.

Net neutrality

Finally, there is an obvious analogy between the issues with which we are concerned here and the current controversy about "net neutrality" (Joch 2009). The World Wide Web is essentially a transport network for "data packets", which have traditionally had equal rights to travel down the fibre-optic cables that form the backbone of the Internet, regardless of their origin or destination. In recent years, major telecommunications service providers have begun challenging the egalitarian notion of an "open" internet, instead privileging the delivery of data from particular locations, customers, or services in order to increase their market share of the pool of possible subscribers (by offering better service to their own customers) or to promote the offerings of particular content providers to which they are linked (Gharakheili et al. 2016). This phenomenon provoked a substantial public backlash and a movement to defend access to data services as a right by enshrining the principle of "net neutrality" in the law regulating telecommunications (Wu 2003).

V. The social costs of markets in mobility

The various precedents discussed above clearly show that markets in mobility are already accepted in some contexts. Nevertheless, there are significant social, ethical, and political costs when mobility is distributed in accordance with ability to pay (Baeten 2000; Graham 1998; Mladenovic and McPherson 2016; Vanoutrive 2017). Moreover, there is reason to believe that these costs would be particularly high when it comes to the expansion of markets in mobility on the roads. In this section, we contribute to the investigation of "the political and ethical dimensions of uneven mobility" (Sheller 2014; see also Hannam et al. (2006)) by highlighting three sorts of costs that we believe policymakers should take into account when determining policy relating to autonomous vehicles.

The psychological and social impacts of making way for the wealthy

One set of costs are associated with the experience of social status that such a market would produce for those using the roads: people would be constantly reminded of their place in the social pecking order by the interactions between their vehicle and the vehicles of others. Because the interactions would take place in public and be visible to 3rd parties they would also reveal one's capacity to pay for mobility to other road users.[4] There is an increasing amount of evidence that this sort of status inequality has a significant negative effect on the well-being of both those who are privileged and those who are disadvantaged in the interaction (Fiske 2011; Wilkinson and Pickett 2010).

As we noted above, there are already interactions, in airport departure lounges or on roads that include HOT lanes, which generate these sorts of experiences. Significantly, there is some evidence that these interactions do impact negatively on the happiness and well-being of air travellers, at least (DeCelles and Norton 2016). Moreover, our suspicion is that some of the exchanges between networked autonomous vehicles would feel more

individual and more personal than those that occur in airports or near HOT lanes. When Person A's car slows down, pulls aside, or waits at an intersection, so that Person B can get to their destination faster, we think it is more likely that A is going to resent B than when B is just one of the people flying by in a faster lane.[5] Another point to note here is that while, for the moment, these sorts of status interactions are confined to particular, and reasonably uncommon, contexts, the advent of networked autonomous vehicles may render this experience ubiquitous given how much time people living in modern cities typically spend on the roads.

Even if people were to become accustomed to the experience of making way for the wealthy, such that they no longer found it distressing on a daily basis, there is a social cost associated with accepting that wealthier people should have right of way when we meet them on the roads, which is highlighted by considering the historical example of commoners having to step aside for the nobility. To modern eyes, this practice is confronting because it offends against egalitarianism. The right to occupy space in the world is an important expression of individuals' moral and political status, which is why systems of gendered and racial hierarchy so often feature restrictions on who can sit at the front of the bus, walk level with others, or appear in public without a chaperone (Sheller 2008, pp. 17-18). For this reason, requiring the poor to make way for the wealthy communicates that the interests of the wealthy are more important than those of the poor.[6] Recognising these sorts of status distinctions on a daily basis is highly likely to be corrosive of egalitarian sentiments more generally (Fiske 2011; Kraus et al. 2017). This undercutting of moral and political sentiments that are fundamental to a democratic society should, we believe, be accounted a significant cost of the use of markets in mobility on the roads.

Social justice and invisible privilege

Concerns about the social and psychological impacts of inequality are, for the most part, premised on the idea that people will be aware of when they are being treated unequally. However, as we noted above, some of the ways in which markets in mobility might allocate access to the roads are likely to be invisible to road users. Insofar as the systems that determine routes for users are obscure to them this practice will raise important issues relating to the transparency and accountability of AI systems that have been discussed extensively elsewhere (O'Neil 2016).

However, systems that are designed to allow the wealthy to move through space more freely than the poor also constitute the building of inequality into the (electronic) infrastructure of cities (Graham and Marvin 2001). As we noted above, to an extent, the very existence of a road network privileges the interests of the wealthy over the poor: toll roads and congestion taxes render roads unavailable to those who cannot afford to pay the toll or tax. Nevertheless, building and maintaining a complex and dynamic citywide electronic (and to an extent physical) infrastructure, which was invisible to its users, to prioritise the mobility needs of the wealthy would, we believe, take this phenomenon to a new level. Being able to channel the wealthy and the poor (secure and insecure) via electronic infrastructure also raises the spectre of creating mobility "ghettos", to which the poor are confined, while the wealthy are moved along safer routes (See Urry 2000, p 76; Graham and Marvin 1996). As we discuss further below, whether the existence of such a system *per se* would be unjust or not will depend on the answers to larger questions about the appropriateness of distributing fundamental social goods by means of the market. Regardless, the fact that the mechanisms that determine these prices — and the patterns of

road usage that result from them — will be invisible to consumers also poses a challenge to democratic ideals of public reason. It will be difficult for citizens to make informed decisions about policy related to transport when traffic flows are determined by algorithms the full consequences of which no road user ever experiences (Wood and Graham 2006).

The privatisation of public space

We imagine that many readers, especially those more sympathetic to the operations of the free market, will be unmoved by the considerations we have addressed so far. Capitalism is premised on the idea that markets distribute goods efficiently and need not be unjust (Nozick 1974). If those who own goods wish to sell them to the highest bidder, and to offer different quality goods at different prices, that is their business.[7] Indeed, the idea that policymakers should be *increasing* the extent to which markets are used to deliver road transport is increasingly hegemonic in the transport policy literature (Eliasson 2018; Roth 2017).

What this line of objection brings to the fore, however, is that the introduction of markets in mobility is premised on an effective *privatisation* of the use of the road network (Vanoutrive 2017): what was previously public space, available to anyone with a car, would increasingly be controlled by the large corporations that provide mobility services. To be sure, the extent of this privatisation will depend on the details of the social, economic, and legal relationships that govern access to mobility on the roads. If individual private vehicles still maintain the right to use the roads without participating in systems that allow other individuals to purchase priority access then, at a theoretical level, the roads will remain public. Nevertheless, the MaaS model presumes that in the future most people will access the road network via contracts with private providers (Seba 2014; Zimmer 2016). Moreover,

allowing individuals to opt out of the electronic infrastructure that shapes journey times in accordance with the price paid to travel jeopardises the provision of efficient access to the road space to all individuals. It therefore seems likely that, in the future, road use may be dominated — and effectively controlled — by a small number of companies running fleets of autonomous vehicles. Alternatively, private owned vehicles may be permitted to use the roads but only if they participate in the electronic infrastructure that allows pricing of journey times – in which case they will also have to make way for the wealthy. If road users have to purchase rights to use the roads in order to secure particular trip times to particular destinations, access to the roads will be privatised (Buitelaar et al. 2007) even if the roads themselves are not.

Again, the private provision of transport *per se* is hardly unprecedented. However, privatisation of access to (all of) the roads is problematic for a number of reasons. The triumph of a privately-provided MaaS model on road networks would represent the enclosure of a resource that had previously, for the most part, belonged to — and had been funded by — the public. People spend a significant amount of time on the roads and so privatising this space will mean that they spend that much more of the day in private rather than public spaces.[8] It would also result in private corporations controlling access to a good — mobility — that is itself essential to social and political participation (Sheller 2008; Urry 2000, p. 191; Cresswell 2013, p. 110). There is a political dimension to allowing private individuals (or corporations) to exercise control over goods that were previously in the public domain. A MaaS system based on autonomous vehicles would also involve an unprecedented level of surveillance of people's movement through space and so, when it

comes to thinking through the nature of this political dimension, privacy and human rights issues will loom large (Bianchini and Avila 2014; Graham 1998; Wood and Graham 2006).

Moreover, while many goods — including some forms of transport — may be freely bought and sold in modern capitalist societies there remain any number of what Michael Walzer (1983) calls "blocked exchanges". For instance, votes, judicial decisions, organs, or children may *not* be bought and sold. More generally, the nature and extent of property rights is always ultimately constrained by considerations of public policy. Even liberals will typically concede that when access to a particular good or class of goods is vital to the recognition or exercise of fundamental moral or political rights, it is entirely appropriate that governments should step in to regulate — or even prohibit — the operations of markets in such goods.

Advocates of net neutrality have drawn on these sorts of arguments to suggest that governments should regulate to ensure that all parties have equal access to the infrastructure of the Web. We believe that these considerations are still more powerful when it comes to physical mobility. As the literature on mobility justice has emphasised, mobility is a fundamental social resource (Sheller 2018). Even in the age of the Internet, many forms of social, economic, and political participation are premised on the ability to be in particular places at particular times (Sheller 2008; see also Urry 2000, pp. 191-192). Further increasing inequalities in access to urban mobility through differential pricing of travel via autonomous vehicles will entrench and exacerbate social inequality in multiple dimensions. Moreover, the public nature of the interactions on the road, as opposed to online, is likely to make these inequalities more socially and psychologically salient — and thus stressful for all concerned (Wilkinson and Pickett 2010). Even if it could be shown that

the poor would be better off in terms of being able to access the roads when journey times are priced, the resulting increase in inequality is an affront to any account of social justice that emphasises equality of opportunity.

VI. Markets and mobility justice

Markets are double-edged swords when it comes to matters of social policy. Granted various — not always plausible — assumptions, markets can accurately convey information about costs and consumer preferences so as to produce an efficient allocation of resources. However, in the real world, individuals' capacity to translate their needs or desires into signals that the market recognises depends upon their access to wealth. For this reason, and for many other reasons as the mobilities literature has highlighted, in practice markets will often reproduce and/or exacerbate existing inequalities.

Road transport policymakers have long wished to bring about a more efficient use of the roads by subjecting road users to the discipline of the market (Rooney 2014; Vickrey 1963): we have suggested that the advent of autonomous vehicles may offer an unprecedented opportunity to do so by costing the use of the road network on a *per* trip basis. Past attempts to achieve this, though, through the introduction of congestion taxes or the establishing of HOT lanes, have often been resisted by the voters, and by some politicians, in the name of equity (Levinson 2010; Viegas 2001; Weinstein and Sciara 2006). We have argued that any scheme to allow pricing of journey times will effectively require those vehicles transporting ordinary consumers to give way to the vehicles of those who have paid higher prices to secure shorter trip times. Despite — indeed, in some cases, because of — the existence of a number of relevant precedents and analogies, we think that any such

proposal is likely to be resisted by the public. Given the extent to which this new sociotechnical system would privatise the roads and the connection between access to space and social status and between mobility and social justice, the public may even be right to do so. Regardless, it is clear that those who would like to realise the benefits that might be made available by pricing journey times in the way we have described here — as well as those who would resist such a proposal — must reckon with the social and political implications of requiring the driverless vehicles of ordinary consumers to "make way for the wealthy."

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Conflict of interest statement

On behalf of all authors, the corresponding author states that there is no conflict of interest.

References

Altshuler, Alan. 2010. "Equity, Pricing, and Surface Transportation Politics." *Urban Affairs Review* 46 (2): 155-179.

Amato, Joseph A. 2004. *On Foot: A History of Walking*. New York: New York University Press.

Anderson, James M, Kalra Nidhi, Karlyn D Stanley, Paul Sorensen, Constantine Samaras, and Oluwatobi A Oluwatola. 2014. *Autonomous Vehicle Technology: A Guide for Policymakers*. Santa Monica: Rand Corporation.

Arbib, James, and Tony Seba. 2017. *Rethinking Transportation 2020-2030: The Disruption of Transportation and the Collapse of the Internal-Combustion Vehicle and Oil Industries*. RethinkX.

Baeten, Guy. 2000. "The Tragedy of the Highway: Empowerment, Disempowerment and the Politics of Sustainability Discourses and Practices." *European Planning Studies* 8 (1): 69-86.

Bartling, Hugh. 2006. "Suburbia, Mobility, and Urban Calamities." *Space and Culture* 9(1): 60–62.

Bianchini, David, and Ismael Avila. 2014. "Smart Cities and Their Smart Decisions: Ethical Considerations." *IEEE Technology and Society Magazine* 33 (1): 34-40.

Block, Walter. 1996. "Road Socialism." *International Journal of Value-Based Management* 9 (2): 195-207.

Bonsall, Peter, and Charlotte Kelly. 2005. "Road User Charging and Social Exclusion: The Impact of Congestion Charges on at-Risk Groups." *Transport Policy* 12 (5): 406-418.

Buitelaar, Edwin, Rob Van der Heijden, and Raffael Argiolu. 2007. "Managing Traffic by Privatization of Road Capacity: A Property Rights Approach." *Transport Reviews* 27 (6): 699-713.

Burns, Lawrence D. 2013. "Sustainable Mobility: A Vision of Our Transport Future." *Nature* 497 (7448): 181-182.

Butcher, Melissa. 2011. "Cultures of Commuting: The Mobile Negotiation of Space and

Subjectivity on Delhi's Metro." *Mobilities* 6 (2): 237-254.

Carlino, Dustin, Stephen D Boyles, and Peter Stone. 2013. "Auction-Based Autonomous Intersection Management." 2013. *16th International IEEE Conference on Intelligent Transportation Systems-(ITSC)*.

Chen, Lei, and Cristofer Englund. 2016. "Cooperative Intersection Management: A Survey." *IEEE Transactions on Intelligent Transportation Systems* 17 (2): 570-586.

Chronopoulos, Themis. 2012. "Congestion Pricing: The Political Viability of a Neoliberal Spatial Mobility Proposal in London, Stockholm, and New York City." *Urban Research & Practice* 5 (2): 187-208.

Cramton, Peter, R Richard Geddes, and Axel Ockenfels. 2017. "Markets in Road Use: Eliminating Congestion through Scheduling, Routing, and Real-Time Road Pricing." Working Paper, University of Maryland, December.

Cresswell, Tim. 2013. "Citizenship in Worlds of Mobility." In *Critical Mobilities*, edited by O. Söderström, D. Ruedin, S. Randeria, G. D'Amato and F. Panese, 105-124. London: Routledge.

Curran, Dean, and David Tyfield. 2019. "Low-Carbon Transition as Vehicle of New Inequalities? Risk-Class, the Chinese Middle-Class and the Moral Economy of Misrecognition." *Theory, Culture & Society* 37: 131-156.

DeCelles, Katherine A, and Michael I Norton. 2016. "Physical and Situational Inequality on Airplanes Predicts Air Rage." *Proceedings of the National Academy of Sciences* 113 (20): 5588-5591.

Dresner, Kurt, and Peter Stone. 2004. "Multiagent Traffic Management: A Reservation-Based Intersection Control Mechanism." *Proceedings of the Third International Joint Conference on Autonomous Agents and Multiagent Systems-Volume 2*.

Eliasson, Jonas. 2018. “Congestion Pricing.” In *The Routledge Handbook of Transport Economics*, edited by Jonathan Cowie and Stephen Ison, 209-226. New York: Routledge.

Fagnant, Daniel J, and Kara Kockelman. 2015. “Preparing a Nation for Autonomous Vehicles: Opportunities, Barriers and Policy Recommendations.” *Transportation Research Part A: Policy and Practice* 77: 167-181.

Fagnant, Daniel J, and Kara M Kockelman. 2018. “Dynamic Ride-Sharing and Fleet Sizing for a System of Shared Autonomous Vehicles in Austin, Texas.” *Transportation* 45 (1): 143-158.

Ferreira, Michel, Ricardo Fernandes, Hugo Conceição, Wantanee Viriyasitavat, and Ozan K Tonguz. 2010. “Self-Organized Traffic Control.” *Proceedings of the seventh ACM international workshop on VehiculAr InterNETworking*.

Ferreras, Luis E. 2013. “Autonomous Vehicles: A Critical Tool to Solve the XXI Century Urban Transportation Grand Challenge.” *Third international conference on urban public transportation systems*, Paris, 17-20 November.

Fiske, Susan T. 2011. *Envy up, Scorn Down: How Status Divides Us*. New York: Russell Sage Foundation.

Fraedrich, Eva, Sven Beiker, and Barbara Lenz. 2015. “Transition Pathways to Fully Automated Driving and Its Implications for the Sociotechnical System of Automobility.” *European Journal of Futures Research* 3 (1): 1-11.

Frey, Bruno S. 2003. “Why Are Efficient Transport Policy Instruments So Seldom Used?” In *Acceptability of Transport Pricing Strategies*, edited by Jens Schade and Bernhard Schlag, 63-75. Pergamon Press.

Gharakheili, Hassan Habibi, Arun Vishwanath, and Vijay Sivaraman. 2016. “Perspectives on

Net Neutrality and Internet Fast-Lanes." *ACM SIGCOMM Computer Communication Review* 46 (1): 64-69.

Giuliano, Genevieve. 1992. "An Assessment of the Political Acceptability of Congestion Pricing." *Transportation* 19 (4): 335-358.

Gössling, Stefan. 2016. "Urban Transport Justice." Journal of transport Geography 54: 1-9.

Graham, Stephen. 1998. "Spaces of Surveillant Simulation: New Technologies, Digital Representations, and Material Geographies." *Environment and Planning D: Society and Space* 16 (4): 483-504.

Graham, Stephen, and Simon Marvin. 1996. *Telecommunications and the City.* London: Routledge.

Graham, Stephen, and Simon Marvin. 2001. *Splintering Urbanism: Networked Infrastructures, Technological Mobilities and the Urban Condition*: London: Routledge.

Greenblatt, Jeffery B, and Susan Shaheen. 2015. "Automated Vehicles, on-Demand Mobility, and Environmental Impacts." *Current sustainable/renewable energy reports* 2 (3): 74-81.

Hannam, Kevin, Mimi Sheller, and John Urry. 2006. "Mobilities, Immobilities and Moorings." *Mobilities* 1 (1): 1-22.

Hine, Julian. 2016. "Mobility and Transport Disadvantage." In *Mobilities: New Perspectives on Transport and Society*, edited by M Grieco and J Urry, 21-40. London: Routledge.

Jimenez, Felipe. 2017. *Intelligent Vehicles: Enabling Technologies and Future Developments*. Oxford: Butterworth-Heinemann.

Jittrapirom, Peraphan, Valeria Caiati, A-M Feneri, Shima Ebrahimigharehbaghi, María J Alonso González, and Jishnu Narayan. 2017. "Mobility as a Service: A Critical Review

of Definitions, Assessments of Schemes, and Key Challenges." *Urban Planning* 2 (2): 13-25.

Joch, Alan. 2009. "Debating Net Neutrality." *Communications of the ACM* 52 (10): 14-15.

Kraus, Michael W, Jun Won Park, and Jacinth JX Tan. 2017. "Signs of Social Class: The Experience of Economic Inequality in Everyday Life." *Perspectives on Psychological Science* 12 (3): 422-435.

Levinson, David. 2010. "Equity Effects of Road Pricing: A Review." *Transport Reviews* 30 (1): 33-57.

Lindsey, Robin. 2006. "Do Economists Reach a Conclusion?" *Econ Journal Watch* 3 (2): 292-379.

Ling, Richard. 2012. *Taken for Grantedness: The Embedding of Mobile Communication into Society*. Cambridge, MA: MIT Press.

Litman, Todd. 2018. *Autonomous Vehicle Implementation Predictions: Implications for Transport Planning*. Victoria, BC, Canada: Victoria Transport Policy Institute

Lucas, Karen, Giulio Mattioli, Ersilia Verlinghieri, and Alvaro Guzman. 2016. "Transport Poverty and Its Adverse Social Consequences." *Proceedings of the institution of civil engineers-transport*.

Marsh, Peter E, and Peter Collett. 1986. *Driving Passion: The Psychology of the Car*. London: Jonathan Cape.

Martens, Karel. 2006. "Basing Transport Planning on Principles of Social Justice." *Berkeley Planning Journal* 19 (1): 1-17.

Middleton, Jennie. 2016. "The Socialities of Everyday Urban Walking and the 'Right to the City'." *Urban studies* 55 (2): 296-315.

Milakis, Dimitris, Bart Van Arem, and Bert Van Wee. 2017. "Policy and Society Related

Implications of Automated Driving: A Review of Literature and Directions for Future Research." *Journal of Intelligent Transportation Systems* 21 (4): 324-348.

Mladenovic, Milos N, and Tristram McPherson. 2016. "Engineering Social Justice into Traffic Control for Self-Driving Vehicles?" *Science and engineering ethics* 22 (4): 1131-1149.

Mullen, Caroline, Miles Tight, Anthony Whiteing, and Ann Jopson. 2014. "Knowing Their Place on the Roads: What Would Equality Mean for Walking and Cycling?" *Transportation Research Part A: Policy and Practice* 61: 238-248.

Naumann, Rolf, Rainer Rasche, and Jürgen Tacken. 1998. "Managing Autonomous Vehicles at Intersections." *IEEE Intelligent Systems and their Applications* 13 (3): 82-86.

Newton, Casey. 2014. "Uber Will Eventually Replace All Its Drivers with Self-Driving Cars." *The Verge*, 28 May.

Nozick, Robert. 1974. *Anarchy, State, and Utopia*. New York: Basic Books.

Oberholzer-Gee, Felix, and Hannelore Weck-Hannemann. 2002. "Pricing Road Use: Politico-Economic and Fairness Considerations." *Transportation Research Part D: Transport and Environment* 7 (5): 357-371.

O'Neil, Cathy. 2016. *Weapons of Math Destruction: How Big Data Increases Inequality and Threatens Democracy*. New York: Crown Books.

Pangbourne, Kate, Dominic Stead, Miloš Mladenović, and Dimitris Milakis. 2018. "The Case of Mobility as a Service: A Critical Reflection on Challenges for Urban Transport and Mobility Governance." In *Governance of the Smart Mobility Transition*, edited by Greg Marsden and Louise Reardon, 33-48. Bingley, UK: Emerald.

Rooney, David. 2014. "The Political Economy of Congestion: Road Pricing and the Neoliberal Project, 1952–2003." *Twentieth Century British History* 25 (4): 628-650.

Roth, Gabriel. 2017. *Street Smart: Competition, Entrepreneurship and the Future of Roads*.

London and New York: Routledge.

Rutten, Timothy. 2009. “Congestion Pricing: A Slippery Slope to Toll Roads.” *Los Angeles Times*, June 10.

Schepperle, Heiko, and Klemens Böhm. 2007. “Agent-Based Traffic Control Using Auctions.” *International Workshop on Cooperative Information Agents*, Berlin.

Schreurs, Miranda A, and Sibyl D Steuwer. 2015. “Autonomous Driving-Political, Legal, Social, and Sustainability Dimensions.” In *Autonomes Fahren*, edited by Markus Maurer, J Gerdes, Barbara Lenz and H Winner, 151-173. Berlin, Heidelberg: Springer Vieweg.

Seba, Tony. 2014. *Clean Disruption of Energy and Transportation: How Silicon Valley Will Make Oil, Nuclear, Natural Gas, Coal, Electric Utilities and Conventional Cars Obsolete by 2030*. United States of America: Tony Seba.

Sheller, Mimi. 2008. “Mobility, Freedom and Public Space.” In *The Ethics of Mobilities: Rethinking Place, Exclusion, Freedom and Environment*, edited by Sigurd Bergmann and Tore Sager, 25-38. Aldershot, England; Burlington, VT: Ashgate.

Sheller, Mimi. 2014. “The New Mobilities Paradigm for a Live Sociology.” *Current Sociology* 62 (6): 789-811.

Sheller, Mimi. 2018. *Mobility Justice: The Politics of Movement in an Age of Extremes*. London: Verso Books.

Sheller, Mimi, and John Urry. 2006. “The New Mobilities Paradigm.” *Environment and Planning A* 38 (2): 207-226.

Sheller, Mimi, and John Urry. 2003. “Mobile Transformations of 'Public' and 'Private' Life.” *Theory, Culture & Society* 20 (3): 107-125.

Sparrow, Robert, and Mark Howard. 2017. “When Human Beings Are Like Drunk Robots:

Driverless Vehicles, Ethics, and the Future of Transport." *Transportation Research Part C: Emerging Technologies* 80: 206-215.

Spieser, Kevin, Kyle Treleaven, Rick Zhang, Emilio Frazzoli, Daniel Morton, and Marco Pavone. 2014. "Toward a Systematic Approach to the Design and Evaluation of Automated Mobility-on-Demand Systems: A Case Study in Singapore." In *Road Vehicle Automation*, edited by G Meyer and S Beiker, 229-245. Cham: Springer.

Urry, John. 2000. *Sociology Beyond Societies: Mobilities for the Twenty-First Century*. London: Routledge.

Urry, John. 2007. *Mobilities*. Cambridge, UK: Polity.

Vanoutrive, Thomas. 2017. "Don't Think of Them as Roads. Think of Them as Road Transport Markets: Congestion Pricing as a Neoliberal Political Project." *Progress in Planning* 117: 1-21.

Vanoutrive, Thomas, and Toon Zijlstra. 2018. "Who Has the Right to Travel During Peak Hours? On Congestion Pricing and 'Desirable'travellers." *Transport policy* 63: 98-107.

Vaporis, Constantine N. 2005. "Lordly Pageantry: The Daimyo Procession and Political Authority." *Nichibunken Japan Review* 17: 3-54.

Vasirani, Matteo, and Sascha Ossowski. 2012. "A Market-Inspired Approach for Intersection Management in Urban Road Traffic Networks." *Journal of Artificial Intelligence Research* 43: 621-659.

Vickrey, William S. 1963. "Pricing in Urban and Suburban Transport." *The American Economic Review* 53 (2): 452-465.

Viegas, Jose M. 2001. "Making Urban Road Pricing Acceptable and Effective: Searching for Quality and Equity in Urban Mobility." *Transport Policy* 8 (4): 289-294.

Walzer, Michael. 1983. *Spheres of Justice: A Defense of Pluralism and Equality*. Oxford:

Blackwell.

Weinstein, Asha, and Gian-Claudia Sciara. 2006. “Unraveling Equity in Hot Lane Planning: A View from Practice.” *Journal of Planning Education and Research* 26 (2): 174-184.

Wilkinson, Richard, and Kate Pickett. 2010. *The Spirit Level: Why Equality Is Better for Everyone*. London: Penguin Books.

Wood, David, and Stephen Graham. 2006. “Permeable Boundaries in the Software-Sorted Society: Surveillance and the Differentiation of Mobility.” In *Mobile Technologies of the City*, edited by Mimi Sheller and John Urry, 177-191. New York: Routledge.

Wu, Tim. 2003. “Network Neutrality, Broadband Discrimination.” *Journal on Telecommunications & High Technology Law* 2: 141-176.

Ye, Mengmeng, and T Donna Chen. 2017. Best Practices for Existing Hot Lanes and Conceptual Framework for Variably Priced Fully Tolled Facilities. In *Transportation Research Board 96th Annual Meeting*. Washington.

Zimmer, John. 2016. “The Third Transportation Revolution: Lyft’s Vision for the Next Ten Years and Beyond.” *Medium, Sept* 18.

[1] Strictly speaking the introduction of such a cloud-based system for pricing access to the roads does not require the development of a MaaS model for the adoption of autonomous vehicles. A determined government could introduce such a system and legislate that all road users obey its dictates as a condition of using the roads (Buitelaar et al. 2007). However, we believe that it is more plausible that cloud-based systems would evolve as a result of private fleets offering pricing of journey times shaped by interactions between their own vehicles and then agreeing that the mechanisms to allow this should be extended across the whole of the road network. At that point it may well prove politically possible to require even vehicles owned by individuals to participate in such a system.

[2] To “network” AVs safely, governments will need to mandate the adoption of a set of standards that promote effective communication between the vehicles of different manufacturers (Sparrow and Howard 2017; also Fagnant and Kockelman 2015). Such standards are presently being developed, for example: SAE J2735 (http://standards.sae.org/j2735_201603/); and the United States Department of Transport connected vehicles program (https://www.its.dot.gov/cv_basics/).

[3] The ultimate impact of congestion taxes on equity remains a matter of significant controversy: Levinson (2010) argues that this depends heavily on how the income raised by these taxes is then spent.

[4] For discussion of the implications of the public nature of interactions on trains, see Butcher (2011). For discussion of the subjective impacts of interactions in public between pedestrians, see Middleton (2016). For some discussion of the importance of this dynamic in relation to the uptake of electric vehicles in China, see Curran and Tyfield (2019).

[5] One important empirical question here is how much the psychology of driving will transfer over to being a passenger in an autonomous vehicle that one does not own. Notoriously, drivers tend to see the vehicles they drive as their own personal territories and thus an extension of themselves, with the consequence that they take infringements of their "rights" on the road as a personal affront (Marsh and Collett 1986). It seems possible that when people cease to drive the vehicles in which they travel, and are typically engaged in other activities (sleeping, working, et cetera) while on the roads, they will cease to care so much about the behaviour of other vehicles.

[6] Superficially, having to make way for the wealthy is different to having to make way for the local nobility insofar as wealth is in theory something that anyone can acquire. However, for most people, who cannot afford to spend extra money on transport, this theoretical possibility is precisely that — entirely theoretical. It is also worth observing that, historically, it was theoretically possible for commoners to become members of the nobility through marriage.

[7] To be clear, we are rehearsing rather than endorsing this argument here. We discuss important limits on the appropriateness of the use of market mechanisms below.

[8] Admittedly, the roads are not very especially "public" – in the sense of being civic spaces in which political discussion occurs - public spaces, given that they are mostly reserved for motor vehicles and the limited range of interactions that people typically have on the roads (Sheller and Urry 2003). Conversely, freeing those involved in road travel to turn their attention to matters other than driving might allow them to participate more in public life online (Sheller 2004).