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Political Competition: How the Public Sector Helps the Sharing Economy Create Value." *Strategic Management Journal* 40(4): 503–32.
Parker, G. G., and M. W. Van Alstyne. 2005. "Two-Sided Network Effects: A Theory of Information Product Design." *Management Science* 51(10): 1494–1504.
Perlman, E. 2016. *Connecting the Periphery: Three Papers on the Developments Caused by Spreading Transportation and Information Networks in the Nineteenth Century United States*. PhD thesis, Boston University, Graduate School of Arts and Sciences.
Redding, S. J., and M. A. Turner. 2015. "Transportation Costs and the Spatial Organization of Economic Activity." In *Handbook of Regional and Urban Economics*, vol. 5, 1339–98. Amsterdam: Elsevier. https://doi.org/10.1016/B978-0-444-59531-7.00020-X.
Relihan, L. 2020. "Is Online Retail Killing Coffee Shops? Estimating the Winners and Losers of Online Retail Using Customer Transaction Microdata." London: London School of Economics working paper.
Roche, M. P. Forthcoming. "Taking Innovation to the Streets: Microgeography, Physical Structure and Innovation." *Review of Economics and Statistics* 102(5): 912–28.
Rochet, J. C., and J. Tirole. 2006. "Two-Sided Markets: A Progress Report." *RAND Journal of Economics* 37(3): 645–67.
Sohn, E., R. Seamans, and D. Sands. 2019. "Technological Opportunity and the Locus of Innovation: Airmail, Aircraft, and Local Capabilities." New York: New York University Stern working paper.
Sokoloff, K. L. 1988. "Inventive Activity in Early Industrial America: Evidence from Patent Records, 1790–1846." NBER Working Paper No. 2707. Cambridge, MA: National Bureau of Economic Research.
Wallsten, S. 2015. *The Competitive Effects of the Sharing Economy: How Is Uber Changing Taxis?* Washington, DC: Technology Policy Institute.

Comment Gilles Duranton

In their excellent chapter, Derrick Choe, Alexander Oettl, and Rob Seamans take a deep dive to examine two areas of the transportation sector, warehousing and personal travel with ridesharing services, and the future emergence of self-driving vehicles. Instead of trying to provide even more nuance to these thorough explorations, I would like to step back and draw some more general lessons, from these two case studies and from my own experience as someone who has been involved in transportation research for nearly 15 years. Doing this, I will highlight four key features of transporta-

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tion and seek to understand what they imply for innovation in the sector and in the broader economy.

The first key feature of transportation is the presence of externalities. For many good reasons, transportation is often synonymous with congestion. While the true economic cost of congestion is still open to debate, Parry, Walls, and Harrington (2007) suggest a social cost of congestion of 5 to 7 cents per mile based on the best existing evidence. This seems small relative to some popular estimates, for two reasons. First, analysts often appraise congestion relative to a free-flow benchmark. This is not correct, since it would be deeply wrong to allow only a few vehicles (to allow them to travel at full speed) during peak hours when everyone wants to travel. Instead, we must assess congestion relative to some optimal level. Second, the bulk of travel takes place outside the most congested areas and not at peak hours. Commutes, according to the National Household Travel Survey, represent less than one in five trips and only account for about a quarter of total mileage. Despite these caveats, "fixing congestion" through a Pigovian tax seems like a no-brainer. Unfortunately, it is easier said than done. Only a tiny number of cities worldwide have managed to impose congestion pricing. Despite its advantages, taxing congestion is a deeply unpopular policy.

Unfortunately, the story does not end here. Most importantly, "innovations" in transportation often worsen congestion. While ride-hailing services offer many advantages, they also possibly lead to more vehicles on the road. Worse than that, these vehicles often block an entire lane for a short time to allow passengers to get in or out. This delay does not seem like much, but in a congested urban environment, traffic can only move as fast as the slowest vehicles. A similar assessment can be made for last-mile delivery or new forms of micro-mobility. Because they worsen congestion, these innovations do not generate as much social surplus as they should. Self-driving cars will have similar implications. To see this, note that human-driven and self-driving cars will have to share the road, at least during a long transition period when human-driven cars are phased out. Then, the lower cost of self-driven travel relative to human-driven travel will lead to more miles traveled. Unfortunately, the presence of human drivers will preclude the benefits from stacking cars close to one another or from keeping intersections fluid in urban environments.

Levying a congestion charge on these innovations could increase economic efficiency. The optimal congestion tax depends sensitively on the state of traffic in a given location at a given time. But even such fine-tuning, if it ever becomes possible, would not achieve the efficient outcome. Driver behavior also matters. A driver who tries to go through creates much less congestion than a driver who slows down while cruising for parking. To avoid this type of congestion-inducing behavior, we need "urban innovations" beyond charging for congestion. Such innovations include smart metering for parking and reinventing the curb for deliveries and for the pick-up and drop-offs of new mobility services. Because congestion is an externality, there is no direct way to provide the right market incentives. Much of the answer here will depend on the authorities in charge of the cities. Unfortunately, local governments face governance challenges of their own, weak incentives to innovate, and an increasing reluctance to tackle issues where their policies might create some losers.

The second major externality associated with motorized vehicles is accidents. According to the review by Parry, Walls, and Harrington (2007), we might face a cost of about 5 cents per mile, corresponding to the valuation of more than 35,000 deaths and 3 million injured on American roads every year. The situation is much worse in developing countries, with perhaps more than a quarter million deaths annually on the roads of India. Because accidents hurt others, the incentives for drivers to pay attention are too weak. This situation is compounded by a variety of behavioral traits, such as most drivers think they drive better than most others and get distracted by new communication technologies. Worse, innovations in this area are skewed toward improvements in one's own protection, regardless of the social cost imposed on others. For instance, American drivers keep driving heavier vehicles to protect themselves against the carelessness of other drivers. In equilibrium however, the resulting rat race makes the situation worse for everyone.

In practice, governments are in charge of road security nearly everywhere in the world. They impose a variety of security mandates on vehicle producers and decide on the appropriate driving behavior and how strictly (or leniently) to enforce it. This regulatory role is often conducted without much economic thinking and is constrained by both industry lobbying and potential political backlash from reluctant drivers.

The third main externality in transportation is pollution. CO_2 emissions leading to climate change are obviously important. However, and perhaps surprisingly, local emissions—small particulates especially—are even more important, as their effects are immediate and, all too often, lethal. Overall, the cost of pollution associated with motorized vehicles is estimated at around 3 cents per mile (Parry, Walls, and Harrington 2007). Relative to the previous two externalities, pollution is perhaps handled better in the US. The gas tax can be viewed as an antipollution instrument, albeit an imperfect one. That said, this outcome is largely incidental, since the primary objective of the gas tax is to fund the federal road system.

Electric vehicles and fuel cells look like a game changer for pollution, provided that the original source of energy is cleaner than the fuel burned by combustion engines. Here again, governments manage innovation in the absence of strong market incentives. They do so very unconventionally relative to what happens in innovative industries like high-tech or pharmaceuticals. The traditional tools of patents, prizes, and patronage play minor roles in reducing pollution. Instead, most of the impetus for innovation is coming from indirect instruments like fuel economy regulations or direct subsidies for cleaner vehicles. Because there is little entry into the automotive sector (with Tesla being a conspicuous exception), most existing innovations come from incumbent firms with little that could be called "entrepreneurship." While this innovation system is far from what the textbook would recommend, there is little evidence about its efficiency or lack thereof.

A second key feature of the transportation sector is the fundamental role of public goods. The Interstate Highway System is one of the most significant pieces of infrastructure in the US. The large public good component of transportation gives governments an important role, perhaps even more than because of the externalities discussed above. In the US, various levels of governments fund the bulk of the transportation infrastructure, own most transit vehicles, and extensively regulate the operation of transportation from parking to taxis.

This public good dimension opens up a range of issues related to innovation. First, in the US, as in many countries, the transportation infrastructure can be accessed freely or at very low cost. This acts as a subsidy. Historically, building and paving roads was instrumental to the diffusion of automobiles. Today, the challenges are about providing a charging infrastructure for electric vehicles or developing a system of communication between vehicles over a range of a couple of blocks to facilitate the operation of autonomous vehicles.

Second, we can ask whether infrastructure provision can be harnessed to promote innovation. This was certainly the case with digital infrastructure. We would like to see more evidence for the role of transportation in the innovation process. One of the authors of chapter 5 has provided some pioneering evidence (Agrawal, Galasso, and Oettl 2017), but more work is arguably needed. Third, another challenge arises from the management of existing infrastructure. How can we make infrastructure better and more efficient? For instance, how do we get governments to adopt state-of-the-art traffic management technologies or smart metering for parking? How can we make buses more attractive? Governments have a fundamental role to play in addressing these challenges, but a big part of the difficulty is that they do not act in a void. Extensive government intervention has favored the emergence of powerful vested interests, who have a large say in how the transportation infrastructure is used or regulated. Transit unions and taxi associations are two cases in point.

The third key feature of transportation is the durability of its assets. Motorized vehicles typically last for 10 years or more, while roads are extremely long lived. Duranton and Turner (2012) show that early exploration roads of North America are good predictors of contemporary roads in the US. This fundamental feature of transportation has several implications for innovation in the sector. First, innovations may generate large social losses through the traditional business stealing effect. For instance, new and better vehicles lead to the depreciation of the value of older vehicles. Hence, the benefits of a new vehicles must then be weighted against the depreciation losses they generate for the existing fleet. While the business stealing motive pushes toward more innovation than is socially desirable, other forces push in the opposite direction. First, since older and less efficient vehicles see their value depreciate instead of being retired, the adoption of new vehicles is slow. In turn, this slow pace of adoption possibly reduces the incentives to innovate, since the profits of new and better vehicles will only appear far in the future. Then, knowing that a lot of capital gets sunk into transportation assets, buyers facing some uncertainties about the pace of innovation will prefer to wait before investing in something new. In short, as often happens, asset durability implies strategic delays.

That said, not all transportation innovations are about improving durable and expensive assets. The recent past offers two conspicuous exceptions. First, ridesharing platforms like Uber or Lyft did not involve the development of new assets. Instead, these platforms redeployed existing assets. As a result, they could grow extremely fast, since minimal investments are needed to transform a regular car into an "Uber" or a "Lyft." Second, the ongoing micro-mobility revolution in many large cities relies on asset-light vehicles, like electric scooters. Despite desirable properties, these two innovations have some drawbacks. Taxi rents were capitalized into highly valued medallions. These values plummeted after the entry of Uber and Lyft, creating large losses for taxi drivers who had recently acquired one. Eliminating the medallions rents is a sign of the greater efficiency of ridesharing platforms, but it also created serious unease. New micro-mobility vehicles will eventually require a dedicated infrastructure. This will entail some costs for governments and, likely, reduced capacity for other road users. So even innovations that can seemingly be deployed in a short time, like ridesharing or micro-mobility, face resistance by losers (ridesharing) or require some complementary investments (micro-mobility) leading to long adjustment periods.

The last key feature of transportation is that it affects the entire economy well beyond the 3.2 percent share in US GDP of the transportation sector. For instance, Americans in 2018 devoted nearly 16 percent of their expenditure and more than an hour daily to transportation. Transportation and logistics are also at the heart of all economic activity and increasingly complex value chains. What happens to transportation has economy- and society-wide implications through powerful general equilibrium effects.

Most importantly, transportation links our choice of residence to our choice of workplace through commuting. Put differently, transportation dictates what happens to our cities. The mass adoption of the automobile combined with the development of highways led to a massive physical extension of cities in the US with initially the suburbanization of residents followed by the decentralization of jobs. At the same time, city centers suffered following the exodus of better-off residents who could afford a car. The new highways also scarred city centers by cutting through neighborhoods and generating noise and pollution. Closer to us, there is emerging evidence that ridesharing services have already affected our cities, boosting areas that were previously less accessible with transit (Gorback 2020). This gain may have come at the expense of more accessible locations.

Looking forward, self-driving cars will have a first-order effect on our cities. There is no consensus yet on the subject. A lower cost of travel will likely favor remote locations, as it did in the past. If true, this transportation innovation will lead to another major wave of urban expansion. At the same time, a strong case can be made that central locations also have a lot to win from self-driving cars. Time in traffic obviously represents an important fraction of trip time but far from all of it. Reaching one's vehicle, getting into traffic, finding parking, and reaching one's final destination all take time. Being able to ride door-to-door and avoid all these steps will save a lot of time in city centers. In turn, following their physical expansion and their densification, the most prosperous cities may be able to grow their population by a lot. If that growth exceeds nationwide demographic growth, something will have to give. Less prosperous cities and rural areas may be in for an extremely hard time.

To conclude, the four key features of transportation highlighted here affect how innovation works in transportation. The first two, transportation externalities and the public good nature of the transportation infrastructure, give governments overwhelming influence. As we saw, several elements point to a limited ability of governments to innovate, including a lack of incentives and a reluctance to adopt innovations for fear of alienating some voters or some powerful vested interests. The third key feature of transportation, the durability of its assets, also appears to slow down innovation through several channels. Despite this, changes are happening, as documented by the authors of chapter 5. These changes have wide-ranging implications through general equilibrium effects, the fourth key feature of transportation highlighted here. The research challenge is thus twofold. First, we need to understand the broader implications of changes in transportation. Second, how can we better incentivize innovation in transportation despite its complicated and unusual environment? While the first challenge has received a lot of attention by transportation scholars, the second has barely been touched. I very much hope innovation scholars will push this agenda forward.

References

Agrawal, Ajay, Alberto Galasso, and Alexander Oettl. 2017. "Roads and Innovation." *Review of Economics and Statistics* 99(3): 417–34.

Duranton, Gilles, and Matthew A. Turner. 2012. "Urban Growth and Transportation." *Review of Economic Studies* 79(4): 1407–40.

Gorback, Caitlin. 2020. "Your Uber Has Arrived: Ridesharing and the Redistribution of Economic Activity." Working paper, Wharton School of the University of Pennsylvania, PA.

Parry, Ian W. H., Margaret Walls, and Winston Harrington. 2007. "Automobile Externalities and Policies." *Journal of Economic Literature* 45(2): 1335–53.