Micro-Regulation in the Platform Economy

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ABSTRACT

The widespread adoption of gig economy platforms like Uber, Lyft, and Airbnb has had a significant impact on local economies. City governments have struggled to address conflicts between local interest groups, incumbent industries, and the platforms themselves. While the focus has been on these conflicts, the policy debate has largely overlooked ways in which these platforms might—and already do—serve as a powerful tool for city governments to effect difficult policy goals. This Article explores how platform intermediaries like Uber and Lyft can serve as "intermediary regulators," using their unique economic position to aid in the implementation of public policy. Drawing on a novel dataset of vehicle registrations, this Article shows that Uber's and Lyft's own embedded vehicle eligibility requirements have already achieved progress on vehicle emissions reduction, increases in capacity utilization, and increased vehicle access and employment opportunities for low-wage and underemployed residents With this proof of concept in hand, the Article explores other ways that platform intermediaries can be engaged to further public policy goals, with an eye toward a realistic implementation of so-called micro-directives.

INTRODUCTION

When the United States withdrew from the Paris Climate Accord, mayors of thirty of the largest US cities decided they would uphold the agreement without the federal government.[1] Committing primarily[2] to expand renewable energy, vehicle emissions standards, and energy efficient buildings, the mayors hope to meet the Paris climate accord goals of reducing their cities' greenhouse gas emissions 26 to 28 percent below 2005 levels

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1   See Hiroko Tabuchi and Henry Fountain, *Bucking Trump, These Cities, States and Companies Commit to Paris Accord* (NY Times, June 1, 2017), online at http://www.nytimes.com/2017/06/01/climate/american-cities-climate-standards.html (visited Dec 28, 2018) (Perma archive unavailable); Michael D. Regan, *U.S. Cities, States Pledge Support for Climate Accord* (PBS, Nov 11, 2017), archived at http://perma.cc/NL7D-RL3A.

2   See Kristin Igusky, et al, *America's Pledge Phase 1 Report: States, Cities, and Businesses in the United States Are Stepping Up on Climate Action* *9–10 (Bloomberg Philanthropies, Nov 2017), archived at http://perma.cc/HTT8-AJ4C.

by 2025[3] without the involvement of the federal government. The so-called "Chicago Climate Charter" attracted city and state signatories that together account for more than 35 percent of the US economy.[4] In consequence, successfully meeting these goals would contribute significantly toward achieving the now-abandoned federal goal.

This is not the first time that US mayors have made joint environmental pledges. In 2005, the Mayors Climate Protection Center was founded with a similar goal. When the United States declined to ratify the Kyoto Protocol,[5] participating mayors pledged to "[s]trive to meet or beat the Kyoto Protocol targets in their own communities, through actions ranging from anti-sprawl land-use policies to urban forest restoration projects to public information campaigns."[6] Their enthusiasm notwith-standing, the mayors were largely unsuccessful. Among the cities that actually tracked and reported their progress, New York's and Chicago's emissions increased rather than decreased, with Chicago's 2020 emissions levels projected to be 62 percent above the target.[7] Commentators and academics have pointed out that while cities and local governments can pursue some avenues, such as educational programs and agreements with local businesses, they are unable to engage in policies that may have wider and more significant effects, such as implementing energy taxes or setting fuel efficiency standards.[8] Facing these limitations, they argue that national-level action may be a necessary ingredient in achieving these local goals.

This Article suggests that help lies in an unlikely place: American cities currently face the seemingly unrelated problem

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[3]   See Mitch Smith, *4 Takeaways from a Gathering of Mayors on Climate Change* (NY Times, Dec 5, 2017), online at http://www.nytimes.com/2017/12/05/us/climate-change-mayors-chicago.html (visited Dec 28, 2018) (Perma archive unavailable).

[4]   See *About* (We Are Still In, 2018), archived at http://perma.cc/V5KH-YR2X. See also, generally, City of Chicago, Office of the Mayor, *Chicago Climate Charter* (Dec 5, 2017), archived at http://perma.cc/98LK-95NR.

[5]   See Paul Reynolds, *Kyoto: Why Did the US Pull Out?* (BBC, Mar 30, 2001), archived at http://perma.cc/E343-XKKX.

[6]   See *Mayors Climate Protection Agreement,* (United States Conference of Mayors) archived at http://perma.cc/C5UB-6QX7.

[7]   See Todd Myers, *U.S Mayors on Climate: This Time Will be Different* (National Review, June 15, 2017), archived at http://perma.cc/Z5MM-APG4.

[8]   See Miranda A. Schreurs, *From the Bottom Up: Local and Subnational Climate Change Politics* 17 J Envir & Dev 343, 349–352 (2008). See also Samuel Fraiberger and Arun Sundararajan, *Peer-to-Peer Rental Markets in the Sharing Economy* *25 (NYU Stern School of Business Research Paper, 2017), archived at http://perma.cc/EC8S-UBWD;

of managing the rapid growth and adoption of gig economy[9] businesses like Uber, Lyft, and Airbnb. These businesses, at their heart, lever technology to create low-cost two-sided markets, connecting, for example, riders and drivers in the case of Uber and Lyft, or empty housing with vacationers in the case of Airbnb. These businesses have been embroiled in regulatory controversies and pushback from all sides, even as they have ballooned in popularity around the world. Commentators have decried,[10] incumbents have lobbied, and cities in the US[11] and globally[12] have responded with outright bans or per-use taxes on rideshare services aimed at raising revenue.[13]

This Article takes these controversies between gig economy platforms and the various interest groups in opposition as given and does not attempt to resolve them. These controversies notwithstanding, the Article instead seeks to highlight the underappreciated opportunities that these new businesses and two-sided platforms—more generally—offer that can aid cities in effecting unrelated policy goals. Government engagement with these platforms has so far been limited to ignoring them, banning them, or imposing limited surcharges.[14] In short, these platforms furnish local regulators with a powerful set of levers perfectly suited to the monitoring and enforcement of otherwise difficult to implement regulatory aims. As platform intermediaries between two broad groups of people, their technology, their

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[9]   Others have used terms like "sharing economy" or "new economy." See generally, for example, John J. Horton and Richard J. Zeckhauser, *Owning, Using, and Renting: Some Simple Economics of the 'Sharing Economy"* (NBER Working Paper 22029, Feb 2016), archived at http://perma.cc/VK8A-SJPJ; Maryam Razeghian and Thomas A. Weber, *To Share or Not to Share: Adjustment* Dynamics in Sharing Markets (École Polytechnique Fédérale de Lausanne Research Paper, Nov 2016), archived at http://perma.cc/S2E8-4MAN. This paper adopts "gig economy" to emphasize the two-sided nature of the markets that these services create, which is central to this Article's themes.

[10]   For a detailed account, see generally Brishen Rogers, *The Social Costs of Uber* 82 U Chi L Rev 85 (2016); Cristiano Codagnone, Federico Biagi, and Fabienne Abadie, *The Passions and the Interests: Unpacking the 'Sharing Economy'* (Joint Research Centre, 2016), archived at http://perma.cc/BP3G-UM96.

[11]   See Dave Lee, *What Happened in the City that Banned Uber* (BBC News, Sept 30, 2017), archived at http://perma.cc/5L8L-7SLZ.

[12]   Anna Rhodes, *Uber: Which Countries Have Banned the Controversial Taxi App* (Independent, Sept 22 2017), archived at http://perma.cc/C3NZ-WKZQ.

[13]   Winnie Hu, *When Calling an Uber Can Pay Off for Cities and States* (NY Times, Feb 18, 2018), online at http://www.nytimes.com/2018/02/18/nyregion/uber-lyft-public-transit-congestion-tax.html (visited Dec 28, 2018) (Perma archive unavailable).

[14]   See, for example, id (illustrating how New York, Philadelphia, and Boston implemented surcharges to raise money for other projects).

interests in data collection, and their centralized control over their platforms make possible regulations that city governments could not currently implement. By working with, rather than against, these platform intermediaries, cities have the opportunity to capture the power of what this Article calls intermediary regulators. These intermediary regulators can in turn be harnessed to make progress on issues in which cities have an intense regulatory interest.

Consider, for instance, the mayors' climate pledge. How, for example, might a city reduce vehicle carbon emissions? Consider first a ban or tax on vehicle emissions imposed at the city level. Monitoring and enforcement will likely be expensive for a city to handle on its own. Difficulties in implementation will likely be compounded by geographical realities.

For example, if vehicles registered in New York City are required to meet certain emissions standards or pay a tax, how should the city handle out-of-city commuters coming from Long Island or New Jersey? Additionally, political economy issues arising from conflicts between state and local regulators are an important consideration. Vehicle registrations, inspections, and record-keeping occur at the state level, and to the extent that cities and states have different political aims, cities may be handicapped in their ability to lever this existing data infrastructure.

Additionally, such regulations likely exist on a spectrum of hard-edged and simple to implement versus soft-edged and hard to implement. An outright ban of certain high-emissions vehicles in the city, for instance, is relatively straightforward to implement given current technology and infrastructure.[15] Such a ban, however, has drastic and hard-edged consequences for drivers of banned cars, and is likely to be regressive in effect as lower-income residents on average own older, cheaper, and more polluting cars. Low-income residents, additionally, are least able to adjust the vehicles they drive. A lighter-touch regulation, such as a charge per gram of carbon dioxide emitted, would have a less dramatic impact but detecting an (even approximate) amount of CO_2 emitted within city limits for a given vehicle is well beyond the current infrastructure capabilities of most city governments.[16] One can imagine additional refinements, such as

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[16] Annual mileage checks, for example, will not work, as it would not be possible to tell which miles were driven within the regulating city's limits.

bonuses for carpooling, whose implementation is even further out of reach.

Consider instead the intermediary regulation approach. In exchange for a license to operate, the city asks rideshare intermediaries like Uber and Lyft to pay fees based on the amount of emissions their drivers generate. The incidence of this tax falls jointly on the intermediary, the driver, and the rider, giving them each soft incentives to alter their behavior. For example, the intermediary may implement fuel emissions standards as a requirement to drive. In response, the driver, when choosing among vehicles, might pick a more fuel-efficient one. The rider, facing slightly higher costs, might walk or take public transportation if he or she is close to indifferent. Monitoring and enforcing this regulation imposes essentially no extra costs on the rideshare services because they already require vehicle inspections and collect highly detailed, geocoded data regarding trips for their own internal marketing and pricing purposes. Additionally, in contrast to fees or bans applied wholesale to all cars registered in the city, such a regulation would apply only to those cars and drivers who affirmatively chose to take part in the sharing economy and only when they do take part in the sharing economy, making the regulation a much lighter touch. Finally, since sharing economy applications by design track usage and distance driven, the regulation is easy and natural to apply to usage directly, by manner of the activity that actually generates the pollution. Refinements, such as bonuses for carpooling, driving in a more fuel-efficient manner, or even more targeted location-based regulations, impose essentially no extra cost to implement.

The main question is whether this approach is powerful enough to make a quantitatively meaningful impact. Using an intermediary regulation that is already in place by Uber and Lyft, this Article provides empirical support in the affirmative. Uber and Lyft impose age and body type requirements on the vehicles used on their platforms. This Article shows that, following the entry of Uber or Lyft, there is a significant shift in the composition of a city's overall automobile stock toward Uber or Lyft-eligible vehicles. Rideshare drivers acquire eligible vehicles and nondrivers rely on their own, ineligible vehicles less. The overall stock of vehicles, as opposed to simply those used by rideshare drivers, becomes more compliant on average. This is true in terms of both raw registrations and utilization rates. Moreover, while these requirements only directly concern age

and body type, age and body type are empirically related to greater fuel economy and lower carbon emissions. As a consequence, cities that rideshare services have entered have already seen an increase in overall fuel economy and a decrease in average emissions.

This Article goes on to consider other avenues through which rideshare services in particular, and gig economy intermediaries in general, can work together with city governments and other regulators as light-touch policy instruments. Rather than applying narrowly to vehicle environmental considerations, the framework also applies to a broad collection of regulatory considerations: traffic congestion, vehicle safety, green buildings, and even labor law. More theoretically, intermediary regulation is a first, realistic step toward implementing micro-directives of the kind envisioned by Professors Anthony J. Casey and Anthony Niblett, in their series of works discussing self-driving laws and contracts.[17] This Article discusses these applications as well as potential drawbacks and shortcomings in subsequent Sections.

In the broadest sense, this Article suggests reimagining the industrial organization of regulation. Taking the amount of desired regulation as given, one might ask how various regulatory functions should be divided among the implicated governments and economic actors. These trade-offs touch on lessons from the Coasean theory of the firm as applied to regulators: What are the property boundaries of the regulator in a given market? That is, conditional on a regulatory goal, which aspects of its implementation are best suited to take place inside the regulator proper, and which aspects are more efficiently handled by an actor other than the regulator? This Article suggests that, when it comes to markets in which these technological intermediaries operate, the intermediaries possess an immense comparative advantage in implementation and enforcement over a government regulator. For example, certain regulatory activities that the government proper undertook on taxi licensing, vehicle emissions inspections, driver certification, and collection of fees can be implemented at a much lower cost by virtue of intermediaries already being positioned to collect data and transactions

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[17] See generally Anthony J. Casey and Anthony Niblett, *The Death of Rules and Standards,* 92 Ind L J 1401 (2017); Anthony J. Casey and Anthony Niblett, *Self-Driving Laws,* 66 U Toronto L J 429 (2016); Anthony J. Casey and Anthony Niblett, *Self-Driving Contracts*, 43 J Corp L 1 (2017).

on their platforms. The proper role of the government, then, focuses on choosing from among a richer menu of policy options and ensuring compliance among a small set of intermediaries. The Article considers, along with the possible benefits outlined here, some drawbacks and criticisms of such an approach.

The Article proceeds as follows: Part I begins with an in-depth case study regarding Uber's and Lyft's existing intermediary regulation and its quantitative effects. Having shown that such an approach can be a powerful regulatory lever, the Article proceeds in Part II with a broader view, introducing a simple framework for intermediary regulation and discussing other applications, both in the context of Uber and Lyft but also in other sharing economy services.

I. UBER AND LYFT: A CASE STUDY

Uber began operation in San Francisco in 2009. It has since spread to other cities in the United States and worldwide, with competitors like Lyft following closely behind. While initially marketed as a premium, members-only cab service[18] with its own fleet of cars, Uber quickly grew in size and scope and allowed any qualified driver with an eligible car to drive. Uber's main competitor, Lyft, followed a similar approach, albeit typically slightly behind its larger competitor. These services impose eligibility requirements on vehicles used on their platforms. While self-imposed, these regulations resemble the type that a city or municipal government might consider in order to achieve some policy goal. For instance, extending the eligibility requirement to explicitly cover carbon emissions is one such possibility that would resemble very closely the current eligibility requirements in application. Consequently, this Part takes the existing eligibility requirements as a case study in the dynamics and effectiveness of such a regulation.

This Part begins by describing the big-picture reasons for why Uber and Lyft, and intermediary regulators more generally, have the potential to be plausible and powerful tools in regulation. This Article then finds support for these contentions in the data. It shows empirically the broad reach of these services and that the existing eligibility requirements have had a significant aggregate impact in the cities in which these services operate.

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[18]   See John Mannes, *Here is Uber's First Pitch Deck* (TechCrunch, Aug 23, 2017), archived at http://perma.cc/8EM6-PC37.

A.   Uber and Lyft as Intermediary Regulators

The key role of Uber and Lyft, and indeed most gig economy apps, is that they act as middlemen between customers buying a service (a ride, a place to sleep, a moving helper) and suppliers of that service (drivers, hosts, or movers). Gig economy applications provide a platform, facilitate transactions, and monitor the activity on the platform to ensure that their customers and suppliers connect quickly, easily, and with minimal difficulties. As intermediaries, Uber and Lyft (1) reach many people on both sides of the market, and (2) monitor and collect extensive data used to enforce compliance among their user base. It is these two characteristics that make them powerful intermediary regulators with advantages over traditional regulators.

1.   Intermediaries and the law of large numbers.

Uber and Lyft reach a large market, and it is in their interest to do so. Figure 2 Panel (a) shows that Uber, Lyft, or both Uber and Lyft are active in American cities whose total population is roughly 200 million, amounting to over 60 percent of the total American population. These numbers represent potential demand-side users of the platform. On the supply side, the number of active drivers is also large. Figure 2 Panels (b) and (c) show active Uber drivers from Uber's internal data. Panel (b) shows that there were roughly 500,000 registered Uber drivers in 2016, with that number growing to 800,000 in 2017. Driver growth continues long after the platform enters a given market: Panel (c) shows that in San Francisco, where Uber has been active the longest, the platform attracted 10,000 new drivers in 2016 alone, representing a roughly 30 percent year-over-year growth rate even seven years after its initial introduction. These numbers do not include Lyft drivers, and, while there is significant overlap between the groups, it is not total. These estimates therefore represent a lower bound on supply-side participation in ridesharing services.

These large raw numbers make two important points. First, these numbers illustrate that these intermediaries have great reach in terms of potential riders and drivers. As a consequence, they are likely to wield significant influence over the lives and economic decisions of the people whose transactions they intermediate. This Part concerns itself with documenting the characteristics of these people and the specific ways in which the platforms' policies have influenced their behavior.

Second, these numbers support the idea that gig economy intermediaries benefit from significant economies of scale. On the technology side, the economies of scale materialize because the large fixed costs of developing and supporting the platform are spread over many users, with each new user contributing only small marginal costs: the app, once developed, flexibly accommodates additional users and cities. Contrast this with, for example, one hundred separate city-level systems of recording and monitoring drivers in the city, in which there are similar economies of scale *within* the city but not *across* cities. This means that, while such a system may be economical for New York, a smaller city may struggle.

In fact, the large user base is precisely what makes the platforms' services valuable to consumers. For riders to have low wait times and drivers to have low idle times, there needs to be a sufficiently active user base on both sides of the market in order to smooth out the periodic arrival of riders and drivers. Uber is a more valuable service for riders when there are many drivers. Conversely, Uber is a more valuable proposition for drivers when there are many riders. The business model is essentially an application of the law of large numbers. Consequently, all users on the platform, including the platform itself, benefit when many participate on the platform. As a result of these forces, gig economy intermediaries have an especially strong incentive to get large and grow larger. This plays directly into their power as instruments of regulation.

2. Intermediaries and data collection.

The platforms' position as intermediaries means that they can and do collect a significant amount of data. When drivers register on the platform, they are subject to initial background screening and automobile inspection to ensure that they meet the platform's requirements. Once on the platform, users generate additional data: times and locations of requests and pickups, routes taken, and so on. Importantly, it is in the platform's economic interest to collect this data and to do so accurately. For the platform to work, it needs to know drivers' and riders' locations. But the value of the data collection goes beyond this: to keep users active on the platform, the intermediaries utilize this data to minimize waiting times and idle times for riders and drivers, while also maximizing revenues for the platform itself. Doing so requires understanding supply and demand trends in

real time. Again, this necessitates significant data collection. Somewhat controversial policies like Uber's surge pricing are attempts to equalize the number of riders and drivers on the system as demand and supply ebb and flow. Platforms also have an interest in optimizing routes for traffic flow and so on, particularly for their carpooling services like Uber Pool and Lyft Line.

The effect of this data collection is to greatly expand the potential contracting or regulation space. It expands what is observable, verifiable, and enforceable. Complicated contingent contracts can be enforced because this data makes the platform an objective judge, jury, and executioner, all the while leaving an auditable data trail that accountable to government oversight. The platform can, for instance, go so far and in such great detail as to penalize a driver who drives a loud vehicle model too fast down a particular residential street late at night.

The combination of broad reach and detailed data collection makes these rideshare services powerful potential regulators. The large user base means that the policies that they implement will reach broad swaths of people. The detailed data collection and control over the platform means that the intermediary can set and enforce very detailed and fine-tuned regulations over participation in the platform. The upshot is that city governments and gig economy regulators can potentially regulate a large number of people with a very detailed set of regulations, from vehicle characteristics to emissions taxes to carpool programs specifically targeted toward certain times and locations.

The regulations work through voluntary compliance on the part of the users. For instance, when it comes to emissions regulation, the government will not ban anyone from driving a polluting car or suddenly render old vehicles belonging to lower income drivers illegal. Rather, the regulation applies only to those who willingly avail themselves of the platform: a rider will be riding in a more fuel-efficient car, or a driver will be driving a more fuel-efficient car. A driver may be subject to a lower emissions fee by driving a lower emissions vehicle. A rider may take advantage of carpooling subsidies by joining Uber Pool or Lyft line.

The set of possible regulations is not limitless, however. The voluntary and soft-touch nature of the approach means that to the extent that the policy reduces the number of users on the platform, or drives people away from using the platform altogether, strict regulations lead to exit from the regulated ecosystem and less regulation overall. Data generated by the interme-

diaries themselves will go a long way toward quantifying these potential effects.

B. Intermediary Regulation in Practice

The question remains whether this theoretical approach has any real-world teeth. To answer this question, this Article considers the case of a self-imposed intermediary regulation: vehicle eligibility requirements. To a first approximation, a vehicle is eligible for Uber of Lyft if it:[19]

1. Is no more than 10 or 15 years old (depending on the market)
2. Is a four-door sedan, SUV, or minivan
3. Is in good condition with no cosmetic damage
4. Has no commercial branding
5. Passes a vehicle inspection

The required vehicle inspection involves a physical inspection at a Greenlight Hub or Spot,[20] where an Uber Expert verifies that the car complies with the requirements. The driver cannot sign onto the Uber system until he or she passes the inspection.[21]

This Article explores whether this regulation has impacted vehicle stocks, purchases, and usage in Uber and Lyft cities. The outcome of interest is not simply whether the drivers themselves comply, which is, of course, required. Rather, the question is whether, through the drivers' compliance, there are measurable shifts in aggregate behavior.

This Article begins by measuring how vehicle access and financing have changed and shows that indeed there have been large changes as residents of Uber and Lyft-treated cities have responded to the platforms' entry. This Article then shows how the characteristics of the driven vehicles, in terms of quantity, usage, and desirability of features, have begun to react. Finally, this Article takes a step back to survey the total changes so far, both in terms of drivers and in the characteristics and usage of the vehicles in the affected markets. This Article then considers how far these changes may go. By studying this particular intermediary regulation, this case study aims to present evidence

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[19] See Figure 1 for details.
[20] See, for example, *Vehicle Inspections: Seattle* (Uber), archived at http://perma.cc/K99L-M5UF.
[21] See id.

of the mechanisms of potential effectiveness of intermediary regulation more generally.

C.   Data

This Article brings together a number of novel and existing data sets. This Section briefly describes the collection, scope, and limitations of the data.

1.   Uber and Lyft data.

The Article uses two sources of data on Uber and Lyft: one created from public data, one a proprietary dataset provided by Uber. The public dataset provides the locations and dates of rideshare entry for both Uber and Lyft. This dataset is hand collected using news reports and company press releases. Uber and Lyft entry happens approximately at the city (CBSA) level, beginning in 2010 and still ongoing as of 2017. The services did not enter all locations at once. Rather, they entered cities in a staggered fashion.

The proprietary dataset provided by Uber is at the Uber market and month level. An Uber market is approximately a CBSA. The dataset records the number of active drivers in each market and at each month. A driver is active if he or she picks up at least one passenger within the Uber market within the month.

2.   Departments of motor vehicles (DMV) data.

This Article makes use of vehicle registration data from Indiana, South Carolina, and Washington. While all states track vehicle registrations, these states made their data available for use in this study. Drivers must register their vehicle in order to drive it on public roads. Registration costs money and requires an up-to-date inspection. As such, this data set provides a clean and comprehensive measure of the active automobile capital stock within a state across time. The registration data include all vehicle registrations from 2010 to 2016. The data also include the vehicle identification number (VIN), zip code, and month of registration. Additionally, South Carolina and Washington record odometer readings when vehicle registrations change hands. While this data is extremely detailed, the primary drawback is that is it not linked to individual drivers and so inferences regarding vehicle ownership must be done at the zip code level.

3. NHTSA and FuelEconomy.gov database.

The VIN recorded in the vehicle registration data contains a detailed vehicle make and model identifier that can be merged with the National Highway Traffic Safety Administration's (NHTSA) database. This database contains detailed physical attributes and manufacturer attributes of the car, including model year, manufacturer, engine displacement and horsepower, number of doors, and body type. This can also be merged, albeit in a more manual way, with data from FuelEconomy.gov, which contains, in addition to fuel economy data, emissions and other environmental data. The upshot of this merger is that each vehicle registration provides detailed car-level attributes about the registered vehicle.

4. Credit data.

The Article uses credit data from Equifax to measure the numbers of new and outstanding auto loans. The data are recorded at the zip-reporting, month-origination month level. Breaking this down, for a particular zip-month, the data present the loan balance and performance data for each vintage of loans. It covers auto loans, as well as mortgages, student loans, credit cards, and other consumer finance loans. This data allows for a zip-quarter measurement of new loan originations, total outstanding loans across existing vintages, and loan performance. As with the DMV data, a limitation of this data is that it is linked to zip codes rather than individuals.

5. Demographic data.

This Article complements the rideshare, vehicle, and loan data with standard demographic variables from the 2010 United State Census and American Community Surveys between 2010 and 2016. The Article utilizes zip and CBSA-level data regarding, among other things, population, wages, unemployment, public transportation use, worker commutes, education, race, and age.

D. Funding Uber Drivers

As a descriptive matter, ridesharing services attract a large number of drivers. Figure 2 Panel (b) shows the total number of registered Uber drivers in the United States. Panel (c) shows this broken out for a few representative cities. As of the end of

2016, there were nearly 800,000 Uber drivers. This does not include Lyft drivers, although, anecdotally, there is significant overlap. This number has grown rapidly and appears to show no signs of slowing down. Panel (c) shows that even for San Francisco, where Uber has been active the longest, the number of drivers continues to rise rapidly. Note also the number of Uber drivers in Austin, Texas dropped when the city banned Uber in 2016.

Though it may go without saying, in order to be an Uber or Lyft driver, one needs a car. Matching drivers to cars is not a trivial problem. A major selling point of the rideshare economy is that drivers can earn extra money with the car they already have. This misses the fact that those who owned cars before Uber or Lyft came into being are not typically good candidates to be Uber or Lyft drivers, and those who are good candidates to be Uber or Lyft drivers are significantly less likely to own cars before the services entered their local economies. In particular, car ownership is highly correlated with earnings, and a high-earner has a high opportunity cost of time spent being an Uber driver, making driving for Uber an unattractive proposition for ex ante car owners, on average. This tension, arising from the mismatch in who owns cars ex ante versus who is an efficient rideshare driver, leads to a large reallocation in ownership and vehicle financing when Uber or Lyft enters a market.[22] It is this large reallocation and its effects that this sSection documents and explores.

This Section leads off with an analysis of which segments of the population possessed cars before ridesharing applications entered the market. The data shows the number of auto loans by zip code. The objective is to understand, within a city, which zip codes tend to have more auto loans. The question of ex ante allocation is important because it greatly impacts the nature of the reallocation and purchasing of new, eligible vehicles that occurs upon entry. The following regression sheds light on this question:

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[22]   Using more macro data in China, Professors Jing Gong, Brad N. Greenwood, and Yiping Song show a similar jump in the quantities of vehicle registrations around Uber entry. This Article provides greater detail regarding financing and vehicle characteristics in the US market. See generally Jing Gong, Brad N. Greenwood, and Yiping Song, *Uber Might Buy Me a Mercedes Benz: An Empirical Investigation of the Sharing Economy and Durable Goods Purchases* (May 19, 2017), archived at http://perma.cc/B7Q9-G2LM.

$$\left(\frac{Loans}{Capita}\right)_z = x_z'\beta + \gamma_c + \epsilon_z \ (1)$$

x_z is a vector of demographic characteristics of the zip code and γ_c is a CBSA fixed effect. This regression differences out average differences in demographics across CBSAs and therefore focuses on within-CBSA differences among zip codes. In particular, what are the relative characteristics of a zip code within a city that are associated with vehicle ownership?

Table 1 shows the results for 2010, before the entry of Uber and Lyft. Column (1) looks at outstanding loans per capita while Column (2) looks at new originations per capita. Importantly, regarding labor market conditions in the zip code, high-wage zip codes have significantly more outstanding loans and new originations per capita, with zip codes of 1 percent higher relative wages having roughly nine more outstanding loans per one thousand residents. Similarly, higher-unemployment zip codes have fewer auto loans, with a 1 percent higher relative unemployment rate being associated with roughly eighteen fewer loans per one thousand residents. While these labor market indicators are the most important finding of this analysis, it is also worth noticing the perhaps unsurprising result that there are more auto loans in areas with fewer people taking public transit and greater commute times.

The upshot of Equation (1) and Table 1 is that prior to the entry of Uber and Lyft, car possession was concentrated in high-wage, low-unemployment zip codes. This presents a problem for the gig economy's pitch of households using their cars to earn extra money. High wage earners with low unemployment rates are not good candidates to be Uber drivers because the value of their time is high. Rather, the ideally suited candidates are low-wage people with poor employment prospects. The problem that the above analysis reveals is that this segment of high-productivity drivers is much less likely to have cars. Therefore, for the platform to attract drivers, lower-wage people will need to get cars. Because they are unlikely to be able to pay outright, they will need to get car loans. Consequently, the next Section investigates how the entrance of Uber and Lyft impacts consumer auto credit with an eye toward whether the predicted drivers in low-income households indeed increase borrowing in order to finance vehicle purchases.

Because Uber and Lyft entered different markets at different times, this Article uses a difference-in-difference approach to

study loan growth in different cities and different zip codes after entry. Note that entry is staggered, but not all zip codes receive treatment. Therefore, treated and untreated zip codes are matched based on population, wage, and commute time. With the matched sample, the Article considers the following regression specifications:

$$\Delta Loans_{zt} = \beta_1(Post_{mt} \times Treated_z) + \gamma_{tm} + \gamma_z + \epsilon_{zt} \qquad (2)$$

$$\Delta Loans_{zt} = \beta_1(Post_{mt} \times Treated_z) + \beta_1(Post_{mt} \times Treated_z \times Char_z) \, \gamma_{tm} + \gamma_z + \epsilon_{zt} \, (3)$$

The first specification is a standard difference-in-difference approach comparing like treated and untreated zip codes before and after treatment has occurred. In this specification, $\Delta Loans_{zt}$ is cumulative loan growth since 2010. $Post_{mt}$ is whether the matched pair's treated zip code has received treatment as of time t. $Treated_z$ is an indicator for treatment within the matched pair. γ_{mt} and γ_z are match-time and zip code fixed effects. The zip code fixed effect γ_z absorbs unobserved zip-level differences in growth while the match-time fixed effect γ_{mt} absorbs time differences within the matched pair. The regression tests whether loan growth is faster in treated zip codes as compared to the zip code's untreated match.

The second specification includes a third difference, testing whether the treatment effects are larger for zip codes or CBSAs with different characteristics. The characteristics are (1) relative wage of the zip code within the CBSA, which is testing the hypothesis that low-wage zip codes see greater loan growth because low-wage workers are better candidates to participate in the sharing economy, and (2) ex ante correlation between wages and car ownerships within the CBSA.

$$\Sigma_c = Correlation \, (log \, wage_z, \, loans_z) \quad (4)$$

This tests the hypothesis that cities in which, prior to rideshare entry, car ownership was most correlated with wage need to do the most adjusting of car ownership toward low-income zip codes. Consequently, these cities see the greatest loan growth. Note that the specification in (3) allows for CBSA-year fixed effects, which would absorb any endogeneity in the entry of Uber and Lyft, although the tables in this Article omit

this fixed effect so that the level effects can be compared with the interactions. Unreported regressions, with these fixed effects included, confirm the third difference results shown here.

The results of (2) and (3) are shown in Table 3. Columns (1)–(3) study new loan originations; (4)–(6) study outstanding loan growth. All columns include time-match fixed effects as well as zip fixed effects, which controls for all time-invariant, zip-level, unobservable characteristics. The Post coefficients capture the different impacts of treatment after treatment has occurred. Column (1) shows that new loan originations are roughly 5 percent higher in treated zip codes in the years following rideshare entry as compared to untreated zip codes after treatment, suggesting that the entrance of Uber or Lyft is associated with a significant increase in overall credit. This is confirmed in Column (4), which shows a similar increase in the stock of outstanding auto loans of 2.3 percent in treated zip codes following rideshare entry.

Besides the level effect, this is also a large differential effect based on zip code wages and ex ante correlations of ownership and wages. Column (2) shows that while the overall effect is positive, treated zip codes with higher wages see significantly lower new loan growth. Column (5) confirms that this finding holds with respect to the stock of outstanding loans. This is consistent with the hypothesis that it is low-wage, rather than high-wage, workers, who are most likely to enter the ridesharing economy as drivers and acquire new vehicles when doing so.

Finally, Columns (3) and (6) show that the ex ante distribution of auto credit access had a large effect on the subsequent credit expansion. Those cities in which wages and ownership were highly correlated saw the greatest growth in new loan origination and total outstanding loan growth. This is, again, consistent with the hypothesis that cities in which car ownership was concentrated in the highest-wage zip codes had the most reallocation of ownership toward low-wage zip codes, in which workers are more suited to spend their time driving in the gig economy. When cities have high-wage-ownership correlation, it means that the rich have cars and the poor do not. This is a double effect for the gig economy: not only do the poor have to obtain cars in order to participate, but the rich having cars ex ante indicates a high demand for car services. This means the demand for gig economy services is likely to be higher in that city.

Before concluding this Section, this Article turns briefly to identification concerns. The critical assumption in the difference-in-difference empirical setup is that of parallel trends pre-treatment. That is, that treated zip codes and their untreated matches should see similar rates of loan growth. A violation of this requirement could indicate, for example, that Uber and Lyft located cities in which low-wage zip codes were increasing their auto-borrowing and entered there endogenously, knowing that these cities would have large pools of potential drivers with cars.

To rule out this possibility, the event study shown in Figure 3 shows differences between treated and untreated zip codes versus event time, whereby entry occurs at time t = 0. Panel (a) considers loan growth overall, (b) considers differences between high and low-wage zip codes, and (c) considers high- and low-wage-ownership correlation cities. In all cases, pre-trends show close to no differences before treatment. Notice also that these figures show essentially no loan growth in the highest-wage zip codes and in the cities with the least ex ante misallocation. Additionally, Table 4 recreates the event study with treatment status and time randomly assigned within matched pairs. As expected, this placebo test produces a null result. Finally, unreported analyses predicting entry indicate that the best predictors of rideshare entry in a city are overall population levels and mobile broadband access. These are both absorbed in zip code fixed effects.

The analysis in this Section concludes with a brief test of how the intermediaries are themselves affected by this process of reallocation. Because, on average, a reallocation from rich to poor is necessary for the widespread entry of Uber or Lyft drivers, does this reallocation presents a hindrance to the intermediary's expansion in a city? For example, do low-wage borrowers appear to have trouble obtaining auto credit if they otherwise have bad credit scores? This is important from the intermediary's perspective because it suggests that the intermediary could benefit from stepping in to solve this problem, if it exists.

To test this, this Article first constructs a simple proxy of differential rideshare credit cost across cities as follows:

$$Cost_c = Correl(\log wage_z, GoodCredit_z) \quad (5)$$

This measure is the within-city correlation between wages and good credit, whereby good credit is defined as the percent of mortgage borrowers who are not subprime borrowers. The cost is

high for cities in which high-wage zip codes are most likely to be good-credit zip codes. Note that on average this number is positive but there is significant variation across cities. The intuition behind this measure is that when the good-credit zip codes are the high-wage zip codes, the low-wage potential drivers face greater credit costs when they seek to obtain credit. The prediction is that cities with greater costs see slower uptake of rideshare driving. In particular, the test is whether six months after Uber entry, cities with high costs have fewer drivers per capita than cities with low costs. The regression is as follows:

$$\left(\frac{Drivers}{Capita}\right)_c = \beta_0 + \beta_1 Cost_c + x'_c \Gamma + \epsilon_c \qquad (6)$$

β_1 is the coefficient of interest. χ_c is a vector of controls. The results in Table 8 confirm the intuition. Columns (1)–(3) differ only in the controls they use. Consistently, the results show that in cities in which potential drivers face greater expected credit costs, the uptake of Uber driving is significantly slower. This shows that the reallocation does potentially present problems for the intermediary, which it could benefit from solving, especially in cities in which access to credit is likely to be more expensive for the lowest-income citizens who would otherwise make good drivers.

To conclude this Section, a brief summary of the findings follows. The entry of rideshare applications prompted a significant change in levels and allocations of car ownership and auto financing, broadly concentrated among the highest-productivity rideshare drivers: those with low wages. The amount of loans increased overall, suggesting that drivers who did not previously have cars obtained them in response to the opportunities presented by the gig economy. This significant uptick in loan volumes contradicts the simple promise made by the gig economy that it simply allows people to use cars or other capital, more generally that they already had in order to participate. Rather, it shows that, while these applications provide new opportunities to low-wage workers, they also make large differences in the purchasing and credit decisions of those workers. First, it shows that sharing economy intermediaries have large effects on the behaviors of those populations that interact with them, and second, that those populations are typically demographically similar to those whom policymakers pay particular attention and concern themselves with.

E.   Drivers' Acquisition of Suitable Capital

While the previous Section establishes increases and broad demographic shifts in car ownership resulting from Uber or Lyft's entry in a market, this Section explores how these shifts translated into changes in the capital stock of cars. The focus is, in particular, on how Uber's and Lyft's eligibility requirements impacted the capital stock. Uber's and Lyft's eligibility requirements impose specific restrictions on the cars that can be used on their platforms, and this Section tests whether, indeed, the cars purchased overall conform to those requirements. The prediction is simple: in order to drive for Uber or Lyft, one needs an automobile that complies with Uber and Lyft's requirements. Consequently, one should see that following rideshare entry, the desirability of rideshare-eligible cars increases. This Section aims to put a dollar value on eligibility following Uber and Lyft entry. In other words, if a city government had chosen instead to subsidize (or penalize) the acquisition of a vehicle with certain characteristics, what would have been the per car dollar amount of the subsidy leading to a similar impact as the rideshare intermediary regulation?

To approach this question, the Article borrows a simple discrete choice model of consumer demand,[23] exploiting the staggered entry of Uber and Lyft across different markets. Consumer i faces a choice between $j = 1$, ... , J vehicles. The model assumes that consumer i's utility from having car j is:

$$u_{ij} = x'_j \beta_i + \xi_j + \epsilon_{ij} \, (7)$$

In this equation, x_j is a vector of observed automobile characteristics (such as price, number of doors, horse power, and manufacturer), β_i is a vector of consumer-specific preference parameters, ξ_j is a vector of unobserved automobile characteristics, and ε_{ij} is a consumer-automobile-specific random shock, with independently and identically distributed as a type-one extreme value (T1EV) distribution. Importantly, x_j contains whether the vehicle is rideshare-eligible. The main identifying assumption used here is that consumer preferences are constant across

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[23]   See Steven Berry, James Levinsohn, and Ariel Pakes, *Automobile Prices in Market Equilibrium*, 63 Econometrica 841, 845 (1995). While this approach has become a workhorse in estimating consumer demand, the original paper studies, fittingly, consumer demand for automobiles.

markets except after the entry of rideshare applications. Variations on the model specification will relax this assumption along several dimensions.

The well-known result[24] for a demand system given by (7) is that the log market share for product j within a given market is given by the following linear equation:

$$log \; s_j = \alpha + x'_j\beta + \xi_j \quad (8)$$

Under the assumption that pre-rideshare consumer preferences are β_{pre} and post-rideshare consumer preferences are β_{post}, to identify changes in consumer preferences arising from rideshare entry, the Article runs the following regression at the auto *j*, year *t*, city *c* level:

$$log \; s_{jtc} = x'_j\beta_i + (Post_{tc} \times x'_j)\beta_2 + \gamma_* + \epsilon_{jtc} \quad (9)$$

In this equation, γ_* represents fixed effects in several specifications, discussed shortly. The main coefficient of interest is on rideshare eligibility (contained in χ_j) times $Post_{tc}$, which identifies how consumers value a vehicle's rideshare eligibility differently once a rideshare service enters his or her market. For purposes of interpretation, the coefficient on price is also relevant. Dividing the post times eligibility coefficient by the price coefficient gives a dollar equivalent value change of eligibility.

Table 5 shows the results. For purposes of exposition, most controls and interactions are omitted. Controls are price, car age, miles per gallon, horsepower per doors, and doors. All specifications include at least CBSA-Year fixed effects, which allows the outside option to vary by CBSA-Year market. The most basic specification in Column (1) estimates a positive and significant coefficient on eligibility after rideshare entry, meaning that consumers value driving rideshare-eligible cars more after ridesharing enters.

Column (2) adds CBSA-Year-Manufacturer fixed effects, which means the regression is comparing the market shares of manufacturers within a given market. This handles the concern that Uber or Lyft enter areas in which, for example, luxury brands specializing in eligible automobiles are gaining market

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[24] See Aviv Nevo, *A Practitioner's Guide to Estimation of Random-Coefficients Logit Models of Demand*, 9 J Econ & Mgmt Strategy 513, 521 (2000).

share, due to underlying correlated economic effects. These underlying correlated economic effects are time-city-brand specific effects that may be correlated with Uber or Lyft's entry. The size of the coefficient on eligibility remains relatively unchanged. Column (3), additionally, adds VDS fixed effects. Recall that VDS contains extremely detailed car-level information, down to the engine displacement, doors, trim of the vehicle, and so on. Note that this absorbs all time-invariant unobservable vehicle characteristics except, for example, wear and tear on specific cars. Again, the size of the coefficient on eligibility remains largely unchanged.

To control for possible time-varying preferences regarding vehicle characteristics, such as a time trend in preferences for doors, fuel efficiency, or age, Column (4) includes VDS-year fixed effects. This absorbs variation in vehicle preferences that move in parallel over time but not differently across different cities. Again, the coefficients on eligibility are largely unaffected. Finally, Column (5) also includes VDS-CBSA fixed effects to control for variation in CBSA preferences for physical details of the car that do not change over time. This means all variation identifying the changing preferences over eligibility come from within-year and within-city differences in preferences over vehicle eligibility before and after rideshare entry. In this final, most conservative specification, the coefficient becomes smaller but is still statistically and economically significant. The interpretation of the 0.014 coefficient is that after the entry of Uber or Lyft, comparing vehicles of the same manufacturer within a city, an Uber or Lyft-eligible model becomes valued approximately $2,300 higher than it was before entry.

Figure 4 shows an event study of the value of Uber and Lyft eligibility around the event date. As in the previous Section, the key result this figure shows is that there is no trend in the value of eligibility in the quarters leading up to rideshare entry, and the value jumps at the point of entry. This confirms that the parallel trends assumption in the difference-in-difference approach is satisfied.

F.   Intermediary Regulation's Measurable Impacts

Having documented that Uber's and Lyft's entry-initiated changes in aggregate ownership patterns and the vehicles that drivers acquire, this Section quantifies the accumulated impact so far. It begins by documenting the demographic shifts in fi-

nancing before moving on to exploring changing vehicle characteristics and utilization patterns.

1. The changing demographics of vehicle ownership and financing.

Earlier analysis shows that prior to Uber's or Lyft's entering, car ownership was strongly correlated with high wages and low unemployment. High-wage workers do not make good Uber drivers. Consequently, the entry of rideshare applications triggered not only a shift of credit expansion and car acquisition overall but a shift that was especially concentrated in low-wage zip codes. In fact, there was essentially no effect in the highest-wage zip codes. How has this shift affected the link between wage and car ownership? The following regression sheds light on this question:

$$\left(\frac{Loans}{Capita}\right)_{zt} = \beta_1 Post_{zt} + x'_{zt}\beta_2 + (Post_{mt} \times x'_{zt})\beta_3 + FE + \epsilon_{zt}$$
$$(10)$$

In parallel to Regression (1), the outcome variable is loans per capita. The objective is to study how loans per capita varies with treatment and zip code characteristics. The data consists of two time periods 2010 and 2015. Each zip code is observed in each time period. $Post_{zt}$ is an indicator for treated zip codes in the post period and estimates the standard difference-in-difference coefficient. χ_{zt} is a vector of zip code demographic characteristics. $Post_{zt}$ X χ_{zt} interacts treatment with zip code characteristics and estimates a third difference. In particular, it shows how the effect of treatment varies with zip code characteristics, or equivalently, how the link between zip code characteristics and ownership is impacted by treatment. The term FE includes various fixed effects detailed below.

Table 2 shows the result. Columns (1)–(3) study new loans while Columns (4)–(6) study outstanding loans. Columns (1) and (4) look only at the pre-period to reiterate the results in Table 1 that a high wage is strongly correlated to loan access. Columns (2) and (5) add the difference-in-difference term along with state times time-fixed effects to absorb state-level economic changes. The coefficient on $Post_{zt}$ shows that zip codes in which Uber or Lyft entered saw a positive and significant expansion in

new and outstanding loans per capita. This suggests that rideshare entry has increased credit access overall on a per capita basis, consistent with earlier results in Table 3.

Most interestingly, Columns (3) and (6) study how the relationship between auto credit and wage has changed as a result of rideshare entry. This specification includes a triple interaction term between wages, treatment, and post, together with CBSA times time-fixed effects. For new loans, the relationship between wages and loans decreases by roughly a quarter. Prior to entry, a 1 percent higher relative wage was associated with roughly 0.46 more new loans per one thousand residents. In treated zip codes following entry, the relationship flattens by 0.12 loans per one thousand residents, representing roughly a 25 percent reduction in the strength of the relationship. This shows a decreasing association between wages and new loan originations. Column (6) shows a similar result for outstanding loans, with the 9.1 pre-entry coefficient dropping by roughly 1.2 in treated zip codes.

These results, taken together, suggest that the reallocation of auto credit toward rideshare drivers has had a significant effect in broadening and democratizing credit access, especially among low-income borrowers. To the extent that a city government desires to implement or avoid this outcome, rideshare services, and the policies that they implement, are highly relevant.

2. The changing nature of the capital stock.

How has the introduction of rideshares and their eligibility requirements impacted the aggregate capital stock? Recall that in order for a car to be used in Uber or Lyft, it must comply with certain eligibility rules, the principle ones being an age requirement and a four-door body-style requirement. Previous results using a consumer demand framework suggest that consumer preferences shifted toward preferring eligibility as a vehicle characteristic upon rideshare entry. Given this evidence, one may expect the capital stock to shift toward eligibility on average. To what extent is this true, and does this eligibility requirement cause spillovers in characteristics that are correlated to eligibility? The following difference-in-difference regression sheds light on this question:

$$Char_{zt} = \beta Post_{zt} + \gamma_z + \gamma_t + \epsilon_{zt} \quad (11)$$

$Char_{zt}$ is an average characteristic of the auto stock within zip code z at time t. This Section considers three characteristics: Uber/Lyft eligibility, fuel efficiency, and carbon dioxide emissions. γ_z and γ_t are zip code and time-fixed effects. The difference-in-difference coefficient, β, measures how average vehicle characteristics within the zip code change after Uber or Lyft enter the market.

Table 6 shows the results. Column (1) shows that following rideshare entry, the percentage of the capital stock that is eligible increases by roughly 0.60 percent, a modest but significant amount relative to the typical ratio of Uber drivers to the overall population. Column (2) shows that average fuel economy increases by roughly 0.06 miles per gallon, and similarly Column (4) shows that CO_2 emissions decrease by roughly 0.9 grams per mile driven. As with eligibility, these changes are modest but are significant relative to the percentage of rideshare drivers present.

The intermediary regulations explicitly require vehicle eligibility; they do not explicitly require anything regarding fuel economy or emissions. A natural question to ask is whether these nonmandated changes are driven by rideshare drivers choosing more fuel-efficient or lower-emission vehicles on purpose or whether they are driven by the fact that the explicit requirements on vehicle eligibility are correlated with these secondary characteristics? To answer this question, Columns (3) and (5) include a control for percent eligibility in the fuel economy and emissions regressions. The approach here is to remove variation in fuel economy and emissions that can be explained by the explicit intermediary regulations and test whether there are additional changes in these characteristics following entry.

The findings for both fuel economy and vehicle emissions paint a similar story: when controlling for eligibility, the size of the effects shrink dramatically from 0.06 to 0.02 and from -0.90 to -0.21 for fuel economy and emissions, respectively. After including the control, neither change is statistically significant. These results indicate that the hard-and-fast eligibility requirements explain the lion's share of changes to these vehicle characteristics, although the residual coefficients still fall in the expected direction. The upshot from this analysis is that the intermediary's regulation appears to be the primary driver of these changes, again suggesting the power that intermediaries have in affecting potentially beneficial social changes.

3. Vehicle utilization.

With these large shifts in ownership patterns and car characteristics, the next question is whether these shifts lead to dramatic changes in utilization. In particular, one might expect that utilization rates among potential drivers with eligible vehicles should increase as these drivers join the platform and drive part- or full-time. One major benefit of a greater capital utilization rate is that the same quantity of capital goods can produce a greater quantity of capital services. This amounts to a gain in productivity. Additionally, in keeping with the themes of this Article, a greater utilization rate among rideshare drivers in particular means that on a use-basis, any effects of the intermediary regulation are magnified because the directly regulated drivers account for a larger share of total driving. Consequently, utilization rates are of first-order importance.

To help study this question, the DMV data for South Carolina and Washington contain information on mileage that is updated when ownership changes. This allows for measurement of capital utilization, which, for this Article, is defined as thousands of miles driven per year. To study the utilization question, the Article runs the following regression at the vehicle-registration level:

$$Util_{izt} = \beta_1 Post_{zt} + \beta_2(Post_{zt} \times Eligible_{it}) + x'_{izt}\Gamma + FE + \epsilon_{izt}$$
$$(12)$$

$Util_{izt}$ is the yearly utilization rate of vehicle i whose registration spell began in zip code z at time t. $Post_{zt}$ is whether zip code z, time t was treated when the spell began; $Eligible_{it}$ is whether the vehicle was eligible to drive for Uber or Lyft at the time the spell began. x_{izt} are vehicle level controls that include the previous utilization rate for the particular vehicle, measured as cumulative miles driven at the start of the spell, divided by vehicle age at the start of the spell. The fixed effect term, *FE*, contains various fixed effects, described below. The regression omits spells that began before entry and ended after entry.

Table 7 reports the results. Column (1) measures only the overall utilization rate, not broken out by eligibility or zip code characteristics. It includes month and zip code fixed effects and is the standard difference-in-difference estimator. The coefficient on *Post* is positive but not statistically significant. This

suggests that, overall, the entry of the sharing economy does not, in fact, increase the utilization rate in a statistically significant way. Column (2) includes the *Post* times *Eligible* interaction term, which allows for measurement of how the utilization rate of eligible vehicles changes after entry as compared to ineligible vehicles after entry. Here, there is a positive and significant coefficient of roughly 0.67, or an additional 670 miles per year. Column (3) is the same regression but replaces the month and zip code fixed effects with month times zip code fixed effects. This inclusion absorbs the level impact of entry and directly compares utilization of eligible vehicles in treated zip codes to utilization of ineligible vehicles in treated zip codes. Column (4) additionally includes a VDS fixed effect, which includes very detailed make-model-year information. The inclusion of this fixed effect absorbs any unobserved vehicle differences in utilization, handling the concern that the distribution of vehicles may be correlated with changing usage patterns unrelated to ride sharing. This inclusion does not impact the findings.

Columns (5)–(7) study how ridesharing differentially impacts utilization across zip codes characteristics and car eligibility, with a particular focus on zip code wages. The prediction is that low-wage zip codes should see the greatest utilization rate increase, with these increases concentrated among eligible vehicles. Column (5) shows a negative but not statistically significant differential impact by wage. Column (6), which includes an additional interaction with eligibility, now finds a significantly negative impact for eligible cars in low-wage zip codes with a 1 percent higher relative wage seeing more than twenty-one miles per year less utilization in eligible cars. Including VDS fixed effects in Column (7) provides a similar result. To convey these results graphically, Figure 5 shows simple averages in utilization rates pre and post-entry by eligibility and zip code wage. It is interesting to note that only eligible cars in low-wage zip codes see utilization increases. Eligible cars in high-wage zip codes see decreases, as do ineligible cars regardless of zip code.

These results suggest that, indeed, rideshare services do live up to the promise of greater capital utilization, but only significantly so for those likely to be using their cars as drivers. There have not been, at least so far, significant increases in capital utilization, on average, because gains for ridesharing drivers are offset by losses for non-ridesharing drivers. This is likely driven, in large part, by stickiness in the car stock and slow adoption of the ridesharing technology: A household may be us-

ing their car less yet, nonetheless, hold on to the car and continue maintaining and registering the car simply because it is inconvenient to sell it. Alternatively, households may choose to retain their cars although they use them less because there are certain uses a long trip, for example that ride sharing cannot replace. Of course, the alternative would be to stop having a car and renting it temporarily when they need a non-rideshare service.

From the perspective of a city regulation, this result raises several important issues. On one hand, the effect on utilization is positive but muted; Uber and Lyft have not yet dramatically impacted overall utilization rates, so this does not constitute a strong argument in favor of Uber of Lyft on its own. However, importantly, in an intermediary regulation framework, the vehicles that are most likely to be directly impacted by the regulation are used more frequently than other vehicles. This has the impact of magnifying any intermediary regulation on a use-weighted basis: The cars most often used in a post-Uber or post-Lyft world are those cars that Uber and Lyft directly influence.

Taking a self-imposed eligibility requirement as a test case for intermediary regulation more generally, this case study explores the power and limitations that such a regulation can have. It first shows that Uber or Lyft entry leads to significant changes in the demographic patterns of vehicle ownership and financing. These facts provide support for the notion that intermediary regulation can have a plausibly wide reach. Moving on to the physical capital stock directly, the study shows that rideshare entry makes compliance with vehicle eligibility rules a more valuable vehicle characteristic. Using a revealed-preference analysis, the value consumers attach to eligibility in treated zip codes increases by thousands of dollars after treatment. These changes together result in significant shifts in average characteristics of the capital owning population and in the capital stock itself. These shifts primarily concern rideshare eligibility, but the changes also spill over into other characteristics such as increased fuel efficiency and decreased emissions. Additionally, utilization of eligible vehicles registered in low-income zip codes increases. Taken together, these results provide empirical support for the argument that intermediary regulation can have large and wide-ranging effects.

II. INTERMEDIARY REGULATION MORE GENERALLY

Taking the results established in the previous Part as a proof of concept, this Part takes a step back to consider intermediary regulation more generally. It first suggests specific ways that governments can work with existing gig economy platforms to advance specific policy aims. It then considers how the position of gig economy intermediaries can be used to implement more theoretical regulatory schemes such as micro-directives. It concludes by raising and partially addressing some criticisms.

A. Other Applications for Intermediary Regulation in the Gig Economy

The case study presented in Part I concerns only the already-existing and self-imposed intermediary regulation regarding vehicle eligibility. The results show that, as a large number of drivers join Uber and Lyft, these requirements have a measurable impact not only on the types of vehicles driven by rideshare drivers but also on the overall capital stock of automobiles, rideshare or not. This Part considers other possible applications of similar intermediary regulation, both in ridesharing applications and in other gig economy applications, by outlining simple intermediary regulations and contrasting them with the analogous conventional regulation targeted toward the same goal.

1. Environmental regulation.

As noted in the introduction, vehicle environmental regulation is a natural application of so-called intermediary regulation through rideshare applications. In fact, the eligibility requirements that did not explicitly target changes in fuel efficiency or emissions nonetheless led to measurable increases in average fleet fuel efficiency and decreases in average carbon emissions. An eligibility requirement that explicitly targets fuel efficiency or emissions could have an even greater effect. For example, in addition to requiring a vehicle to be relatively new and have four doors, the eligibility requirement could be extended to cover mileage or emissions standards or to require a hybrid or electric vehicle. Vehicle inspections already occur by default, so this is a trivial addition to the already-existing screening process.

Alternatively, by taking greater advantage of the data that ridesharing platforms already collect, cities and rideshares could

adopt a softer, more targeted approach. For example, rather than imposing explicit vehicle requirements, the city could charge the intermediary based on realized carbon emissions of its drivers. This directly internalizes the production of harmful emissions. These costs would presumably be partially or wholly passed on to drivers, and, on the margins would lead drivers to choose lower emissions vehicles. Additionally, drivers that already own higher-emissions vehicles may choose to drive less. The effect would be, in the aggregate, a shift toward lower emissions vehicles both in terms of total quantity and especially in terms of utilization rates.

As discussed earlier, such an approach has several advantages over an alternate non-intermediary regulation. First, monitoring and enforcement, particularly of the later Pigouvian emissions tax is trivially simple for the intermediary given its infrastructure in place. A city, on the other hand, essentially has no way to monitor vehicle use or emissions within the city. Yearly inspections, for example, could not differentiate use of the vehicle in the city versus use of the vehicle outside of the city. Additionally, such a tax would not work on out-of-city drivers who register their vehicles in other cities or states and drive into the regulating city. On the other hand, by levering the rideshare platforms' location-based data, the tax is trivial to implement regardless of where the vehicle is registered and used.

Moreover, the realistically implementable city regulation at hand has hard edges, making it necessary for all drivers, rideshare and nonrideshare alike, to get new vehicles if they do not comply. This adjustment cost is likely to fall the hardest on low-income drivers who tend to have older cars, have longer commutes, and possess less wealth with which to make the adjustment. The intermediary regulation, on the other hand, is completely opt in on the part of the drivers and riders who will ultimately bear the cost. The tax therefore impacts, most directly, the most elastic drivers who are most likely to adjust their behaviors in response to price changes. Because the objective is to change behavior, the fact that a small tax can have large quantifiable effects on the extensive margin is another benefit.

2. Road congestion and public transit.

Another application that utilizes Uber and Lyft's detailed time and location-tracking technology targets issues surrounding road usage such as traffic congestion, carpooling, and, sur-

prisingly, the expansion of public transit utilization. In each application, financial carrots or sticks that depend on the timing, location, and passengers in the car can help facilitate these various urban planning goals.

Cities battling congested streets and highways can lever ridesharing intermediary regulations through the implementation of dynamic use taxes and fees. For instance, if certain routes are particularly busy during rush hour while others are not, the intermediary can be charged a fee for all rides that take the busier route. This fee can easily be communicated and applied directly to drivers and their payments from the platform, giving the decision maker a clear, real time incentive to take the less-trafficked route. The passenger could even have the option of paying the fee in order to take a faster but more congested route. The technical and infrastructure requirements to implement such a system likely already exist and would be trivial to implement. Cities could take an even more hands-off approach and simply charge fees to rideshare services per amount of time spent idling in traffic, thus encouraging these services to find alternative, less-crowded routes, without direct control from the city or planners. Because these services are so large, they at least partially internalize their own effect in causing congestion.

Contrast this approach with a more conventional regulation strategy. The conventional approach administered through the city directly would require significantly more infrastructure investment if it is to be flexible, dynamic, and applied everywhere. Indeed, cities have been experimenting with dynamic tolls: a toll road near Washington, DC recently charged \$40 during peak time in order to reduce traffic. However, applying such a policy citywide on a street-by-street basis is not currently possible: cities have no way to collect tolls or to limit access except on particular, limited-access stretches of road. Implementing this through rideshares, on the other hand, has the advantage of being fully flexible and dynamic down to the resolution of the application's internal navigation capabilities. The case in which an intermediary regulation potentially comes up short, however, is when that it targets only cars being used for rideshare. This presents a choice between a blunt instrument regulation that affects all vehicles, but is very limited in scope and specificity, versus a highly-targeted regulation that only impacts rideshare riders and drivers. However, even moving a small percentage of vehicles off the most trafficked thoroughfares could lead to a significant reduction in overall congestion.

Ridesharing intermediary regulation can also encourage carpooling. The technology to plan routes for multiple customers in the same car already exists, as evidenced by Lyft Line and Uber Pool. Utilizing this technology, cities can provide discounts to carpooling ridesharers (or penalties to single riders) in the busiest times along the busiest streets. Whereas current high-occupancy-vehicle lanes are mostly limited to particular major highways, the logic that they embody can easily be transported to smaller but still busy streets. Conventional approaches to this problem face similar limitations to those in the case of dynamic tolls. Current high-occupancy-vehicle lanes are limited to particular major highways because access limitation and monitoring is difficult to implement more broadly. A carpooling policy implemented through intermediary regulation, on the other hand, would fit snugly in the dynamic tolling and fees approach discussed above. Fees, for example, could be eliminated for high-traffic areas when the rideshare vehicle has more than one passenger. As before, the technology for monitoring and enforcement already exists. For a city wishing to go this route, it is only a matter of deciding when and where a carpool policy should apply.

While much discussion of rideshare applications has lamented the fact that they reduce the socially beneficial widespread use of mass transit, ridesharing, on the contrary offers a solution to a known problem facing mass transit: this problem is known as the last mile problem.

The last mile of a commute, the trip from the closest mass transit station to work or to home presents an issue for many commuters. While the mass transit system may be effective in taking commuters from the station to the city and back, many commuters, particularly those in under-served neighborhoods face difficulty in getting to the station in the first place. Ridesharing presents a natural solution with monetary incentives, specifically for ferrying rides to and from mass transit stations. By levering the time and location-based data automatically collected by the services, trips beginning or ending at a mass transit station can receive a small subsidy from the city or rideshare program. The effect, interestingly, could be a net decrease in the amount of car commuters and a net increase in mass transit use. This resolution of the last mile issue makes mass transit a viable alternative to an owned-car-based commute.

Consider other conventional ways to solve this problem: it requires, essentially, creating another mass transit line, for ex-

ample a bus line, in a location where there was likely not enough demand for there to be a bus line in the first place. The ridesharing solution, on the other hand, naturally provides the right number of drivers at the time passengers need them.

3. Homesharing and Airbnb.

Beyond Uber and Lyft, homesharing platforms like Airbnb offer potential applications of intermediary regulation. Like Uber and Lyft, Airbnb has been subject to its share of legal troubles and controversies around the world. Like Uber and Lyft, Airbnb provides an opportunity to affect certain policy goals with light-touch regulations mediated through the platform. Environmental regulations, for example, are a natural candidate: cities wishing to encourage lower-energy-usage design, water or gas-saving policies, or even increased solar energy usage can charge fees (or not provide subsidies) to properties that fail to follow certain targeted environmental requirements. The platform's rating system provides a simple means of monitoring, by which guests can easily report whether the property complies along several dimensions. Enforcement and collection of the fees can be handed simply though the existing online interface. Safety compliance is another dimension along which such a system could operate. As before, the enactment of the regulation through the intermediary obviates the need for the city to monitor and enforce the regulation, and the opt in nature of the requirement means it does not fall most heavily on those residents least able to afford compliance if it were mandatory.

4. Blockchain and beyond.

On the technological frontier lies technologies like smart contracts and blockchain. A smart contract, for example, will be an unchangeable, self-executing contract that takes some action when the right conditions are met. For instance, a smart contract for a car loan could automatically transfer title of the collateral vehicle to the secured lender if the borrower fails to make a payment. It is likely that such contracts will still require some action from a court or legal authority. In the car loan example, a court officer will still need to seize the car. In the case of a contract, determining whether performance was satisfactory may require a court ruling. In these circumstances, there is scope for a kind of noncentralized intermediary regulation. In particular, a city that wants to make sure sales taxes are paid, labor laws

are followed, or usury laws are complied with, could require that these smart contracts are only enforceable in court if they contain the necessary contract provisions, provide for automatic payment of sales tax upon execution, or comply with applicable law. While these examples lack a centralized intermediary, standardized protocols recorded in a centralized database in the blockchain essentially fill this role.

B.   Intermediary Regulation and Micro-Directives

Taking a more theoretical turn, this Section considers the applicability of intermediary regulation more broadly. It focuses on a theoretical discussion of the application of intermediary regulation to recent proposals relying on big data regulation. In particular, it considers intermediary regulation in the context of the so-called micro-directives of Professors Casey and Niblett .[25] The contention is that intermediary regulation provides a system that uses already existing infrastructure to implement many personalized and dynamic micro-regulations, which are otherwise only theoretical proposals.

Casey and Niblett, in their article *The Death of Rules and Standards*[26] envision a world in which, using big data, lawmakers will be able to use predictive and communication technologies to enact complex legislative goals that are translated by machines into a vast catalog of simple commands for all possible scenarios.[27] When an individual citizen faces a legal choice, the machine will select from the catalog and communicate to that individual the precise context-specific command (the micro-directive) necessary for compliance.

Whether this constitutes a normatively appealing world to live in, in 2018, it appears to be merely a theoretical exercise. However, intermediary regulations do in fact provide the technology to begin implementing some of these ideas. For example, the authors imagine a micro-directive providing a specific speed limit to a particular driver for a particular time and weather conditions. There are really two parts to the micro-directive: deciding on the appropriate speed limit and communicating and enforcing the micro-directive. The particular speed, Casey and Niblett the authors suppose, is the solution to a complicated op-

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[25]   See Casey and Niblett, 92 Ind L J at 1416–17 (cited in note 17).

[26]   92 Ind L J 1401 (2017).

[27]   See id at 1410–12.

timization problem requiring big data inputs. With current technology, determining the optimal speed is not an insurmountable problem. The larger issue, however, is how to communicate this speed to the driver in real time and enforce the directive in a reasonably implementable way.

For Uber or Lyft drivers, this infrastructure already exists. Drivers are in constant communication with the application, so communicating the micro-directed speed limit presents no problem. Moreover, the application is constantly monitoring speed and location, so the application (and, by extension, the regulator) can track the driver's speed. Finally, the application already handles the financial transactions between the driver and the passenger, so applying a financial penalty to the driver if his tracked speed violates the micro-directive is a trivial task. This entire process requires essentially no new hardware—only a monitoring channel between the micro-directive regulator and the driver. While enforcement of micro-directives through gig economy applications covers only a small portion of the population, as empirical evidence in this Article shows, the gig economy is sufficiently widespread that regulations impacting sharing economy participants can spread out to the economy at large. Moreover, micro-regulations like traffic speeds have natural snowballing effects: if a rideshare driver is asked to drive more slowly, this reduces the speed of drivers around the rideshare driver, even if they are not rideshare drivers themselves.

Implementing these ideas through sharing economy intermediaries has a potential additional advantage over direct government implementation (technology and infrastructure issues aside): participation in these services, both as a supplier of a service and a customer of a service is completely opt in; individuals objecting to government overreach and control in the minutiae of everyday life have the option to simply not participate in the gig economy.

C.   Some Notes of Caution

This Section concludes by discussing some drawbacks of the intermediary regulation approach outlined in this Article. It begins with potential complications of the specific proposals mentioned above. It then lays out some bigger picture criticisms and some possible responses.

The empirical case study in this Article centered on a time frame during which there was massive growth in the number of

Uber and Lyft drivers. As the analysis showed, many of these drivers needed to acquire cars before joining the platform, rather than using cars they already had. As a consequence, the pace of capital stock change found here may have been accelerated relative to a less transitional period. If more potential drivers had already owned cars, the adjustment might have been less dramatic. In other words, once the economy enters a steady state of rideshare allocation, there may be lower volumes of vehicle transactions and, consequently, gentle nudges toward drivers to purchase different vehicles may have a smaller effect.

Suppose, for example, that a city in which Uber is already well established decides to implement a stricter set of emissions standards through an intermediary regulation. To implement the requirement, the city requires Uber and Lyft drivers to drive lower-emissions vehicles. Imagine that the city adopts a hard mode of implementation: beginning on a fixed day, only vehicles meeting the new requirement are allowed on the platform and non-compliant vehicles will be kicked off. This stark approach will likely force many drivers off the platform if they cannot afford the upgrade or if the required upgrade does not make economic sense. Rather than adopting lower emissions vehicles, many may simple exit. While this will mechanically increase the average fuel efficiency of vehicles used for rideshare, the net effect on overall emissions may be muted, as use of rideshare vehicles which, on average, are more fuel efficient declines. Moreover, such large disruptions may be undesirable to drivers, riders, and the city overall.

Imagine instead a softer approach, by which vehicles that were eligible pre-requirement are grandfathered in until they age out of the platform naturally. While not as disruptive, this approach has the drawback that the capital stock will shift at the natural rate of vehicle attrition. Regardless of the approach undertaken, the worry is that affecting changes to the capital stock of a market in which rideshare is already well established may be slower and more disruptive.

This weakness does not necessarily spell doom for the entire approach, however. First, it applies only to regulations targeting the properties' durable capital goods used to participate in the gig economy. It does not apply to scenarios like traffic reduction, public transportation uptake, or speed controls. Second, while it might dull the effect to changes to the capital stock in well-established, stable rideshare markets, as of 2017, there are no well-established, rideshare markets. Even San Francisco, where

Uber has been present for the longest period of time, is still see-ing rapid increases in the number of Uber drivers. Finally, there are still likely to be large disruptive and unforeseen technologi-cal changes that cause rapid changes in the capital stock. One example on the horizon is self-driving cars: to the extent that Uber or Lyft or other applications seek to acquire a large fleet of self-driving cars, this large upcoming shift presents a clear op-portunity for cities facing various regulatory aims to require that Uber or Lyft acquire a fleet of self-driving cars that is con-sistent with their objectives.

This Article next considers likely theoretical concerns. One objection centers on outsourcing or privatizing regulation to large, for-profit corporations. This concern is especially relevant when the corporations doing the regulation have a large reach and significant influence over the participation on their platform and are the direct financial beneficiaries of the activity they are asked to regulate. Uber, in particular, has received negative press along several dimensions, and there is a natural concern over whether important regulations should be delegated to these companies, of which there is a significant risk for misbehavior and abuse. For instance, because the scheme relies on data-reporting from the intermediary's platform, there is the possibil-ity that the intermediary could hide or falsify data in order to avoid certain regulations.

From the other side comes potential concerns about inter-mediaries becoming tempting vehicles for social control and over-regulation: with a new regulatory tool in the regulator's tool belt, interest groups may engage in rent-seeking behavior with an aim toward using the tools to turn the economic screws to their advantage. Finally, regardless of one's preferences to-ward any particular regulatory aim, a move toward intermedi-ary regulation does not clear the air in terms of likely political fights and interest group battles. The intermediaries themselves will likely be highly involved and well situated to lobby policy toward their ends.

Despite these clear shortcomings, this Article contends that the options offered by an intermediary regulation framework are superior to those offered by heavy-handed bans on one hand and potentially unfettered free access on the other. To the extent that Uber and Lyft are allowed to exist, and it appears that in most American cities they are here to stay, channeling their in-fluence toward other regulatory ends is likely preferable to total capitulation for those who would otherwise wish to ban the ser-

vices altogether. The platforms will be collecting, analyzing, and making decisions with drivers' and riders' data anyway, and pushing that use toward socially desirable ends can help make the best of an undesirable situation. There exist multiple safeguards, such as auditing procedures, and severe, enforceable penalties (such as banning an application from a market) for the government to keep the intermediary on a short and honest leash.

For those who would prefer unfettered free access, there is a rising pushback against these services in terms of reach, pay, additional regulations, and privacy. To the extent that sharing economy applications' technology in fact makes for better services, a compromise that deploys that technology toward beneficial ends is likely desirable to regressive regulation that stifles the technology's full potential. Finally, while interest groups will continue to fight, by bringing potential gains from regulatory trade to light, the hope is that the range of mutually beneficial agreements that interest groups can adopt expands and encompasses new solutions to pressing urban social problems.

CONCLUSION

Gig economy applications' growth presents a regulatory conundrum. On one hand, these applications disrupt existing industries and are often able to avoid regulations that incumbents face. On the other hand, their place as centralized, data-gathering and platform-controlling middlemen means that they wield significant influence over their many participants. As a consequence, they have the ability to implement regulatory policies that city governments would otherwise struggle to bring about. It is their latter role that this Article highlights. By studying an in-place intermediary regulation (vehicle eligibility requirements for Uber and Lyft), this Article shows that their potential reach extends beyond merely those on their platform. Rather, these applications have caused measurable changes to aggregate vehicle stocks and usage in the cities in which they operate. Taking this as a proof of concept, local regulations can focus not only on the regulatory problems surrounding the gig economy but also the opportunities they bring with them.

While cautiously recognizing the potential drawbacks of such an approach, this Article aims to highlight regulatory gains from regulator–platform cooperation that may have been overlooked in the debate. Of course, this Article considered only a

single case study. Further research may be required to understand the generalizability of these ideas to other rideshare applications or to other platforms like Airbnb. However, the results here suggest that gig economy intermediaries have the potential to be powerful tools in the city regulator's tool belt.

Appendix

TABLE 1: EX ANTE LOANS AND DEMOGRAPHICS

Table 1 shows the relationship between new and outstanding auto loans per capita and demographic characteristics in 2010, before the entry of rideshare applications. The regression is at the zip code level. Column (1) studies outstanding loans per capita and Column (2) studies new loans per capita. Both columns include CBSA fixed effects, so variation in demographics comes from relative differences between zip codes within the CBSA. Standard errors in parenthesis are clustered at the CBSA level.

	Dependent variable:	
	Outstanding / Capita	New / Capita
	(1)	(2)
log(wage)	9.185***	0.462***
	(0.798)	(0.044)
% Unemployment	−18.301***	−0.851***
	(2.435)	(0.135)
% Subprime	−2.411	−0.210**
	(1.801)	(0.096)
log(Population)	−0.271***	−0.023***
	(0.055)	(0.003)
Age	−0.093***	−0.004***
	(0.018)	(0.001)
% Bachelors Degree	−9.259***	−0.446***
	(1.132)	(0.061)
% White	−1.215**	−0.003
	(0.592)	(0.029)
% Using Public Transit	−25.437***	−1.139***
	(0.768)	(0.053)
Commute Time (Minutes)	0.210***	0.009***
	(0.015)	(0.001)
CBSA FE	Y	Y
Observations	28,725	28,725
R^2	0.691	0.637
Note:	$^*p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$	

TABLE 2: EX ANTE LOANS AND DEMOGRAPHICS

Table 2 shows the relationship between new and outstanding loans before and after the entry of rideshare services. Columns (1)–(3) study outstanding loans per capita; Columns (4)–(6) study new loans per capital. All columns include zip-level controls as in Table 1. Columns (1) and (4) correspond to those shown previously in Table 1. Columns (2) and (5) include pre (2010) and post (2015) data. The variable Treated is 1 for treated CBSAs; POST is 1 for 2015. These columns include state times post fixed effects and zip fixed effects. Columns (3) and (6) include wage and treatment interaction terms, along with CBSA multiplied by time fixed effects, which absorbs the level effect of treatment. Standard errors in parenthesis are clustered at the CBSA-time level.

	Dependent variable:					
	Outstanding / Capita			New / Capita		
	(1)	(2)	(3)	(4)	(5)	(6)
log(wage)	9.185***	1.000**	−0.556**	0.462***	−0.073**	−0.013
	(0.798)	(0.461)	(0.232)	(0.044)	(0.029)	(0.027)
Treated×Post	-	0.368***	-	-	0.025***	-
	-	(0.113)	-	-	(0.009)	-
Treated×Post×log(wage)	-	-	−1.203***	-	-	−0.121***
	-	-	(0.298)	-	-	(0.032)
Other Controls	Zip	Zip	Zip	Zip	Zip	Zip
CBSA FE	Y	N	N	Y	N	N
State×Time FE	N	Y	N	N	Y	N
CBSA×Time FE	N	N	Y	N	N	Y
Zip FE	N	Y	Y	N	Y	Y
Sample	Pre	All	All	Pre	All	All
Observations	28,725	57,703	57,703	28,725	57,703	57,703
R^2	0.691	0.974	0.982	0.637	0.925	0.939

Note: *p<0.1; **p<0.05; ***p<0.01

TABLE 3: QUANTITY AND DISTRIBUTION OF LOAN GROWTH

Table 3 shows the effect of rideshare entry on auto loan growth. Treated zip codes are matched to demographically similar untreated zip codes as 2010. The left-hand-side variable is the percent growth in new loans (Columns (1)–(3)) or outstanding loans (Columns (4)–(6)) since 2010. The event window is 2.5 years before and after treatment. Post is equal to 1 for treated zip codes after rideshare has entered and is 0 otherwise. Relative wage is the zip code's relative wage in its CBSA. Misallocation is the ex ante correlation between wage and auto loans per capita. All columns include time-match fixed effects and zip code fixed effects. Variation comes from comparing the treated and untreated zip code within a matched pair before and after rideshare has entered the treated zip. Standard errors in parenthesis are clustered at the CBSA-quarter level.

| | *Dependent variable:* | | | | | |
| | Outstanding Loan Growth | | | New Loan Growth | | |
	(1)	(2)	(3)	(4)	(5)	(6)
Treated×Post	2.329***	3.267***	0.916***	5.323***	6.993***	1.052*
	(0.147)	(0.236)	(0.211)	(0.430)	(0.744)	(0.621)
Treated×Post×Relative Wage		−1.201***	-	-	−6.718***	-
	-	(0.191)	-	-	(0.602)	-
Treated×Post×Misallocation	-	-	5.025***	-	-	15.254***
	-	-	(0.544)	-	-	(1.545)
Time-Match FE	Y	Y	Y	Y	Y	Y
Zip FE	Y	Y	Y	Y	Y	Y
Observations	408,604	408,604	407,816	408,604	408,604	407,816
R^2	0.962	0.962	0.962	0.914	0.914	0.914

Note: *p<0.1; **p<0.05; ***p<0.01

TABLE 4: QUANTITY AND DISTRIBUTION OF LOAN GROWTH
(PLACEBO)

Table 4 shows the effect of rideshare entry on auto loan growth. Treated zip codes are matched to demographically similar untreated zip codes as of 2010. The left-hand-side variable is the percent growth in new loans (Columns (1)–(3)) or outstanding loans (Columns (4)–(6)) since 2010. The event window is 2.5 years before and after treatment. Post is equal to 1 for treated zip codes after rideshare has entered and is 0 otherwise. Relative wage is the zip code's relative wage in its CBSA. Misallocation is the ex ante correlation between wage and auto loans per capita. All columns include time-match fixed effects and zip code fixed effects. Variation comes from comparing the treated and untreated zip code within a matched pair before and after rideshare has entered the treated zip. Standard errors in parenthesis are clustered at the CBSA-quarter level. The placebo is randomized timing (timing of actual entry is randomly assigned) and then treatment within pairs is randomized.

	Dependent variable:					
	Outstanding Loan Growth			New Loan Growth		
	(1)	(2)	(3)	(4)	(5)	(6)
Treated×Post	−0.092*	−0.087	−0.036	−0.134	−0.803	0.476
	(0.052)	(0.177)	(0.096)	(0.177)	(0.571)	(0.297)
Treated×Post×Relative Wage		0.091			1.046*	
		(0.185)			(0.582)	
Treated×Post×Misallocation			−0.240			−2.044**
			(0.256)			(0.795)
Time-Match FE	Y	Y	Y	Y	Y	Y
Zip FE	Y	Y	Y	Y	Y	Y
Observations	408,604	408,604	407,816	408,604	408,604	407,816
R^2	0.962	0.962	0.962	0.914	0.914	0.914
Note:					$p<0.1$; $p<0.05$; $p<0.01$	

TABLE 5: CAR CHARACTERISTICS

Table 5 shows preferences for vehicle characteristics by treatment status. All specifications include all controls and all controls interacted with post. Columns (1) and (6) include CBSA-Year fixed effects only. Columns (2)–(5) include CBSA-Year-Manufacturer fixed effects. Column (3) includes VDS fixed effects (which absorbs all non-interacted controls). Column (4)–(5) include VDS-Year fixed effects. Column (5) also includes VDS-CBSA fixed effects. Column (6) instruments for price with manufacturer's median prices for the previous model year and lagged industry-wide prices for the previous model year. Standard errors in parentheses are clustered at the CBSA-year level.

	Dependent variable:					
	log(share)					
	(1)	(2)	(3)	(4)	(5)	(6) (IV)
Price	−0.006***	0.002***	-	-	-	−0.008***
	(0.0002)	(0.0003)	-	-	-	(0.0004)
Treated×New	0.169***	0.220***	0.301***	0.295***	0.067***	0.092***
	(0.047)	(0.044)	(0.047)	(0.050)	(0.011)	(0.033)
Treated×MPG	0.019***	0.016***	0.017***	0.015***	0.007***	0.019***
	(0.004)	(0.002)	(0.002)	(0.002)	(0.001)	(0.004)
Treated×Doors	0.053***	−0.004	−0.006	−0.009	0.014***	0.043**
	(0.016)	(0.008)	(0.008)	(0.010)	(0.004)	(0.020)
Treated×Eligible	0.144***	0.190***	0.199***	0.192***	0.039***	0.138***
	(0.046)	(0.026)	(0.028)	(0.030)	(0.009)	(0.043)
Other Ctrls/Ints	Y	Y	Y	Y	Y	Y
CBSA-Year FE	Y	N	N	N	N	Y
CBSA-Year-Manu FE	N	Y	Y	Y	Y	N
VDS FE	N	N	Y	N	N	N
VDS-Year FE	N	N	N	Y	Y	N
VDS-CBSA FE	N	N	N	N	Y	N
Observations	4,839,654	4,839,654	4,839,654	4,839,654	4,839,654	4,709,286
R^2	0.529	0.586	0.687	0.699	0.925	0.528

Note: *$p<0.1$; **$p<0.05$; ***$p<0.01$

TABLE 6: CAR CHARACTERISTICS

Table 6 shows how the average characteristics of registered vehicles have changed following rideshare entry. Columns (1)–(5) study the total registered car stock (including previously registered vehicles); Columns (6)–(10) study new registrations. Columns (1) and (6) study the impact on the percentage of the stock eligible to drive for rideshares; Columns (2)–(3) and (7)–(8) study the average fuel economy (MPG) of registered vehicles. Columns (4)–(5) and (9)–(10) study carbon emissions (grams per mile) of registered vehicles. All columns include the variable Uber, which is a 1 for treated zip codes following entry and a 0 otherwise. Columns (3), (5), (8), and (10) additionally contain controls for percentage of rideshare eligible vehicles. All specifications include zip and quarter fixed effects. Standard errors in parentheses are clustered at the CBSA level.

	Dependent variable:									
	Registered Vehicles					*New Vehicles*				
	% Eligible	MPG		CO_2		% Eligible	MPG		CO_2	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Treated	0.607***	0.060***	0.020	−0.899***	−0.208	0.611***	0.079***	0.074***	−1.197***	−1.132***
	(0.125)	(0.011)	(0.015)	(0.153)	(0.198)	(0.135)	(0.018)	(0.018)	(0.274)	(0.275)
% Eligible			0.066***		−1.138***			0.008***		−0.107***
			(0.002)		(0.042)			(0.001)		(0.015)
Zip FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Quarter FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Observations	37,615	37,615	37,615	37,615	37,615	36,733	36,733	36,733	36,733	36,733
R^2	0.946	0.979	0.984	0.981	0.986	0.648	0.822	0.822	0.785	0.785

Note: *$p<0.1$; **$p<0.05$; ***$p<0.01$

TABLE 7: VEHICLE UTILIZATION

Table 7 shows how utilization rates change following rideshare entry. Observations are on the vehicle-ownership spell level. In all cases, the left-hand-side variable is miles driven per year. Column (1) presents the baseline difference in difference utilization result with month and zip fixed effects. Column (2) interacts post with vehicle eligibility. Column (3) adds month-zip fixed effects. Column (4) adds VDS (vehicle physical characteristics) fixed effects. Columns (5)–(7) mirror Columns (2)–(4) but introduce an interaction with zip wage relative to the CBSA. Standard errors in parentheses are clustered at the month-CBSA level.

	Dependent variable:						
	Use / Year (1000 miles)						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Post	0.121	−0.516*	-	-	−0.828**	-	-
	(0.195)	(0.293)	-	-	(0.389)	-	-
Post × Eligible	-	0.683***	0.741***	0.820**	0.994***	1.232***	1.308***
	-	(0.219)	(0.238)	(0.338)	(0.303)	(0.335)	(0.404)
Post × Eligible × High Wage	-	-	-	-	−0.704	−1.108**	−1.217**
	-	-	-	-	(0.502)	(0.539)	(0.580)
Past Use / Year (1000 miles)	0.126***	0.118***	0.117***	0.111***	0.118***	0.117***	0.111***
	(0.012)	(0.013)	(0.012)	(0.014)	(0.013)	(0.012)	(0.014)
Month FE	Y	Y	N	N	Y	N	N
Zip FE	Y	Y	N	N	Y	N	N
Zip×Month FE	N	N	Y	Y	N	Y	Y
VDS FE	N	N	N	Y	N	N	Y
Observations	1,136,820	1,136,820	1,136,820	1,136,820	1,136,800	1,136,800	1,136,800
R^2	0.035	0.038	0.184	0.663	0.038	0.184	0.663

Note: *p<0.1; **p<0.05; ***p<0.01

TABLE 8: DRIVER ENTRY

Table 8 shows the relationship between ex ante ownership and credit conditions in a CBSA and the rate of growth of Uber drivers. The left-hand-side variable is the number of drivers per capita in a CBSA six months after rideshare entry. Correl(Wage, % Subprime) is the (2010) correlation between zip-level relative wage and zip-level relative subprime borrowers in a CBSA. Correl(Wage, Ownership) is the correlation between relative wage and vehicle ownership per capita. Standard errors are in parentheses.

	Dependent variable:		
	Drivers / 1000 Pop		
	(1)	(2)	(3)
Correl(Wage, % Subprime)	0.274**	-	0.281**
	(0.107)	-	(0.107)
Correl(Wage, Ex-ante ownership)	-	0.031	0.048
	-	(0.071)	(0.070)
Ex-Ante Loans per Capita	0.182	0.154	0.300
	(0.399)	(0.443)	(0.435)
Constant	0.261***	0.097	0.230**
	(0.095)	(0.095)	(0.105)
Observations	103	103	103
R^2	0.062	0.002	0.067
Note:	*p<0.1; **p<0.05; ***p<0.01		

FIGURE 1: UBER VEHICLE REQUIREMENTS IN SEATTLE

Vehicle eligibility requirements in Seattle (as of February 8, 2018). Requirements differ slightly by city, typically with respect to the required age of the vehicle.
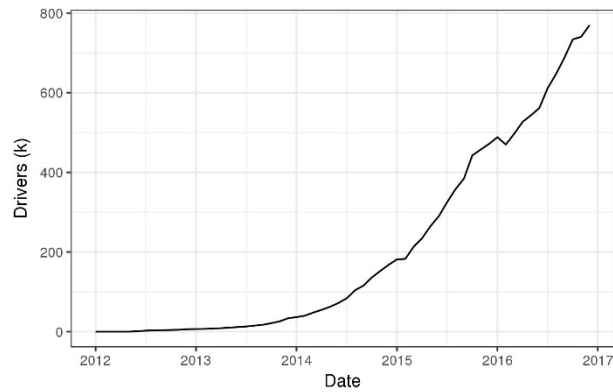
FIGURE 2: UBER AND LYFT ENTRY AND DRIVERS

Entry of Uber and Lyft. Panel (a) shows the cumulative population of cities that either Uber or Lyft have entered. Panel (b) shows the total number of Uber drivers across all cities. Panel (c) shows the cumulative number of Uber drivers for selected cities.
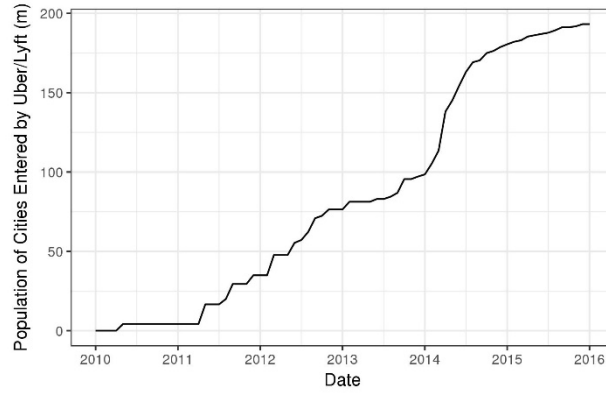
(a): Population of cities with rideshare

(b): Total Uber Drivers, United States
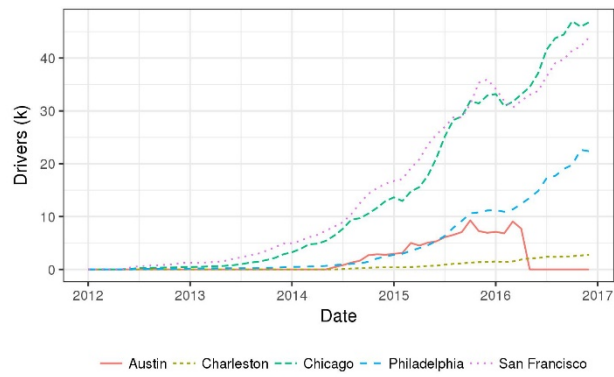
(c): Total Uber Drivers, selected cities

FIGURE 3: OUTSTANDING LOAN GROWTH

Cumulative differences in outstanding loan growth for treated versus untreated zip codes centered at the time when entry occurs within the matched pair at time t = 0. Panel (a) shows growth across all zip codes. Panel (b) breaks out growth by high- and low-wage zip codes. Panel (c) breaks out growth by high- and low-misallocation (as measured by ex ante correlation between wage and ownership within CBSA zip codes) CBSAs.
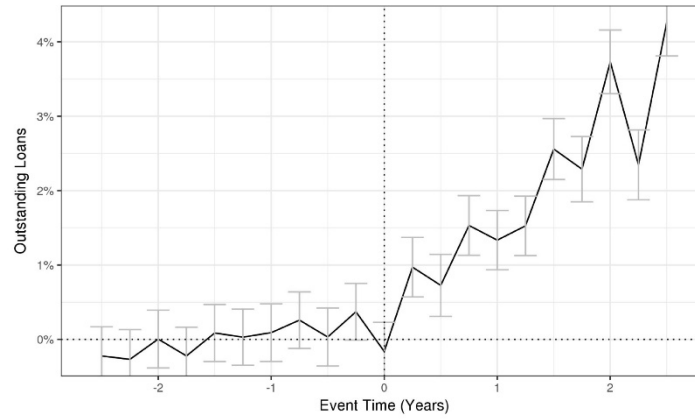
(a): All auto loans
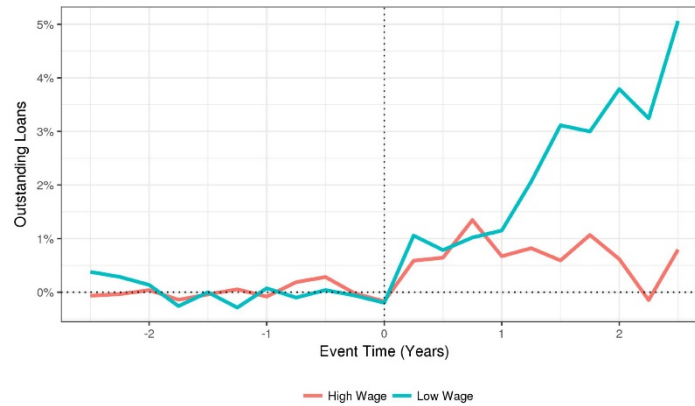
(b): Loans by relative zip wage
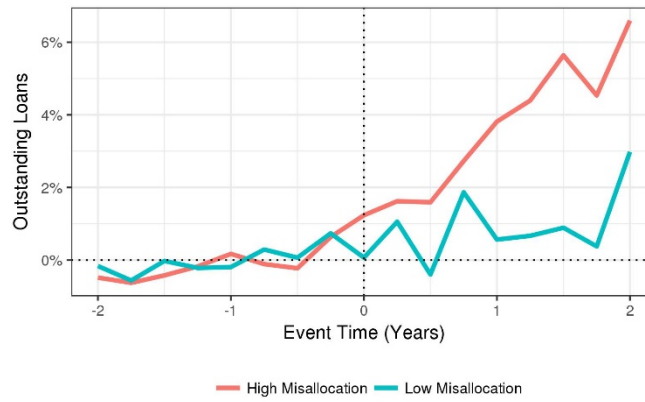
(c): Loans by ex ante CBSA misallocation

FIGURE 4: VALUE OF VEHICLE ELIGIBILITY

Differences in the coefficient on EventTime x Ttreatment x VehicleEligibility in the market share regression, $\log s_{jtc} = x'_j\beta_1 + \left(EventTime_{tc} \times Treated_c \times x'_j\right)\beta_2 + \gamma^* + \epsilon_{jtc}$. The coefficient identifies the implied differences in preferences for rideshare eligibility between treated and untreated zip codes versus event time.
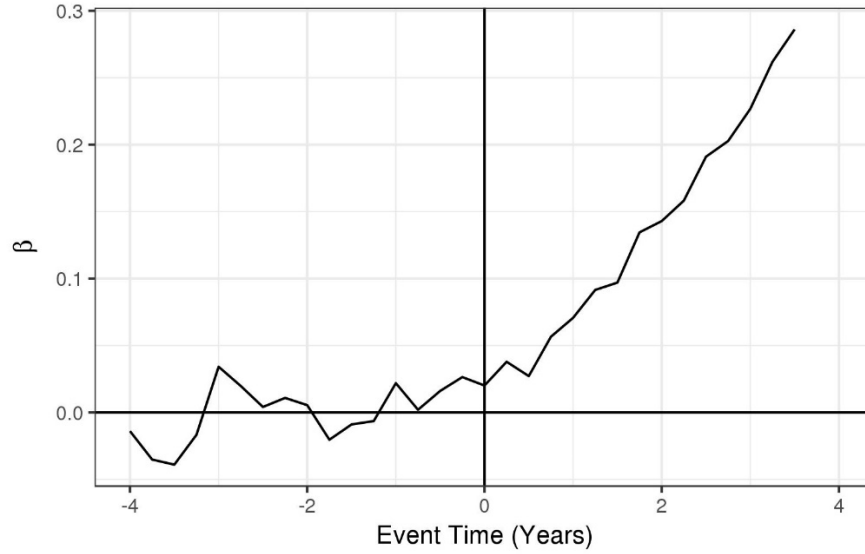
FIGURE 5: VEHICLE UTILIZATION

Average utilization rates in thousands of miles driven per year before and after rideshare entry. Red bars are pre-entry; blue bars are post-entry. Panel (a) considers only ineligible cars by low- and high-wage zip codes. Panel (b) considers only eligible cars by low- and high-wage zip codes. Table 6 shows statistical tests of these differences.
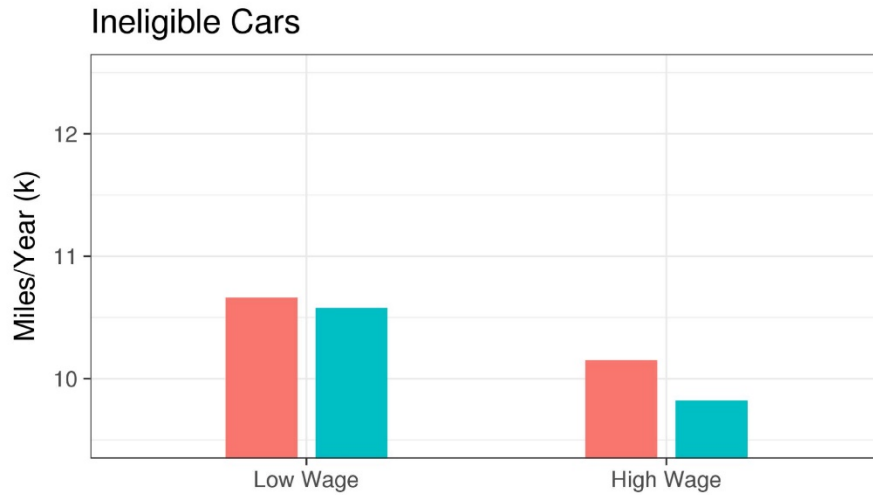
(a): Utilization of ineligible vehicles

(b): Utilization of eligible vehicle