# Driving the Gig Economy*

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**Abstract**

The prototypical gig worker—a contract driver for a ridesharing company—reports self-employment earnings in the Taxi and Limousine Services industry. Growth in the number of self-employed drivers in this industry has dramatically outpaced the growth in solo self-employment in any other industry. We use rich administrative tax data to explore who these workers are, how that has changed over time and how the new drivers combine self-employment with wage and salary work. Uber's entrance to a local labor market leads to significant growth in the number of drivers over the following years. Other than in New York City, where rideshare drivers are required to meet relatively stringent licensing requirements, increases in the number of drivers following Uber entry has been larger in jurisdictions where regulation had limited the number of taxis. The effect of Uber entry on the probability of becoming a self-employed driver is larger for people who have experienced job displacement. Uber entry increases the exit rate of incumbent taxi drivers and reduces their earnings from driving, though the adverse effects on incumbent drivers' total earnings are substantially smaller.

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## I. Introduction

The rise of the "gig economy" has attracted wide attention from both scholars and the popular media. Much of this attention has focused on the increase in jobs mediated through various online platforms. Terms like the "sharing" and "on demand" economy also have been used to refer to this sort of work activity, highlighting the opportunities that apps on smartphones and other web-based applications create for consumers to acquire goods and services directly from providers. New technology is widely perceived to have accelerated the pace of change in the organization of work, with important effects on both workers and firms.

Individuals engaged in gig work should report themselves as self-employed in standard household surveys such as the Current Population Survey (CPS) and American Community Survey (ACS). Perhaps surprisingly, whether counting only those who are primarily self-employed or everyone who reports having self-employment income, self-employment rates in these household surveys have been stable or falling over the post-2000 period. In contrast, administrative tax data show substantial increases in self-employment over this same period (Jackson, Looney and Ramnath 2017; Katz and Krueger 2019; Collins et al. 2019; Lim et al. 2019; Abraham, Haltiwanger, Sandusky and Spletzer 2021; Abraham, Haltiwanger, Hou, Sandusky and Spletzer 2021). The discrepancy in the patterns in household survey data as compared to administrative data is an area of active research, but it raises questions about the use of standard household surveys to study the growth of the gig economy. In this paper, we use data derived from tax records compiled for the Census Bureau's nonemployer statistics program, mainly data from Schedule C's, to study the growth of the gig economy through the mid-2010s and the drivers of that growth.[1]

[1] An issue highlighted by Garin et al. (2022) is the role of reporting incentives related to the Earned Income Tax Credit as a driver of growth in reported self-employment in tax data over the post-2000 period. Their analysis focuses onSchedule SE filers and argues that much of the pre-2011 growth in the number of Schedule SE filers was due to changes in reporting behavior rather than true changes in the prevalence of self-employment. During the years since 2011, there has been little growth in the number of Schedule SE filers and the share of workers filing a Schedule SE has fallen slightly. In contrast, the overall number of Schedule C filers increased by 18% from 2011 to 2018 and the number in NAICS 4853 increased by more than 500%. Understanding this discrepancy is an area of open research but part of the explanation may be that the reporting requirements for Schedule C are more binding than those for Schedule SE, in that even people who have net earnings below the threshold for filing a Schedule SE still may be required to file a Schedule C.

More specifically, we focus on the growth of self-employment in the Taxi and Limousine Services industry (NAICS 4853). This is the industry where drivers for taxi, limousine and ridesharing companies who file tax returns should be expected to report their self-employment earnings. The development of new technology that makes it easy for producers (drivers) and customers (riders) to connect with one another has significantly lowered the barriers to participation for prospective entrants. Better understanding how this new technology has affected the Taxi and Limousine Services industry should provide valuable insights for thinking about the potential effects of this sort of new technology more generally.

Our analysis rests on comprehensive records that allow us to observe both self-employment and wage and salary employment for essentially the entire working population.[2] We integrate longitudinal person-level information on the universe of U.S. sole proprietors with longitudinal information on wage and salary activity for the universe of employees covered by state unemployment insurance systems. Then, we augment these matched administrative data with information about worker characteristics including gender, age, race, ethnicity, and foreign-born status. The data allow us to track entry and exit into and out of self-employment activity as well as wage and salary activity and the changes in earnings associated with these transitions.

We begin with a descriptive analysis of self-employment in the Taxi and Limousine Services industry, the industry that experienced by far the most rapid growth in solo self-employment over our sample period. The Census nonemployer data for NAICS 4853 include traditional taxi and limousine service drivers, most of whom are self-employed independent contractors, as well as drivers whose work is mediated by an online platform ridesharing app.[3] They capture both individuals for whom driving is a main job and individuals for whom it is a secondary source of income.

[2] Our data cover about 96 percent of private, non-farm wage and salary employment and all self-employment reported to the tax authorities by sole proprietors without employees that generates $1,000 or more in gross receipts during a year (or $1 or more in construction)

[4] Occupational Employment Statistics data from the Bureau of Labor Statistics show that in 2010, prior to the advent of ridesharing apps, there were about 42 thousand wage and salary drivers in the Taxi and Limousine Services industry. Published nonemployer data indicate there were about 160 thousand solo self-employed drivers in this industry in 2010, meaning that about 80 percent of Taxi and Limousine Services drivers were self-employed.

Over the period we study, new entrants to NAICS 4853 look increasingly different from incumbent taxi and limousine drivers. Compared to incumbents, entrants during this period of rapid growth in the industry have been much more likely to be young, female, white, and U.S. born. In each new cohort of entrants, average earnings from driving have fallen. Entrants also have been more likely than either incumbents or those in prior entry cohorts to have both wage and salary income and self-employment income from driving. These patterns are consistent with evidence from other sources that many entrants use that work to supplement a primary source of earnings or smooth fluctuations in other earned income, rather than relying entirely or even primarily on income from ridesharing (Farrell and Greig 2016a, Farrell, Greig and Hamoudi 2018, Koustas 2018, 2019).

By lowering the barriers to entry, the entrance of online platform ridesharing companies has pulled workers into the Taxi and Limousine Services industry. Variation in whether and when online platform ridesharing became available in different metropolitan areas allows us to quantify the effects of this important pull factor. Our results show that the pace of entry into solo self-employment in Taxi and Limousine Services rises with the number of years that online platform ridesharing has been available in a metropolitan area. This effect is noticeably stronger in markets with regulations that create barriers to becoming a traditional taxi driver, except in New York City where rideshare drivers also must jump through significant regulatory hoops before they can begin transporting customers.

Self-employment is a well-recognized potential fallback option for workers who are displaced from their jobs or experiencing unemployment for other reasons (Alba-Ramirez 1994, Evans and Leighton 1989, Rissman 2003, 2006). For metropolitan areas without online platform ridesharing, the proportional increase in the probability that a worker enters other types of solo self-employment after a worker after being displaced is much larger than the proportional increase in the probability of their becoming a taxi or limousine driver. For metropolitan areas in which online platform ridesharing activity has become available, however, displacement increases the probability of entry (relative to the mean entry rate) into nonemployer activity in Taxi and Limousine Services by much more than the probability of entry into solo self-employment in other industries. Similar to the pattern of diffusion for other technological innovations, the

full effects of the new ridesharing apps take time to be realized and this gap grows with the number of years online platform ridesharing has been available in a metropolitan area.

One significant advantage of our data infrastructure is that it allows us to examine the effects of the new ridesharing technologies not only on those who enter the industry but also on incumbent taxi drivers. Ridesharing apps have drawn large numbers of new workers into driving, introducing competition for traditional taxi drivers. All else the same, this might be expected to have caused falling earnings and exit of traditional taxi drivers from the industry. By making it easier for customers to connect with a driver, however, ridesharing apps also have increased the demand for driving services. Depending on the overall labor supply response, the earnings of incumbent drivers could have either risen or fallen. We show that the introduction of ridesharing apps in a local labor market has accelerated the exit of traditional taxi drivers from driving. This accelerated exit is somewhat mitigated in regulated markets and especially so in New York City. We also find that the entry of ridesharing lowers incumbents' earnings from driving, conditional on their continuing to work, though the decline in their total earnings is less pronounced than the decline in their earnings from driving. The adverse effects on earnings from driving are mitigated in regulated markets, with some suggestion this may be especially the case in New York City. Incumbent drivers in areas where taxi service is regulated appear to fare no differently than incumbent drivers in other areas with respect to the effects of ridesharing on their total earnings, though again New York City is different, with incumbents' total earnings being more adversely affected there than elsewhere.

The paper contributes in several ways to the existing literature. First, because our data infrastructure includes earnings history information together with information on demographic characteristics for essentially the entire population, we are able to show definitively how ridesharing has transformed the Taxi and Limousine Services industry. Second, to our knowledge, we are the first to quantify the mediating effects of regulation in the taxi industry on the effects associated with the introduction of ridesharing apps. Third, we provide direct evidence not available elsewhere on how the entry of rideshare platforms has affected traditional taxi drivers who were industry incumbents, something that is possible because we are able to follow individual workers over time.

## II. Background

Platform work still represents a small fraction of total employment, but it grew rapidly from the early 2010s through the end of that decade. Driving services account for the largest share of the growth in platform work, (Abraham et al. 2019; Farrell, Greig and Hamoudi 2018), but a growing number of online platforms offer opportunities for workers to earn money. Although ridesharing could be viewed as *sui generis*, its growth illustrates how new technology can disrupt an industry.

Whether platform work is good or bad for workers has been a topic of considerable debate. There are legitimate concerns about the fact that those performing platform work lack employer-provided benefits and typically do not enjoy the protections afforded to wage and salary workers under U.S. employment law. These concerns have prompted efforts to legislate that individuals who find work through platforms be treated as employees rather than as independent contractors (Abraham and Houseman 2021).

On the other hand, the flexibility afforded by a platform—flexibility it would be difficult if not impossible to replicate in the context of a traditional employment relationship—can have significant value to workers. By lowering the barriers to entry, online platforms have made it easier for individuals to take on short-term projects that make use of their skills, either as a main job or as a secondary activity undertaken in conjunction with wage and salary work. The most common reason given for choosing to drive for Uber given by a sample of 601 drivers surveyed in 2014, was "to earn more income to better support myself or my family" (cited by 91 percent of respondents). The three next most common reasons, however, were "to be my own boss and set my own schedule" (87 percent); "to have more flexibility in my schedule and balance my work with my life and family" (85 percent); and "to help maintain a steady income because other sources of income are unstable/unpredictable" (74 percent) (Hall and Krueger 2018). These answers suggest that responding drivers valued the flexibility of rideshare driving.

Econometric estimates suggest that workers accrue a substantial surplus from being able to work when they want (Angrist, Caldwell and Hall 2021; Chen et al 2019; Chen et al 2020). Hall and Krueger

(2018) report that, in both 2014 and 2015, more than half of Uber drivers drove less than 15 hours per week and more than 80% drove less than 35 hours per week. Because workers who work fewer hours should be better able to match their hours to times when expected earnings are high relative to their reservation wage, the surplus they accrue from hours flexibility likely is larger.

Several authors have observed that many drivers are active on the Uber platform only for a short period (Farrell and Greig 2016b; Farrell, Greig and Hamoudi 2018; Hall and Krueger 2018). Anonymized high frequency bank account data suggests that workers use platforms to buffer income fluctuations due to a job loss or reductions in hours. Farrell and Greig (2016a) document that, in months when wage and salary income dips, online platform participants are able to offset much of the decline with platform earnings. Koustas (2018) analyzes transactions-level data for the users of one company's personal financial management software. In a sample of individuals he identifies as receiving regular bi-weekly paychecks, he finds that work as an Uber driver mitigates week-to-week fluctuations in pay and allows drivers to smooth their consumption. One limitation of these studies is that the samples studied may not be representative of the population as a whole. Jackson (2020) uses tax data to study the impact of gig employment. She finds that individuals who have access to platform work experience a smaller short-term decline in earnings when they lose their job than those without such access, though she also finds their earnings are lower two to four years later.

The extent to which the introduction of rideshare platforms alters a local labor market will depend in part on the difficulty of obtaining similar work absent access to a platform. Most jurisdictions have licensing and other requirements for potential taxi drivers, but regulations that limit the number of taxis in service can be an especially significant barrier to entry to work as a taxi driver. Those favoring restrictions on taxi numbers have argued that free entry leads to oversupply of taxis at airports and cab stands, producing long driver wait times and low driver incomes (Schaller 2007). Arguments against entry restrictions include the resulting risk of regulatory capture and anti-competitive practices in the industry (Farren, Koopman and Mitchell 2016). Historically, the number of taxis per thousand residents has been markedly lower in large cities that regulate taxi entry than in large cities that do not (Frankena and Pautler 1984) and taxi

deregulation in the early 1980s commonly led to the entry of new taxi firms providing additional taxi capacity (Teal and Berglund 1987). The introduction of rideshare apps might be expected to have a larger effect on the market for passenger transportation services in cities where regulations have limited the number of taxis, but we know of no empirical evidence on this point.

One important unanswered question about the growth of online apps that match riders with drivers is how the introduction of this technology has affected the incumbent taxi driver workforce. Cramer (2019) uses data for large metropolitan areas covering the period from 2008 through 2014 to study how growth in the number of Uber drivers affected wages and employment in the Taxi and Limousine Services industry. He finds no significant effects on either outcome, but acknowledges that his data are less than ideal for understanding how Uber entry has affected incumbent taxi drivers. One set of models reported by Cramer measures employment and wages using data from the Quarterly Census of Employment and Wages (QCEW), but the majority of traditional taxi drivers are self-employed and the QCEW data cover only wage and salary workers. A second set of results relies on CPS data to measure the same outcomes. In addition to suffering from small sample sizes and well-documented problems with the reporting of self-employment activity (Abraham, Haltiwanger, Sandusky and Spletzer 2021, Abraham, Haltiwanger, Hou, Sandusky and Spletzer 2021), the CPS data do not separately identify traditional and rideshare drivers, which makes them ill-suited for drawing conclusions about the effect of rideshare entry on incumbent taxi drivers.

Berger et al. (2018) use a difference-in-differences strategy to investigate the effects of Uber entry into the 50 largest U.S. metropolitan areas between 2009 and 2015. The unit of observation in their analysis is an MSA-year and the outcomes they study are employment and wages. They use ACS data on workers in the Taxi Drivers and Chauffeurs occupation to measure these outcome variables, looking first at estimates based on everyone with a main job in the occupation and then, to exclude rideshare drivers, at estimates based on the subset of wage-employed workers. They find that Uber entry reduced average hourly earnings in the Taxi Drivers and Chauffeurs occupation by 10 to 17 percent, depending on the specification, but had no effect on the total hours supplied by these workers. Although the ACS is a large survey, the number of drivers observed in an MSA-year cell often is small, averaging 45 drivers but ranging from 2 to 745 drivers.

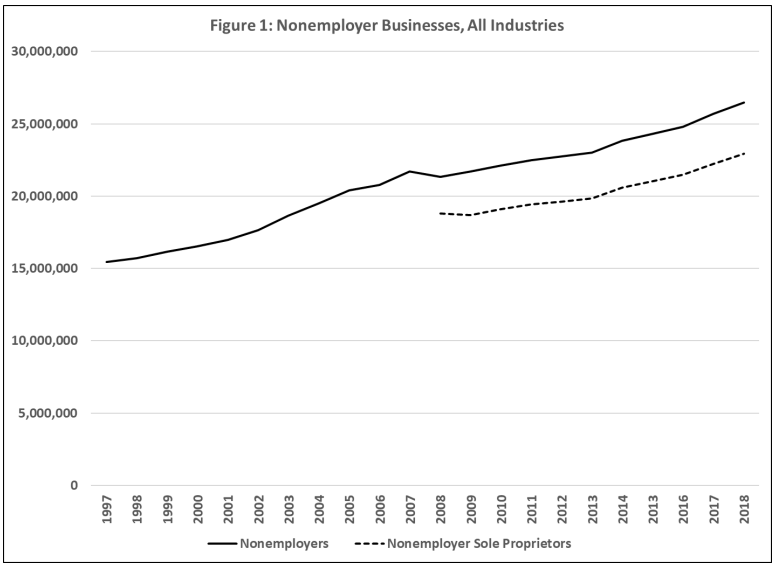
An important limitation of the all-driver models is that, like the results reported by Cramer, they fold together incumbent taxi drivers and rideshare drivers. The models restricted to wage-employed workers in principle should exclude rideshare drivers, but they also exclude the majority of traditional taxi drivers. An additional problem is that, according to data from the Occupational Employment Statistics (OES) survey, many wage employees in the Taxi and Limousine Driver occupation do not work in the Taxi and Limousine Services industry. In 2012, for example, at the midpoint of the authors' study period, 54 percent of these employee drivers worked in some other 3-digit NAICS industry. Using comprehensive administrative data that allow us to follow incumbent drivers over time, we are able to show how the introduction of ridesharing apps has affected those who had been working as traditional taxi drivers prior to their advent, differentiating between the effects in regulated and unregulated taxi markets.

## III. Trends in Nonemployer Self-Employment

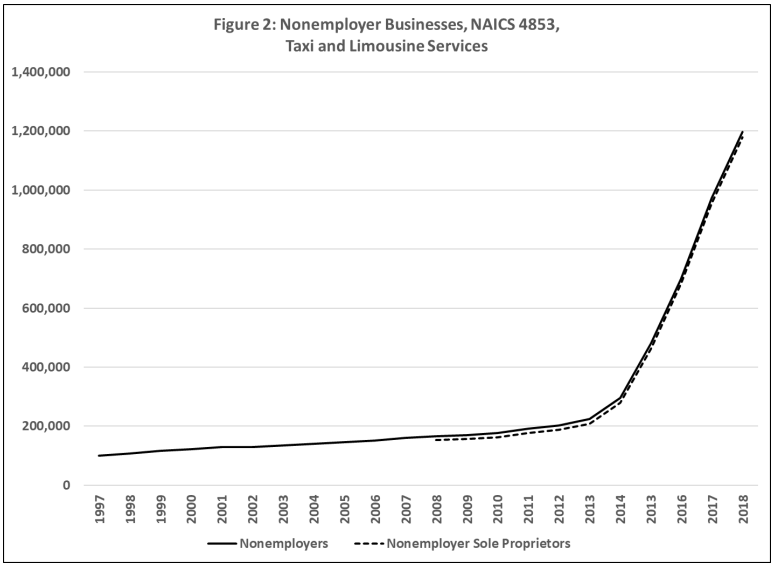
We begin by examining recent trends in the number of nonemployer businesses, both in NAICS 4853, Taxi and Limousine Services, and elsewhere. The Census Bureau defines a nonemployer business as a business that has no paid employment or payroll, is required to file a federal income tax return, and has business receipts of $1,000 or more ($1 or more for the Construction sector).[4] The great majority of nonemployers are self-employed individuals operating as unincorporated sole proprietors, but there also are nonemployer businesses organized as corporations, S-corporations and partnerships. Nonemployer statistics originate from Schedule C's (for unincorporated sole proprietors) and other tax forms providing similar information filed with the Internal Revenue Service. Nonemployer statistics are published for approximately 450 industries categorized according to the North American Industry Classification System (NAICS), at various levels of geography, and, since 2008, also for various legal forms of organization.

[4] The U.S. Census Bureau publishes counts of nonemployers and their receipts at https://www.census.gov/programs-surveys/nonemployer-statistics.html. Since the official nonemployer statistics generally are restricted to individuals with business receipts of at least $1,000, those with the most limited self-employment activity—for example, individuals who try ride-sharing for a short period of time but decide after a small number of rides that it is not for -them—are excluded.

Figure 1 displays the total number of nonemployer businesses for each year from 1997 through 2018 and the number organized as sole proprietorships starting in 2008. In 2018, the most recent year of published data, there were 26.5 million nonemployers with combined receipts of 1.3 trillion dollars. Of these, 22.9 million were sole proprietors, accounting for combined receipts of 0.8 trillion dollars. We are especially interested in nonemployers in NAICS 4853, Taxi and Limousine Services. As shown in Figure 2, after trending slowly upwards from 1997 through 2013, the number of nonemployers in this industry shot up sharply beginning in 2013. The number of self-employed drivers was more than 5 ½ times as large in 2018 as five years earlier, having grown from 223,814 drivers in 2013 to 1,179,167 drivers in 2018. Almost all of these drivers—more than 93% in 2013 and more than 98% in 2018—are unincorporated sole proprietors.




Source: Census Bureau published nonemployer statistics.




Source: Census Bureau published nonemployer statistics.

Nonemployer statistics are published for only a subset of 4-digit NAICS industries, limiting our ability to make cross-industry comparisons at that level. At the 3-digit industry level, over 80 percent of the nonemployers in NAICS 485, Transit and Ground Passenger Transportation, are in NAICS 4853, Taxi and Limousine Services. The growth in the somewhat larger 3-digit industry can be compared to the growth in other 3-digit NAICS industries. NAICS 485 grew by almost 400 percent between 2013 and 2018, adding more than a million nonemployer businesses. As discussed by Abraham et al. (2019), nonemployer growth in NAICS 485 has far exceeded the growth in any other 3-digit industry. Restricting our attention to 3-digit industries with at least 100,000 nonemployers in 2013, the next-fastest-growing was NAICS 492, Couriers and Messengers, which added just over 200,000 nonemployer businesses between 2013 and 2018, a growth rate of 125 percent.

## IV. Data

We use the microdata underlying the Census Bureau's published nonemployer statistics for the years 2010 through 2016 to analyze the transformation of NAICS 4853, the Taxi and Limousine Services

industry.[5] To examine the characteristics of the NAICS 4853 nonemployer workforce and the dramatic changes in the composition of that workforce over our study period, we merge the nonemployer microdata with demographic and other information. We also examine how the entry of Uber into a local labor market affects the entry of new workers to NAICS 4853 and the labor market experiences of nonemployers who had been working as traditional taxi drivers.

Because we need to be able to identify the individuals engaged in nonemployer self-employment rather than simply that a nonemployer business exists, we focus on nonemployer sole proprietors. Each sole proprietor nonemployer record contains the industry in which the business operates; information on gross receipts, expenses and net receipts as reported on the business's Schedule C; and a unique identifier for the business owner, the Census Bureau's Protected Identification Key (PIK).[6] Some people file multiple Schedule C's (i.e., have more than one business). As a first step in preparing the nonemployer microdata for analysis, we collapse the data, based on the PIK, to one record per individual per year, such that each record contains information for all of the businesses that a person may have operated in that year. We restrict the sample to those with valid PIKs and delete as outliers cases with the top 0.1% of values for combined business receipts or combined business expenses, which in all cases were implausibly high. In some of our analyses, we want to know how long a person has been a nonemployer. In addition to complete nonemployer microdata for 2010 through 2016, we also have somewhat less complete microdata for 2007, 2008 and 2009 that allow us to determine in most cases whether a person had nonemployer earnings in those years.

Using the PIK of the business owner as a linking variable, we supplement the 2010-2016 nonemployer microdata with information for the same years on wage and salary earnings from the Longitudinal Employer-Household Dynamics (LEHD) program. The LEHD data are sourced from state

[5] These microdata are a little used resource whose potential for better understanding the dynamics of labor market activity are just beginning to be appreciated; see, for example, Garcia-Perez et al. 2013, Goetz et al. 2017, and Hyatt, Murray and Sandusky 2018.

[6] The availability of a PIK for sole proprietors allows their data to be integrated with other administrative data. Information on business owners is less readily available for nonemployer businesses organized as corporations or partnerships. Beginning in 2007, K-1 filings contain information on business ownership, but this information has notable limitations (Goldschlag et al. 2017). For our purposes, because all of the growth in nonemployers in NAICS 4853 has been among sole proprietors, restricting our analysis to that group is not a serious limitation.

Unemployment Insurance (UI) administrative records and cover all private sector employers subject to state UI coverage (approximately 98% of private sector employment), plus state and local government. Federal government employees are the major omitted group of wage and salary earners. The LEHD contains quarterly earnings information for individuals in all 50 states plus the District of Columbia for each year from 2010 through 2016, with the exception of Massachusetts in 2010 and Alaska in 2016.

The final step in creating our core data infrastructure is to incorporate demographic information from the Census Bureau's Individual Characteristics File (ICF). The ICF includes a record for everyone who has ever applied for a Social Security Number (SSN). The information on the ICF includes gender, date of birth, race, Hispanic origin and place of birth.[7] In merging the nonemployer data with the ICF information, we exclude individuals for whom gender, date of birth, race, ethnicity or place of birth are missing. We restrict our sample to individuals who, based on their birth dates, are 14 to 99 years old in a given year. As shown in Table 1, for the years for which we have nonemployer microdata, the trends both in the overall number of nonemployers and in the number of NAICS 4853 nonemployers are similar in our analytic sample to the trends in published statistics.

Table 1: Nonemployer Sole Proprietors, Published and Analytic Sample

| Year | All Nonemployers, Published | All Nonemployers, Analytic Sample | Industry 4853, Published | Industry 4853, Analytic Sample |
|---|---|---|---|---|
| 2008 | 18,808,725 | | 153,628 | |
| 2009 | 18,701,855 | | 156,905 | |
| 2010 | 19,112,075 | 18,140,000 | 162,732 | 156,000 |
| 2011 | 19,438,914 | 18,450,000 | 177,392 | 169,000 |
| 2012 | 19,634,605 | 18,540,000 | 187,788 | 178,000 |
| 2013 | 19,850,941 | 18,710,000 | 208,692 | 197,000 |
| 2014 | 20,592,806 | 19,320,000 | 279,417 | 263,000 |
| 2015 | 21,023,170 | 19,690,000 | 462,906 | 437,000 |
| 2016 | 21,490,556 | 20,010,000 | 683,135 | 638,000 |
| 2017 | 22,247,406 | | 956,467 | |
| 2018 | 22,933,726 | | 1,179,167 | |

[7] The ICF also includes an education variable, but it is imputed for about 80 percent of individuals and missing for about another five percent.

Being able to link individuals' nonemployer records over time allows us to identify essentially all 2011 through 2016 nonemployer entrants. A year *t* entrant is anyone with nonemployer earnings in year *t* for whom we do not observe nonemployer earnings in year *t-1*. We also are able to identify nonemployer exiters in 2010 through 2015, where a year *t* exiter is anyone who had nonemployer earnings in year *t* but not year *t+1*. To model nonemployer entry, we need to be able to identify the population at risk of entry, which we define to include anyone age 14 to 99 living in the United States in year *t* for whom we do not observe nonemployer earnings in the previous year. Our source for identifying the U.S. resident population is the Census Bureau's Resident Candidate File (RCF) or its predecessor, the Composite Person Record (CPR). The RCF or CPR also tells us each person's state and county of current residence, which we use to determine whether the individual lives in a Core Based Statistical Area (CBSA) and, if so, which metropolitan or micropolitan CBSA that was.[8]

We would like to know how local labor markets are affected when rideshare companies enter. We proxy the availability of rideshare apps based on the date of Uber entry. Although there are other rideshare companies, the entry of the Uber platform is a good indicator of the availability of online rideshare platforms more generally.[9] Other studies using this approach often have restricted their attention to the largest Uber markets (see, for example, Cramer 2019 and Berger et al. 2018). As described more fully in the data appendix, drawing on multiple sources of information, we sought to identify the Uber entry date for all of the metropolitan CBSAs within existing Uber service areas and all of the micropolitan CBSAs in Uber service areas that do not include one or more metropolitan CBSAs. We use the information on date of Uber entry to construct a linear years-since-entry variable.

A mediating factor that could affect the impact of ridesharing on local labor markets is the nature of the regulations governing traditional taxi service. More specifically, we would expect the introduction of

[8] A CBSA is a geographic area consisting of one or more counties (or equivalents) anchored by an urban center of at least 10,000 people plus adjacent counties that are socioeconomically tied to the urban center by commuting. Micropolitan CBSAs are based on Census Bureau-defined urban clusters of at least 10,000 and fewer than 50,000 people. To qualify as a metropolitan CBSA, the urban cluster must have at least 50,000 people.

[9] Uber is the clear market leader in the industry. In September 2013, for example, Uber operated in 20 cities while Lyft operated in 10 cities that were a subset of those in which Uber operated.

ridesharing to have more pronounced effects where regulations have restricted entry to the taxi industry, since the pre-existing barriers to entry would have been larger in those areas. To test this hypothesis, we construct an indicator variable for whether a CBSA's central city limits the number of taxis on the road through a medallion or other system. We examine the mediating effect of a city's regulation status on the effects of Uber entry on the entry of new drivers to NAICS 4853, the exit of incumbent drivers from the industry and from the workforce, and the earnings of incumbent drivers. This assumes, of course, that the entry of rideshare companies in fact significantly lowers the barriers for drivers interested in entering. As we will discuss more fully below, cities may regulate rideshare companies in a way that invalidates this assumption. New York is to date the U.S. city that has regulated rideshare services most stringently. In some models, we allow the effects of Uber entry to be different in the New York City CBSA than in other cities with regulations limiting the number of taxis.

Rideshare drivers often are pulled into driving, in many cases combining income from driving with income from a wage and salary job, but some are pushed into ridesharing as a result of being displaced from their jobs. Using quarterly earnings data from the LEHD, we identify previously-employed individuals who experienced a displacement event during the prior year, defined as a separation from an employer at which there was a large quarter-over-quarter decline in employment in any of the four quarters of the year. This allows us to study how the entry of ridesharing to a market affects the probability that a displaced worker becomes a solo self-employed driver.

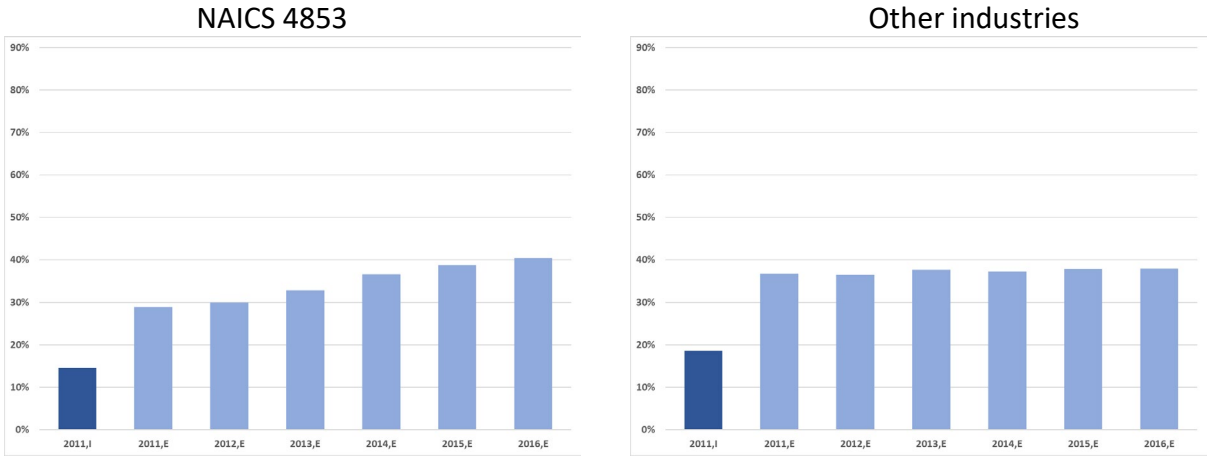
## V. Changes in the Taxi and Limousine Industry Workforce

As already documented, the introduction of ridesharing apps has been associated with the entry of many new drivers to NAICS 4853, Taxi and Limousine Services. The left-hand panel of each of the following figures shows selected characteristics of the nonemployer sole proprietors working in NAICS 4853. The dark blue bar at the left refers to drivers who earned income as a nonemployer in NAICS 4853 both in 2010 and in 2011, a group we refer to as 2011 incumbents. The lighter blue bars refer to drivers who were new entrants to the industry in each year from 2011 through 2016, where an entrant is someone who

earned no income as a nonemployer in NAICS 4853 in the previous year. For comparison, the right-hand panel of each figure shows similar numbers for nonemployer sole proprietors in other industries.[10]

The four panels of Figure 3 trace out changes in the demographics of nonemployer sole proprietors over the period when app-based ridesharing services were beginning to be introduced. New entrants to NAICS 4853 in every year are more likely than are the 2011 incumbents to be young (Figure 3A), female (Figure 3B), white (Figure 3C) and native-born (Figure 3D). Starting in 2013, as the spread of app-based ridesharing services led to sharp growth in the number NAICS 4853 nonemployer sole proprietors, the share of new drivers with these characteristics began to grow, suggesting that platform-based driving attracted groups of workers to NAICS 4853 who previously would not have chosen to work in the industry. Between 2013 and 2016, the share of new entrants to the NAICS 4853 nonemployer workforce who were under age 35 rose from 28.9 percent to 40.5 percent; the share who were female rose from 15.5 percent to 25.0 percent; the share who were white from 46.3 percent to 58.0 percent; and the share who were native-born from 31.1 percent to 57.7 percent. In contrast, the demographic characteristics of new entrants to the nonemployer workforce in other industries were little changed.

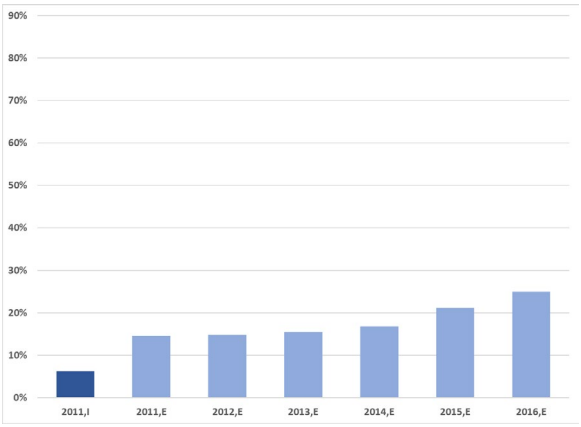
Figure 3A: Percent under age 35, nonemployers in NAICS 4853 and other industries, 2011 incumbents and 2011-2016 entrants




[10] The numbers underlying these figures are reported in Table A1 in the appendix.

Figure 3B: Percent female, nonemployers in NAICS 4853 and other industries, 2011 incumbents and 2011-2016 entrants

NAICS 4853




Other industries

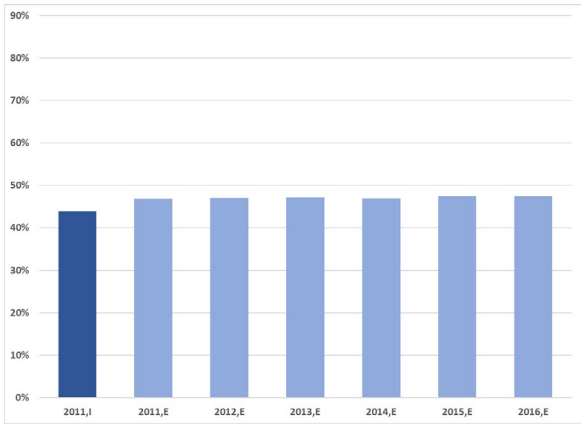
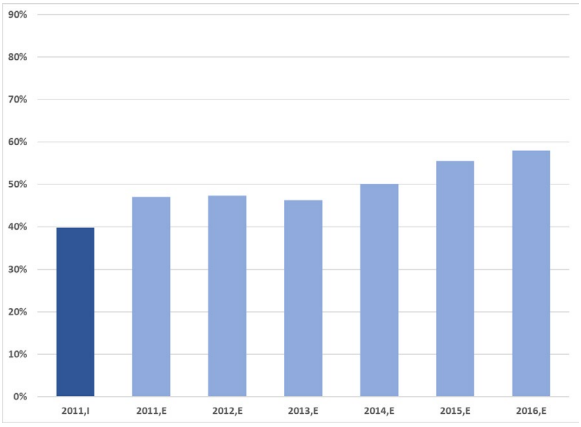



Figure 3C: Percent white, nonemployers in NAICS 4853 and in other industries, 2011 incumbents and 2011-2016 entrants

NAICS 4853




Other industries

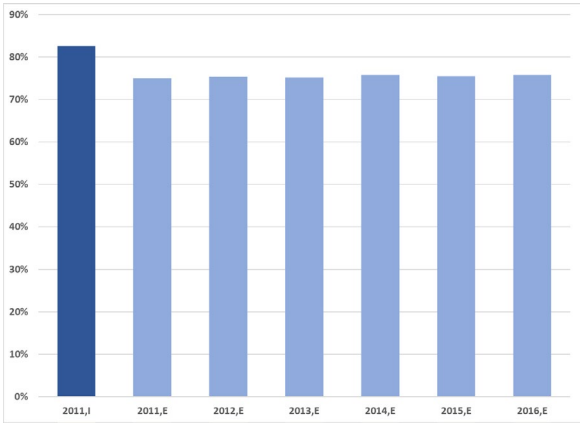
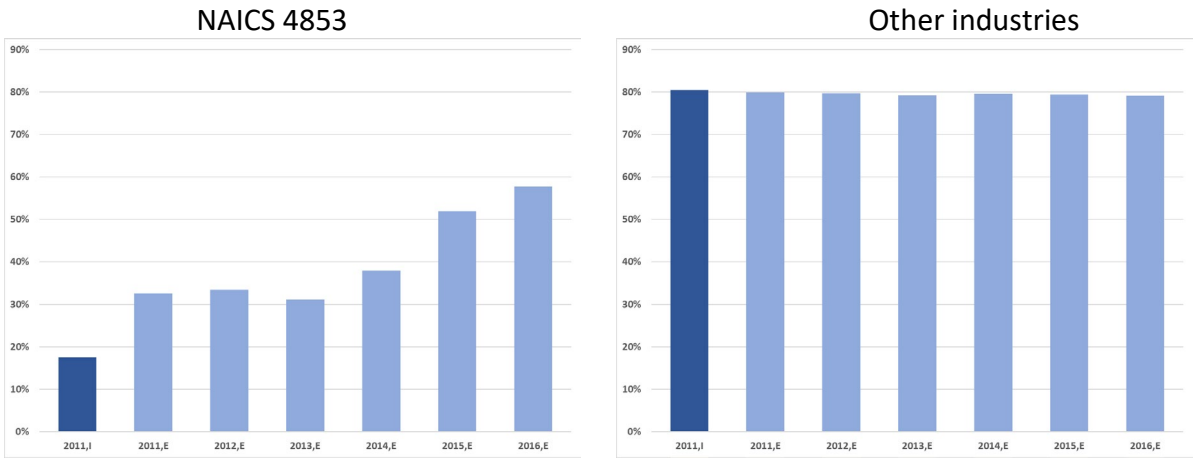


Figure 3D: Percent native born, nonemployers in NAICS 4853 and other industries, 2011 incumbents and 2011-2016 entrants




Figures 4A and 4B display the gross and net earnings of incumbent and entering nonemployer sole proprietors. NAICS 4853 nonemployer incumbents had net earnings that averaged just $12,190 in 2011 (in 2015 dollars), compared with an average of $21,280 for nonemployer incumbents in other industries. Unsurprisingly, both among those in NAICS 4853 and among those in other industries, entrants earn substantially less than incumbents. In 2011, NAICS 4853 entrants earned an average of $7,190 on net, compared to $10,110 for entrants to other industries. Incumbents are both more experienced than entrants and more likely to have worked a full year.[11] Beginning in 2013, however, the earnings of NAICS 4853 entrants begin to fall off sharply. By 2016, the average NAICS 4853 entrant had net earnings of just $2,110. No such pattern is apparent among nonemployer sole proprietor entrants in other industries, whose earnings relative to those of the 2011 incumbents exhibit no particular trend.

[11]Virtually all new entrants spend less than a full year in nonemployer work in the year they enter. Incumbents may work less than a full year in the year they exit, but the modest exit rates documented later in the paper imply that entrants are much more likely than incumbents to have worked a partial year.

Figure 4A: Mean gross receipts, nonemployers in NAICS 4853 and other industries, 2011 incumbents and 2011-2016 entrants (thousands of 2015 dollars)

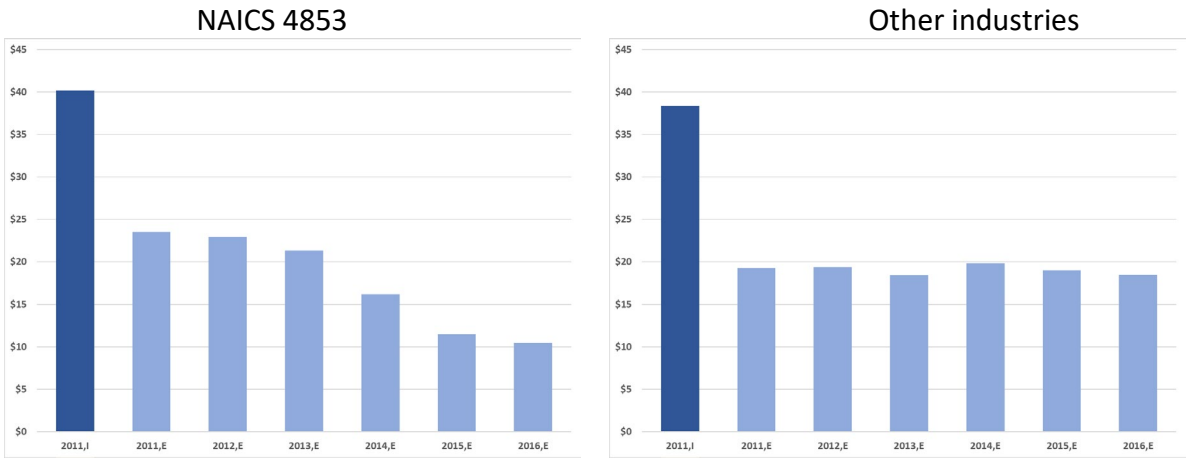



Figure 4B: Mean net receipts, nonemployers in NAICS 4853 and other industries, 2011 incumbents and 2011-2016 entrants (thousands of 2015 dollars)

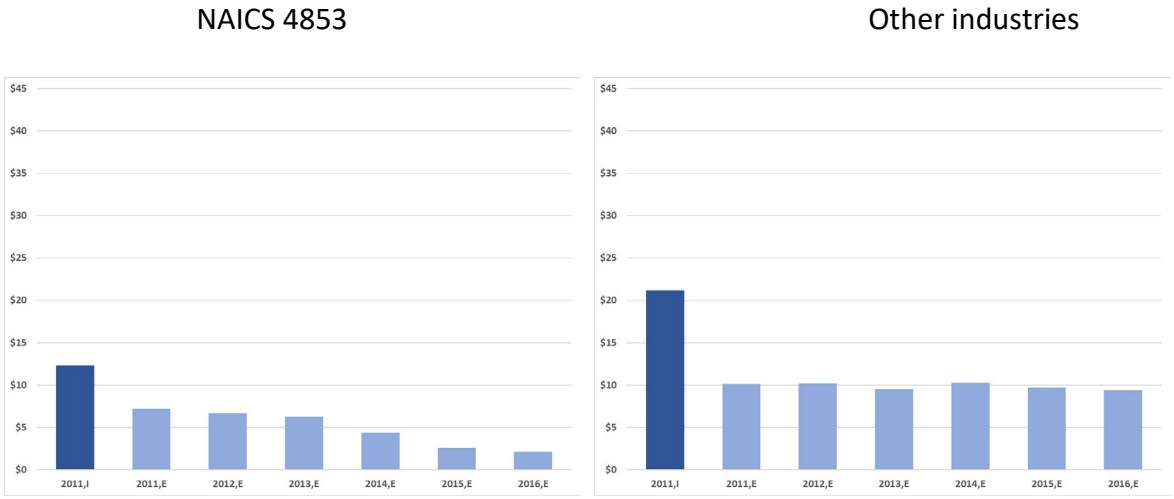
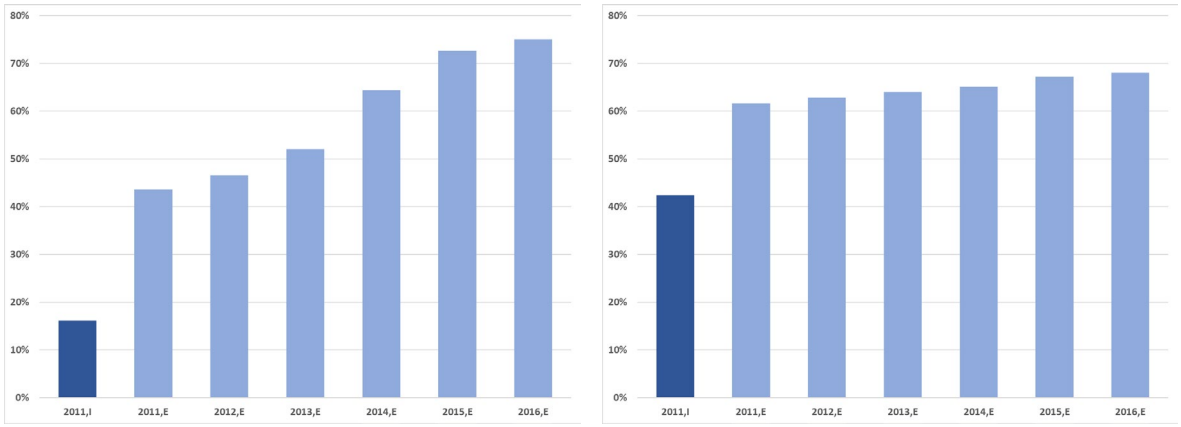


Figure 4C: Percent with wage and salary income, nonemployers in NAICS 4853 and in other industries, 2011 incumbents and 2011-2016 entrants

NAICS 4853 Other industries




One other notable feature of Figures 4A and 4B is the large difference between gross and net earnings for all groups, a difference that is especially large for nonemployers in NAICS 4853. In 2016, for example, the average driver entering NAICS 4853 had gross earnings of $10,460 and net earnings of $2,110 (both in 2015 dollars), meaning that expenses represented 80 percent of gross earnings. By comparison, calculated in the same manner, the expense share of gross earnings for nonemployers entering industries other than Taxi and Limousine Services was 49 percent. Rideshare drivers' deductible expenses include any fees deducted from gross fares by a ridesharing company and the cost of operating the driver's vehicle. They also include items such as tolls and parking charges paid while working as a rideshare driver, a prorated share of auto loan interest or personal property taxes on the vehicle, and refreshment provided to the passenger (H&R Block 2016). Costs of operating the vehicle may be determined based either on applying the IRS-approved mileage cost rate, which varied between 51.0 cents and 57.5 cents per mile from 2011 through 2016, or on actual expenses. If claimed expenses represent true costs associated with earning self-employment income, net receipts should be the figure that corresponds most closely to the earnings received

by a wage and salary worker.[12] On the other hand, for many drivers, the short-term out-of-pocket cost of driving their car is likely to be considerably less than allowable expenses calculated using the IRS-approved mileage rate. To the extent that a rideshare driver cares primarily about the amount she takes home each week, as might be the case for someone who is using ridesharing to smooth temporary fluctuations in other income, gross earnings may be the more salient figure.

Finally, Figure 4C shows the share of nonemployer sole proprietors combining self-employment income with wage and salary income. Because of their greater likelihood of working a partial year as a nonemployer sole proprietor, this is considerably more common among entrants than among incumbents. Once again, however, the pattern for NAICS 4853 begins to change beginning in 2013. Only 52.1 percent of 2013 entrants combined self-employment income with wage and salary income during the year; by 2016, 75.0 percent of entrants did so, more than a 20 percentage point increase. No such change occurred among nonemployer sole proprietors entering other industries.

Taken together, the decline in average nonemployer earnings and increased propensity to combine nonemployer self-employment with a wage and salary job among NAICS 4853 entrants are consistent with earlier findings that many app-based drivers use driving to supplement or smooth their earnings rather than as a primary source of income (Farrell and Greig 2016b, Koustas 2018, 2019).

## VI. Entry into Taxi and Limousine Services

Our baseline estimating equation for studying entry into Taxi and Limousine Services is as follows:

$$(1) \qquad ENTER_{it} = \alpha * YEAR_{it} + \beta * YearsUber_{it} + \tilde{X}_{it}\tilde{\gamma} + \delta * CBSAGROWTH_{it} + \tilde{CBSA}_{it}\tilde{\lambda} + \varepsilon_{it}$$

In this equation, estimated using person-year observations for the period from 2011 through 2016, ENTER equals 100 if a person enters Taxi and Limousine Services as a nonemployer in the given year and otherwise equals zero. With this scaling, the estimated model coefficients represent percentage point changes in the

[12] Net receipts will not be strictly comparable to wages and salaries in terms of the worker's take-home income because the worker is required to pay both the employer and the employee portion of payroll taxes on any net receipts from self-employment.

entry rate associated with changes in the explanatory variables. YEAR is calendar year; YearsUber is the number of years Uber has operated in the individual's CBSA; X is a vector of indicator variables for gender, age group, foreign born, nonwhite, Hispanic and education group, together with indicator variables for missing demographic information; CBSAGROWTH is the percent employment growth in the CBSA from year *t-5* through *t-1*; and CBSA is a vector of CBSA dummies, including a dummy for CBSA missing.

In this model, YEAR captures any underlying trends in entry into Taxi and Limousine Services. Since platform-based ridesharing was introduced in San Francisco, it has spread to most metropolitan areas. Familiarity with ridesharing and thus the demand for those services appears to grow in the years following their introduction in a market, meaning that YearsUber better captures the effects of rideshare entry than a simple indicator for whether Uber has entered as of a particular year.[13] Demographic controls are included to account for cross-group differences in the likelihood of becoming a taxi or rideshare driver. Ridesharing companies did not randomly select the markets in which they made their online platforms available, but rather chose the order of entry based on the opportunities offered in different areas. In practice, this has meant entering the largest CBSAs first.[14] Although there could be underlying differences in self-employment growth rates that are correlated with the availability of online ridesharing platforms, the controls included in our models—a full set of CBSA dummies plus a CBSA missing dummy and the variable CBSAGROWTH to capture recent employment trends in an area—should largely control for any such potential effects. More elaborated models add interactions of YearsUber with a dummy variable for whether regulations limit the number of taxis in the CBSAs core city; the same plus a separate New York City

[13] The use of a simple linear term for years since Uber entered simplifies the estimation of the rich set of interaction terms included in our full specification. It also avoids the disclosure problems that would be created were we to report fully flexible nonparametric specifications containing separate dummies for each possible number of years since online platform ridesharing became available in a CBSA and the interactions of these dummies with other included variables. We have estimated more flexible specifications and the results are very similar to those for the linear specification.

[14] The average 2013 population of the CBSAs where Uber entered was 12.2 million in 2011, 6.6 million in 2012, 3.4 million in 2013, 1.4 million in 2014, 0.5 million in 2015 and 0.3 million in 2016. As explained in the data appendix, we consider Uber to have entered if it arrived in a given CBSA before July 1 of the indicated year. Other studies have found that population size explains a large share of the variation in the year that Uber entered different metropolitan areas (Berger et al. 2018, Jackson 2020).

interaction term; and interactions that allow the effects of Uber entry to differ by an individual's prior year work experience, including whether she experienced a job displacement.

The column (1) model in Table 2 establishes that Uber entry is associated with a significant surge in nonemployer entry into Taxi and Limousine Services. To interpret the coefficients, it is instructive to scale their magnitudes relative to the mean of the dependent variable, 0.0582. The estimated coefficients imply that, in areas where Uber had not entered, the share of the at-risk population entering Taxi and Limousine services as a nonemployer changed very little—growing less than two percent per year from 2011 through 2016 relative to the overall mean entry rate (0.0010/0.0582). In areas where Uber had entered, however, that changed dramatically, with the entry rate growing by roughly 70 percent of the overall mean entry rate in each successive year ((0.0010+0.0404)/0.0582).

Column (2) adds an interaction between YearsUber and a regulation variable that takes the value of one in areas with restrictive regulations and otherwise equals zero. If ridesharing apps lower entry barriers more in labor markets with restrictive taxi regulations, we would expect a positive coefficient on this interaction term. The estimated coefficient is indeed positive and statistically significant, but modest in magnitude, implying an increase in the entry rate of only about 8 percent relative to the mean. This modest effect, however, masks distinct effects in New York City as compared to other regulated areas.

New York City is the largest jurisdiction that limits the number of taxis on the road. In addition to regulating taxis relatively stringently, however, New York also imposes significant requirements on rideshare drivers, meaning that the barriers to becoming a rideshare driver are notably higher there than elsewhere. Rideshare drivers in New York City must have a Taxi and Limousine Commission (TLC) driving license. To obtain a license, they must complete a defensive driving course, a Wheelchair Accessible Vehicle course, and a 24-hour driver education course; pass an exam on the material covered in the driver education course; pass a drug test; get fingerprinted; and pass a TLC medical exam. In addition, the vehicles used by New York City rideshare drivers must be licensed as commercial vehicles.[15]

[15]In 2018, the TLC paused licensing of most new for-hire vehicles and additional rules regarding rideshare drivers were introduced in 2019, but these restrictions did not apply during our sample period.

Table 2: Uber's Presence in a Market and Nonemployer Entry into NAICS 4853, Taxi and Limousine Services, 2011-2016

| | Mean | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|---|
| Year | 2014 | 0.0010 | 0.0013 | 0.0018 | 0.0017 | 0.0018 | 0.0018 |
| Years (+1) that Uber has been in CBSA, 0 if not in CBSA | 1.143 | 0.0404 | 0.0370 | 0.0378 | 0.0378 | | |
| Years Uber * {0,1} Regulation | 0.7855 | | 0.0046 | 0.0078 | 0.0078 | 0.0071 | |
| Years Uber * {0,1} Regulation * NY CBSA | 0.2230 | | | -0.0150 | -0.0150 | -0.0152 | |
| {0,1} Wage and Salary only last year | 0.5469 | | | | -0.0028 | -0.0368 | -0.0389 |
| {0,1} Nonemployer not 4853 only last year | 0.0294 | | | | 0.0317 | -0.0721 | -0.0694 |
| {0,1} Both W&S and Nonemployer last year | 0.0224 | | | | 0.1447 | -0.0269 | -0.0366 |
| {0,1} Displaced last year | 0.0335 | | | | 0.0155 | 0.0023 | 0.0009 |
| Years Uber * W&S only last year | 0.6409 | | | | | 0.0452 | 0.0476 |
| Years Uber * Nonemployer only last year | 0.0339 | | | | | 0.1048 | 0.0932 |
| Years Uber * Both W&S and Nonemployer last year | 0.0283 | | | | | 0.1538 | 0.1746 |
| Years Uber * Not Employed last year | 0.4402 | | | | | 0.0137 | 0.0095 |
| Years Uber * Displaced last year | 0.0388 | | | | | 0.0109 | 0.0125 |
| Years Uber * Regulation * W&S only last year | 0.4400 | | | | | | 0.0062 |
| Years Uber * Regulation * Nonemployer only last year | 0.0239 | | | | | | 0.0085 |
| Years Uber * Regulation * Both W&S and Nonemployer | 0.0200 | | | | | | 0.0059 |
| Years Uber * Regulation * Not Employed last year | 0.3016 | | | | | | 0.0077 |
| Years Uber * Regulation * Displaced last year | 0.0264 | | | | | | 0.0044 |
| Years Uber * Regulation * NY CBSA * W&S only last year | 0.1243 | | | | | | -0.0211 |
| Years Uber * Regulation * NY CBSA * Nonemployer only last year | 0.0063 | | | | | | 0.0233 |
| Years Uber * Regulation * NY CBSA * Both W&S and Nonemployer | 0.0056 | | | | | | -0.0832 |
| Years Uber * Regulation * NY CBSA * Not Employed last year | 0.0868 | | | | | | -0.0023 |
| Years Uber * Regulation * NY CBSA * Displaced last year | 0.0088 | | | | | | -0.0132 |
| R-Squared | | 0.0015 | 0.0015 | 0.0015 | 0.0016 | 0.0019 | 0.0019 |

Note: Sample is person-year observations for individuals age 14 to 99 at risk for entry as a nonemployer to NAICS 4853, Taxi and Limousine Services, in a given year. Dependent variable=100 if person enters NAICS 4853 in observation year, else=0; mean=0.0582. YearsUber is number of years Uber has been present in a Core Based Statistical Area (CBSA); =0 if observation outside a CBSA or Uber not entered by given year. Reg=1 if regulations in CBSA's core city limit taxi numbers, else=0; mean of Reg=0.3884 and mean of Reg*NY CBSA=0.0637. All regressions include controls for gender, age, foreign born, nonwhite, Hispanic, and educational attainment; indicators for missing demographics; percent employment growth in CBSA from year t-5 through year t-1; 919 CBSA dummies; and CBSA missing indicator. Longitudinal Employer-Household Dynamics data not available for Alaska in 2016; dummy variable for those observations included in lieu of explanatory variables requiring LEHD information. Unless shaded, all reported coefficients statistically significant at 0.01 level or better; shaded coefficient statistically significant at 0.05 level. N=1,514,000,000.

In column (3), we add an additional interaction that allows the effects of Uber entry to differ between the New York City CBSA and other CBSAs where the number of taxis on the road is limited. The effect of YearsUber on nonemployer entry to NAICS 4853 is about 20 percent larger in CBSAs other than New York City where regulations limit the number of taxis as compared to the effect in unregulated markets, but in New York City it is about 20 percent smaller. This is consistent with entry to rideshare driving being relatively difficult in New York City compared to other jurisdictions

A natural question is whether certain types of prior experience are associated with the likelihood of entry to NAICS 4853. In column (4), we add controls for having wage and salary income in the prior year; having nonemployer income in the prior year; and having both wage and salary and nonemployer income in

the prior year. This model also includes a variable that captures whether the person had experienced a mass layoff during the previous year. Compared to those who did not work in the previous year, those with prior year nonemployer earnings—and especially those who had been combining wage and salary earnings with nonemployer earnings—are much more likely to become a NAICS 4853 nonemployer. Although the effect is not large, we also observe that individuals displaced from a job during the previous year are more likely to begin earning money as a driver even in the absence of Uber operations.

In column (5), we ask how the pattern of entry changes after ridesharing apps become available in a CBSA. Prior to the introduction of these apps, people who had worked in the previous year are less likely than the nonemployed to begin driving. Once ridesharing apps become available, however, this reverses. Entry into driving becomes more common for all groups, but more so for people who had been working and, especially, for those with prior year nonemployer earnings. Perhaps more interesting, the probability that a displaced worker will turn to driving grows with the number of years Uber has been operating in the CBSA. Displaced workers in any market could enter NAICS 4853 by working as a traditional taxi driver, but the barriers to entry generally are higher and the opportunities to work a flexible schedule more limited than in markets where Uber has entered. Opportunities for self-employment are more accessible to displaced workers in CBSAs where ridesharing has become available. This is manifested as a sharp increase in the rideshare entry rate among displaced workers in CBSAs where Uber has entered. The increase in the entry probability in a CBSA where Uber had been in operation for four years, for example, is estimated to be about 75 percent as large as the mean entry rate in our sample ((4 x 0.0109)/0.0582).

Finally, in column (6), we examine how the patterns of entry among different groups of workers vary depending on the taxi regulation regime in the urban area. The effects of the number of years Uber has been operating are larger for all groups categorized according to their prior year work or displacement experience in regulated CBSAs other than New York City, but generally smaller in the New York City CBSA.[16]

[16] To assess whether our findings regarding the effects of ridesharing apps on nonemployer entry to NAICS 4853 are sensitive to the inclusion of smaller CBSAs in the analysis, Table A-2 in the appendix reports the results of estimating the same set of models as in Table 2, but with the sample restricted to CBSAs with a population of 500,000 or more. The results are very similar.

For comparison with the results for NAICS 4853, in Table 3, we report results for nonemployer entry into other industries. In these models, the population at risk for entry includes only individuals who did no nonemployer work in the previous year.[17] For completeness, the table shows models paralleling each of those reported in Table 2. As can be seen in column (1), non-NAICS-4853 nonemployer entry has trended upwards modestly over time and more so in CBSAs where Uber has entered. A possible explanation for the latter effect is that increasing familiarity with online ridesharing platforms raises awareness of other self-employment opportunities, creating a spillover effect on displaced workers who become more likely to seek out other online platform or other self-employment work. If so, however, this effect is small. Uber having been in an area for one year longer, for example, is estimated to raise the rate of entry into non-NAICS-4853 self-employment by only about half of a percent relative to the mean entry rate, much less than the proportional effect on entry into NAICS 4853 self-employment. In column (3), except in New York City, growth in entry to non-NAICS-4853 solo self-employment has been slower in Uber entry cities with stringent taxi regulations, perhaps consistent with rideshare apps having created new opportunities for those who otherwise might have become non-NAICS-4853 nonemployers. Column (5) establishes that displaced workers are more likely than others to enter solo self-employment outside of Taxi and Limousine Services and that this has become more true in areas where Uber has been present longer, but again the proportional magnitude of the latter effect is small.

[17] This specification is slightly asymmetric with the specification in Table 2 as we exclude individuals with prior year NAICS 4853 earnings from the at-risk group. There are relatively few such workers and excluding them facilitates disclosure avoidance.

Table 3: Uber's Presence in a Market and Nonemployer Entry into Industries other than NAICS 4853, Taxi and Limousine Services, 2011-2016

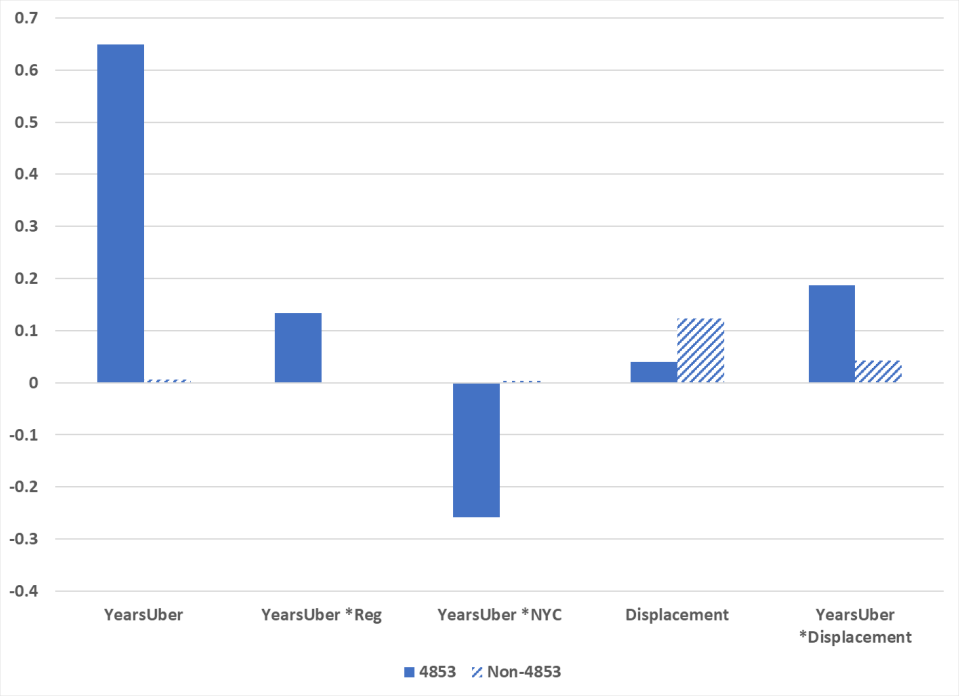
| | Mean | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|---|
| Year | 2014 | 0.0086 | 0.0083 | 0.0081 | 0.0087 | 0.0085 | 0.0084 |
| Years (+1) that Uber has been in CBSA, 0 if not in CBSA | 1.139 | 0.0137 | 0.0165 | 0.0161 | 0.0173 | | |
| Years Uber * {0,1} Regulation | 0.7814 | | -0.0039 | -0.0054 | -0.0055 | -0.0055 | |
| Years Uber * {0,1} Regulation * NY CBSA | 0.2225 | | | 0.0071 | 0.0065 | 0.0052 | |
| {0,1} Wage and Salary last year | 0.5766 | | | | -0.1944 | -0.2539 | -0.2583 |
| {0,1} Displaced last year | 0.0339 | | | | 0.4123 | 0.2966 | 0.3061 |
| Years Uber * W&S last year | 0.6752 | | | | | 0.0354 | 0.0456 |
| Years Uber * Not W&S last year | 0.4642 | | | | | -0.0186 | -0.0250 |
| Years Uber * Displaced last year | 0.0388 | | | | | 0.1014 | 0.0013 |
| Years Uber * Regulation * W&S last year | 0.4634 | | | | | | -0.0148 |
| Years Uber * Regulation * Not W&S last year | 0.3180 | | | | | | -0.0052 |
| Years Uber * Regulation * Displaced last year | 0.0263 | | | | | | 0.1611 |
| Years Uber * Regulation * NY CBSA * W&S last year | 0.1310 | | | | | | -0.0045 |
| Years Uber * Regulation * NY CBSA * Not W&S last year | 0.0915 | | | | | | 0.0271 |
| Years Uber * Regulation * NY CBSA * Displaced last year | 0.0088 | | | | | | -0.0750 |
| R-Squared | | 0.0086 | 0.0086 | 0.0086 | 0.0086 | 0.0087 | 0.0087 |

Note: Sample is person-year observations for individuals age 14 to 99 at risk for entry as a nonemployer to industries other than NAICS 4853, Taxi and Limousine Services, in a given year. Dependent variable=100 if person enters a non-NAICS-4853 industry in observation year, else=0; mean=2.408. YearsUber is number of years Uber has been present in Core Based Statistical Area (CBSA); =0 if observation outside a CBSA or Uber not entered by given year. Reg=1 if regulations in CBSA's core city limit taxi numbers, else=0; mean of Reg=0.3871 and mean of Reg*NY CBSA=0.0636. All regressions include controls for gender, age, foreign born, nonwhite, Hispanic, and educational attainment; indicators for missing demographics; percent employment growth in Core-Based Statistical Area (CBSA) from year t-5 through year t-1; 919 CBSA dummies; and CBSA missing indicator. Longitudinal Employer-Household Dynamics data not available for Alaska in 2016; dummy variable for those observations included in lieu of explanatory variables requiring LEHD information. Unless shaded, all reported coefficients statistically significant at 0.01 level or better; shaded coefficient not significant at 0.01 or 0.05 level. N=1,435,000,000.

To help with visualizing the contrasting results between Tables 2 and 3, Figure 5 illustrates selected key findings by showing selected estimated effects scaled relative to the mean rate of entry into NAICS 4853 (for the Table 2 effects) or into other industries (for the Table 3 effects). The first three comparisons draw on the estimates reported in the tables' column (3). The dramatic difference between the impact of an additional year of Uber operations in a CBSA on entry into NAICS 4853 versus entry into other industries is evident. Outside of New York City, this effect is augmented in CBSAs where taxi numbers are regulated; in New York City, however, additional years of Uber operations have less effect on entry into NAICS 4853. Taking into account the base effect, the regulated city effect and the New York specific effect associated with years since Uber entry, each additional year of Uber operations increases entry into NAICS 4853 in New York City by about 53 percent, considerably less than the 65 percent impact in non-regulated CBSAs and the 78 percent impact in regulated CBSAs other than New York City. The final two comparisons rest on the column (5) estimates. In CBSAs where Uber has not entered, the proportional effect of displacement on entry as a

nonemployer is more than three times as large in other industries as in NAICS 4853. After Uber entry, however, this reverses, with additional years of Uber operations having a proportional effect on entry as a nonemployer to NAICS 4853 that is more than four times as large as the proportional effect on entry to other industries.

**Figure 5: Size of Marginal Effects on Nonemployer Entry Relative to Mean Entry Rate, NAICS 4853 versus Other Industries**




Note: First three pairs of estimates based on coefficients reported in column (3) of Table 2 and Table 3; final two pairs based on coefficients reported in column (5) of the same two tables.

## VII. Impacts of Rideshare Entry on the Traditional Taxi Driver Workforce

While the entry of rideshare services into traditional taxi markets has drawn new workers into the Taxi and Limousine Services industry, many of whom combine wage and salary earnings with self-employment income, there have been concerns about the impact of this transition on incumbent taxi drivers. One valuable feature of our data infrastructure is that we not only are able to track workers who enter Taxi

and Limousine Services following the introduction of ridesharing but also to follow the drivers who worked in the industry prior to the introduction of rideshare apps to observe what happens to them. For this purpose, we define an incumbent driver as someone with nonemployer earnings in Taxi and Limousine Services in both 2009 and 2010. We examine the effects of rideshare apps on exit from the industry and on the earnings of these incumbent drivers. Table 4A reports on the factors that affect the rate of incumbent drivers' exit from the industry. Similar to the models employed to study the impact of the introduction of Uber on nonemployer entry rates, the Table 4A models include various combinations of year; years since Uber entry; and interactions of indicators for taxi regulation with years since Uber entry.[18] .

As would be expected given that turnover rates generally fall with tenure (Farber 1999), the column (1) Year variable coefficient indicates that the underlying pace of exits for incumbent Taxi and Limousine Services declines with time. The presence of ridesharing in a market, however, raises drivers' exit rates relative to the baseline level. All else the same, an incumbent driver who had not already exited is 3.2 percentage points more likely to exit in 2015 in a CBSA where Uber had entered 4 years earlier than in a CBSA where Uber had not yet entered. This exit probability increase is roughly a quarter the size of the overall mean exit rate in our sample and offsets about 40 percent of the decline in exit rates with time that otherwise would have been predicted.

In column (2), we allow the effects of Uber entry to be different in CBSAs that regulate taxi numbers and, in column (3), further allow that effect to differ for the New York City CBSA as compared to other CBSAs with restrictive taxi regulations. The column (3) estimates imply that the effect of rideshare introduction on the exit rate for taxi drivers in regulated markets other than New York City is about 20 percent smaller than the average effect in nonregulated markets, whereas the effect in New York City is nearly 50 percent smaller. In many of these markets, perhaps especially in New York City, the fact that taxi medallions declined in value after Uber entry may have made it more difficult for drivers simply to leave the industry.

[18] All of the Table 4 models also include demographic controls, a measure of CBSA employment growth between *t-5* and *t-1*, and a full set of CBSA dummies.

Table 4A: Uber's Presence in a Market and Exit of NAICS 4853 Incumbents from NAICS 4853, Taxi and Limousine Services, 2010-2015

| | Mean | (1) | (2) | (3) |
|---|---|---|---|---|
| Year | 2013 | -0.0195 | -0.0203 | -0.0200 |
| Years Uber has operated in CBSA, 0 if not in CBSA | 2.132 | 0.0082 | 0.0128 | 0.0131 |
| Years Uber * {0,1} Regulation | 1.817 | | -0.0050 | -0.0031 |
| Years Uber * {0,1} Regulation * NY CBSA | 1.256 | | | -0.0030 |
| R-Squared | | 0.0194 | 0.0195 | 0.0195 |

Note: Sample is nonemployers with NAICS 4853 earnings in both 2009 and 2010 who had NAICS 4853 earnings through observation year. Dependent variable=1 if exit NAICS 4853 in observation year, else=0; mean=0.1260. YearsUber is number of years Uber has been present in Core Based Statistical Area (CBSA); =0 if observation outside a CBSA or Uber not entered by given year. Regulation=1 if regulations in CBSA's core city limit taxi numbers, else=0; mean of Regulation=0.7231 and mean of Regulation*NY CBSA=0.39884. All regressions include controls for gender, age, foreign born, nonwhite, Hispanic, and educational attainment; indicators for missing demographics; percent employment growth in CBSA from year t-5 through year t-1; 778 CBSA dummies; and CBSA missing indicator. All reported coefficients statistically significant at 0.01 level or better. N=484,000.

Exit from Taxi and Limousine services does not necessarily imply that a driver no longer is working, as some of the drivers exiting NAICS 4853 may have found work in another sector. The models in Table 4B examine incumbent drivers' exit from all employment, rather than just exit from NAICS 4853. Similar to the results in Table 4A, the estimated coefficient on the year variable in column (1) shows that, as one might expect, the rate at which drivers exit from employment falls with time, though the rate of decline is smaller than in the corresponding model for exit from NAICS 4853. Being in a CBSA where Uber has entered raises the rate of exit from employment relative to what it otherwise would have been, though again by less than in the corresponding model for exit from NAICS 4853. This difference in the magnitude of the coefficient on years since Uber entry variable suggests that at least some of the additional drivers exiting NAICS 4853 due to the introduction of ridesharing found employment elsewhere.

Column (2) allows for the effects of years since Uber entry on exit to differ depending on whether taxi numbers are regulated in a CBSA and column (3) allows additionally for the effects of years since Uber

entry to be different in the New York City CBSA than in other regulated CBSAs. Focusing on the column (3) results, the positive effect of Uber entry on driver exit is reduced in regulated CBSAs and especially in the New York City CBSA, meaning that drivers there are more likely to continue working than in other CBSAs where Uber has entered.

Table 4B: Uber's Presence in a Market and Exit of NAICS 4853 Incumbents from Any Employment, 2010-2015

| | Mean | (1) | (2) | (3) |
|---|---|---|---|---|
| Year | 2013 | -0.0133 | -0.0139 | -0.0136 |
| Years Uber has operated in CBSA, 0 if not in CBSA | 2.166 | 0.0056 | 0.0089 | 0.0092 |
| Years Uber * {0,1} Regulation | 1.846 | | -0.0035 | -0.0019 |
| Years Uber * {0,1} Regulation * NY CBSA | 1.268 | | | -0.0026 |
| R-Squared | | 0.0156 | 0.0157 | 0.0157 |

Note: Sample is nonemployers with NAICS 4853 earnings in both 2009 and 2010 who had positive employment earnings through observation year. Dependent variable=1 if exit employment in observation year, else=0; mean=0.1078. YearsUber is number of years Uber has been present in Core Based Statistical Area (CBSA); =0 if observation outside a CBSA or Uber not entered by given year. Regulation=1 if regulations in CBSA's core city limit taxi numbers, else=0; mean of Regulation=0.7216 and mean of Regulation*NY CBSA=0.3961. All regressions include controls for gender, age, foreign born, nonwhite, Hispanic, and educational attainment; indicators for missing demographics; percent employment growth in CBSA from year t-5 through year t-1; 778 CBSA dummies; and CBSA missing indicator. Unless shaded, all reported coefficients statistically significant at 0.01 level or better; shaded coefficient statistically significant at 0.05 level. N=510,000.

Anecdotally, in addition to being pushed out of the industry (and in some cases out of employment altogether), incumbent taxi drivers are reported to have suffered significant earnings losses. Table 5 examines the effects of Uber's presence in a market on the earnings of incumbent drivers who continue to work. We look in panel A at changes in earnings from driving; in panel B, at earnings from other nonemployer work; in panel C, at earnings from wage and salary employment; and in panel D, at earnings from all employment combined. all sources. The dependent variables in these models are the change in the

IHS of real earnings of the relevant type (in constant 2015 dollars) from year *t-1* to year *t*.[19] An incumbent taxi driver is included in the sample in a given year as long as the driver had earnings from at least one source in each year through year *t*.

The estimated year coefficient in column (1) of panel A implies an underlying year-to-year increase in real earnings from driving of about 15 percent per year. The entry of ridesharing in a local labor market, however, puts downward pressure on drivers' earnings. All else the same, a 2010 incumbent is predicted to have earning from driving that are about 32 percent less in 2016 if living in a CBSA where Uber had entered 4 years earlier than in a CBSA where Uber had not yet entered.

These estimates, however, paint an incomplete picture of how incumbent drivers who remain in the labor force are faring, in that these drivers may have been able to obtain other work to offset the loss of their earnings from driving. In contrast to the negative effect of years since Uber entry on earnings from driving, the effects of Uber's presence on earnings both from other nonemployer activity and from wage and salary earnings werepositive. The net result is that, although the effect of years since Uber entry on total earnings is negative, that negative effect is proportionally much smaller than the negative effect of years since Uber entry on NAICS 4853 nonemployer earnings. The total earnings of an incumbent driver living in a CBSA where Uber had entered four years earlier are estimated to be about 10 percent lower in 2016 than otherwise would have been the case, a proportional reduction only about a third as large as the estimated 32 percent reduction in earnings from driving.

[19] The IHS of a variable $x$ is equal to $\ln\{x + \text{sqrt}(1+x^2)\}$. We use the IHS of earnings rather than ln(earnings) since net receipts could be zero or negative for some individuals. Except for very small values of x, IHS is approximately equal to ln(x)+ln(2). Most of the variables in our models are dummy variables. We convert the β's that are the estimated effects on the IHS of earnings for these variables to a percentage effect by taking exp(β)-1.

Table 5: Uber's Presence in a Market and Changes in Earnings of NAICS 4853 Incumbents, Taxi and Limousine Services, 2011 to 2016

Panel A: IHS of Nonemployer Earnings, NAICS 4853

| | Mean | (1) | (2) | (3) |
|---|---|---|---|---|
| Year | 2013 | 0.1371 | 0.1431 | 0.1418 |
| Years Uber has operated in CBSA, 0 if not in CBSA | 2.215 | -0.0702 | -0.1025 | -0.1038 |
| Years Uber * {0,1} Regulation | 1.885 | | 0.0344 | 0.0284 |
| Years Uber * {0,1} Regulation * NY CBSA | 1.296 | | | 0.0094 |
| R-Squared | | 0.0033 | 0.0033 | 0.0033 |

Panel B: IHS of Nonemployer Earnings, Non-NAICS 4853 Industries

| | Mean | (1) | (2) | (3) |
|---|---|---|---|---|
| Year | 2013 | -0.0747 | -0.0778 | -0.0772 |
| Years Uber has operated in CBSA, 0 if not in CBSA | 2.215 | 0.0285 | 0.0454 | 0.0460 |
| Years Uber * {0,1} Regulation | 1.885 | | -0.0180 | -0.0152 |
| Years Uber * {0,1} Regulation * NY CBSA | 1.296 | | | -0.0045 |
| R-Squared | | 0.0021 | 0.0022 | 0.0022 |

Panel C: IHS of Wage and Salary Earnings

| | Mean | (1) | (2) | (3) |
|---|---|---|---|---|
| Year | 2013 | -0.0147 | -0.0171 | -0.0133 |
| Years Uber has operated in CBSA, 0 if not in CBSA | 2.215 | 0.0154 | 0.0276 | 0.0311 |
| Years Uber * {0,1} Regulation | 1.885 | | -0.0131 | 0.0035 |
| Years Uber * {0,1} Regulation * NY CBSA | 1.296 | | | -0.0253 |
| R-Squared | | 0.0121 | 0.0121 | 0.0122 |

Panel D: IHS of Total Earnings

| | Mean | (1) | (2) | (3) |
|---|---|---|---|---|
| Year | 2013 | 0.0471 | 0.0475 | 0.0502 |
| Years Uber has operated in CBSA, 0 if not in CBSA | 2.215 | -0.0229 | -0.0250 | -0.0225 |
| Years Uber * {0,1} Regulation | 1.885 | | 0.0023 | 0.0142 |
| Years Uber * {0,1} Regulation * NY CBSA | 1.296 | | | -0.0183 |
| R-Squared | | 0.0011 | 0.0011 | 0.0011 |

Note: Sample is nonemployers with NAICS 4853 earnings in both 2009 and 2010 who had positive employment earnings through observation year. Dependent variable=change in IHS NAICS 4853 nonemployer earnings (panel A); in IHS non-NAICS nonemployer earnings (panel B); in IHS wage and salary earnings (panel C); or in total earnings (panel D) from year t-1 to year t; means -0.3146, 0.1578, 0.1106 and -0.0952, respectively. YearsUber is number of years Uber has been present in Core Based Statistical Area (CBSA); =0 if observation outside a CBSA or Uber not entered by given year. Regulation=1 if regulations in CBSA's core city limit taxi numbers, else=0; mean of Regulation=0.7253 and mean of Regulation*NY CBSA=0.4022. All regressions include controls for gender, age, foreign born, nonwhite, Hispanic, and educational attainment; indicators for missing demographics; percent employment growth in CBSA from t-5 through t-1; 757 CBSA dummies; and CBSA missing indicator. Specifications in panels C and D include a Massachusetts 2010 dummy and an Alaska 2016 dummy.Unless shaded, all reported coefficients statistically significant at the 0.01 level or better; lightly shaded cells statistically significant at the 0.05 level and darkly shaded cells not statistically significant at the 0.05 level. N=455,000.

As with the models for exit from driving and from any employment, we also are interested in whether and how accounting for a CBSA's regulation status alters our understanding of how ridesharing has affected taxi drivers' earnings. In the model shown in column (2) of panel A, the estimated baseline effect of rideshare entrance on taxi drivers' earnings is larger than in column (1), but muted in CBSAs with more restrictive taxi regulations. The column (3) model suggests this may be especially so in New York City, though the relevant coefficient estimate in that model is not statistically significant. In contrast, the models in columns (2) and (3) of panel D suggest that incumbent drivers in the New York City market may have fared relatively worse, not relatively better, with respect to their total earnings.

## VIII. Conclusion

The favorite example in both the popular media and academic research of the rise of the gig economy is the increasingly ubiquitous presence of ridesharing companies. Our findings suggest that the Taxi and Limousine Services industry (NAICS 4853) stands out not only with respect to its rate of growth but also with respect to the changing characteristics of the entrants to self-employment it has attracted and the way in which these entrants appear to be using work in the industry. Entrants to this industry have characteristics that are very different from those of industry incumbents. They are increasingly likely to be young, female, white and U.S. born. Entrants also are increasingly likely to combine wage and salary income with receipts from self-employment. In contrast, the characteristics of entrants to nonemployer activity in other industries have changed little over time and their characteristics are much more similar to those of incumbent nonemployers.

Several findings emerge from our analysis of the factors associated with entry into NAICS 4853 self-employment. First, time since the advent of online ridesharing has a large positive effect on the rate of entry of new workers into the industry. Second, this effect is generally larger in cities with regulated taxi markets, but not in New York City, where the effect of rideshare entry on driver entry rates is smaller than in cities with unregulated taxi markets. Third, time since the advent of online ridesharing platforms in a CBSA has a

proportionally large and positive effect on the probability that a displaced worker will enter solo self-employment in NAICS 4853.

These findings are consistent with the ridesharing industry providing new opportunities for flexible income-generating activity to a wide range of individuals. Given the relatively modest average net earnings from this activity, however, there is little evidence that the typical worker is using ridesharing in the gig economy as a primary means of support. It is useful to recall that nonemployers in the Taxi and Limousine Services industry are traditionally a low earnings group. In 2011, incumbents in this industry, all of whom would have been traditional taxi drivers, averaged just $12,290 in net receipts. Entrants in 2011 earned substantially less, only $7,190 on average, but by 2016, entrants' net earnings averaged just $2,110 (all in 2015 dollars).

Our findings provide unique insights into the impact of ridesharing on traditional taxi drivers. Ridesharing entry into a CBSA produces a substantial increase in the rate of exit of traditional taxi drivers from the industry that grows as the ridesharing companies become more established. This increase in exit generally is mitigated in CBSA with regulated taxi markets, and especially in the New York City CBSA. Even among those who continue working, traditional taxi drivers experience substantial losses in their earnings from driving after ridesharing companies begin to operate in a CBSA and these losses cumulate over time. While also negative, the estimated effect of the introduction of ridesharing on drivers' total earnings is proportionally much smaller. This suggests that, conditional on remaining employed, at least some drivers were able to find other work that paid more similarly to what they could have earned from driving had ridesharing not emerged.

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Table A-1A: Descriptive Statistics (Means), Nonemployer Sole Proprietors in NAICS 4853: Taxi and Limousine Services, 2011 Incumbents and 2011-2016 Entrants

| | Incumbent | Entrants | | | | | |
|---|---|---|---|---|---|---|---|
| | 2011 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
| 1 if Female | .0625 | .1463 | .1474 | .1547 | .1680 | .2113 | .2498 |
| 1 if Age 14-20 | .0005 | .0080 | .0076 | .0081 | .0076 | .0072 | .0075 |
| 1 if Age 21-24 | .0095 | .0435 | .0459 | .0512 | .0595 | .0725 | .0823 |
| 1 if Age 25-34 | .1363 | .2376 | .2458 | .2694 | .2989 | .3082 | .3147 |
| 1 if Age 35-44 | .2628 | .2744 | .2659 | .2670 | .2690 | .2570 | .2533 |
| 1 if Age 45-54 | .3235 | .2496 | .2449 | .2293 | .2090 | .2020 | .1919 |
| 1 if Age 55-64 | .2069 | .1438 | .1443 | .1359 | .1206 | .1151 | .1103 |
| 1 if Age 65-99 | .0605 | .0432 | .0456 | .0391 | .0354 | .0380 | .0400 |
| 1 if Foreign Born | .8256 | .6742 | .6658 | .6890 | .6207 | .4808 | .4227 |
| 1 if Nonwhite | .6018 | .5299 | .5269 | .5370 | .4988 | .4450 | .4202 |
| 1 if Hispanic | .1365 | .1661 | .1615 | .1592 | .1545 | .1852 | .2121 |
| 1 if Education 10 | .2030 | .2045 | .1973 | .1903 | .1757 | .1743 | .1780 |
| 1 if Education 12 | .2231 | .2484 | .2498 | .2414 | .2326 | .2392 | .2474 |
| 1 if Education 14 | .2425 | .2747 | .2759 | .2748 | .2841 | .2952 | .2995 |
| 1 if Education 16 | .2278 | .2329 | .2430 | .2655 | .2897 | .2800 | .2665 |
| 1 if Education Missing | .1036 | .0394 | .0340 | .0280 | .0179 | .0113 | .0086 |
| Receipts 4853 | 40,180 | 23,540 | 22,950 | 21,340 | 16,160 | 11,450 | 10,460 |
| Expenses 4853 | 27,890 | 16,350 | 16,250 | 15,090 | 11,780 | 8,860 | 8,360 |
| Net Receipts 4853 | 12,290 | 7,190 | 6,690 | 6,250 | 4,380 | 2,590 | 2,110 |
| 1 if W&S Earnings | .1619 | .4358 | .4661 | .5205 | .6437 | .7264 | .7500 |
| Sample Size (Thousands) | 119 | 50 | 49 | 58 | 110 | 246 | 368 |

Table A-1B: Descriptive Statistics (Means), Nonemployer Sole Proprietors Not in NAICS 4853:
Taxi and Limousine Services, 2011 Incumbents and 2011-2016 Entrants

| | Incumbent | Entrants | | | | | |
|---|---|---|---|---|---|---|---|
| | 2011 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
| 1 if Female | .4388 | .4685 | .4704 | .4717 | .4696 | .4741 | .4748 |
| 1 if Age 14-20 | .0059 | .0371 | .0359 | .0370 | .0363 | .0363 | .0357 |
| 1 if Age 21-24 | .0263 | .0829 | .0825 | .0861 | .0846 | .0844 | .0825 |
| 1 if Age 25-34 | .1533 | .2470 | .2461 | .2529 | .2521 | .2572 | .2609 |
| 1 if Age 35-44 | .2184 | .2259 | .2239 | .2214 | .2186 | .2193 | .2198 |
| 1 if Age 45-54 | .2538 | .2044 | .2015 | .1959 | .1939 | .1915 | .1876 |
| 1 if Age 55-64 | .2159 | .1381 | .1404 | .1371 | .1416 | .1385 | .1382 |
| 1 if Age 65-99 | .1265 | .0647 | .0696 | .0695 | .0730 | .0728 | .0754 |
| 1 if Foreign Born | .1949 | .2007 | .2032 | .2079 | .2039 | .2057 | .2086 |
| 1 if Nonwhite | .1738 | .2500 | .2456 | .2477 | .2420 | .2448 | .2422 |
| 1 if Hispanic | .1236 | .1568 | .1577 | .1650 | .1623 | .1659 | .1689 |
| 1 if Education 10 | .1372 | .1617 | .1599 | .1638 | .1597 | .1598 | .1584 |
| 1 if Education 12 | .2383 | .2533 | .2522 | .2526 | .2502 | .2495 | .2477 |
| 1 if Education 14 | .2737 | .2903 | .2909 | .2910 | .2917 | .2926 | .2935 |
| 1 if Education 16 | .2841 | .2698 | .2727 | .2697 | .2750 | .2754 | .2809 |
| 1 if Education Missing | .0668 | .0249 | .0242 | .0229 | .0234 | .0227 | .0195 |
| Receipts | 38,380 | 19,250 | 19,420 | 18,440 | 19,830 | 19,020 | 18,480 |
| Expenses | 17,200 | 9,140 | 9,230 | 8,960 | 9,560 | 9,330 | 9,090 |
| Net Receipts | 21,180 | 10,110 | 10,190 | 9,480 | 10,270 | 9,680 | 9,390 |
| 1 if W&S Earnings | .4237 | .6165 | .6283 | .6405 | .6509 | .6718 | .6801 |
| Sample Size (Thousands) | 12,620 | 5,661 | 5,575 | 5,664 | 5,973 | 5,820 | 5,866 |

Table A-2: Uber's Presence in a Market and Nonemployer Entry into NAICS 4853, Taxi and Limousine Services, CBSAs with Populations of 500,000 or more, 2011-2016

| | Mean | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|---|
| Year | 2014 | -0.0062 | -0.0057 | -0.0050 | -0.0050 | -0.0050 | -0.0051 |
| Years (+1) that Uber has been in CBSA, 0 if not in CBSA | 1.632 | 0.0453 | 0.0426 | 0.0439 | 0.0439 | | |
| Years Uber * {0,1} Regulation | 1.166 | | 0.0031 | 0.0061 | 0.0061 | 0.0054 | |
| Years Uber * {0,1} Regulation * NY CBSA | 0.3311 | | | -0.0143 | -0.0143 | -0.0144 | |
| {0,1} Wage and Salary only last year | 0.5551 | | | | 0.0022 | -0.0477 | -0.0514 |
| {0,1} Nonemployer not 4853 only last year | 0.0291 | | | | 0.0963 | -0.0258 | -0.0203 |
| {0,1} Both W&S and Nonemployer last year | 0.0234 | | | | 0.1952 | -0.0456 | -0.0625 |
| {0,1} Displaced last year | 0.0347 | | | | 0.0204 | 0.0037 | 0.0014 |
| Years Uber * W&S only last year | 0.9151 | | | | | 0.0517 | 0.0545 |
| Years Uber * Nonemployer only last year | 0.0486 | | | | | 0.0946 | 0.0788 |
| Years Uber * Both W&S and Nonemployer last year | 0.0405 | | | | | 0.1618 | 0.1869 |
| Years Uber * Not Employed last year | 0.6280 | | | | | 0.0200 | 0.0153 |
| Years Uber * Displaced last year | 0.0555 | | | | | 0.0105 | 0.0125 |
| Years Uber * Regulation * W&S only last year | 0.6532 | | | | | | 0.0045 |
| Years Uber * Regulation * Nonemployer only last year | 0.0355 | | | | | | 0.0094 |
| Years Uber * Regulation * Both W&S and Nonemployer | 0.0297 | | | | | | 0.0017 |
| Years Uber * Regulation * Not Employed last year | 0.4477 | | | | | | 0.0063 |
| Years Uber * Regulation * Displaced last year | 0.0392 | | | | | | 0.0041 |
| Years Uber * Regulation * NY CBSA * W&S only last year | 0.1846 | | | | | | -0.0205 |
| Years Uber * Regulation * NY CBSA * Nonemployer only last year | 0.0094 | | | | | | 0.0278 |
| Years Uber * Regulation * NY CBSA * Both W&S and Nonemployer | 0.0083 | | | | | | -0.0833 |
| Years Uber * Regulation * NY CBSA * Not Employed last year | 0.1289 | | | | | | -0.0015 |
| Years Uber * Regulation * NY CBSA * Displaced last year | 0.0131 | | | | | | -0.0129 |
| R-Squared | | 0.0018 | 0.0018 | 0.0018 | 0.0020 | 0.0022 | 0.0023 |

Note: Sample is person-year observations for individuals age 14 to 99 at risk for entry as a nonemployer to NAICS 4853, Taxi and Limousine Services, in a given year. Dependent variable=100 if person enters NAICS 4853 in observation year, else=0; mean=0.0753. YearsUber is number of years Uber has been present in a Core Based Statistical Area (CBSA); =0 if observation outside a CBSA or Uber not entered by given year. Reg=1 if regulations in CBSA's core city limit taxi numbers, else=0; mean of Reg=0.5766 and mean of Reg*NY CBSA=0.0946. All regressions include controls for gender, age, foreign born, nonwhite, Hispanic, and educational attainment; indicators for missing demographics; percent employment growth in CBSA from year t-5 through year t-1; and 104 CBSA dummies. Unless shaded, all reported coefficients statistically significant at 0.01 level or better; shaded coefficient statistically significant at 0.05 level. N=1,020,000,000.

**Data Appendix: "Driving the Gig Economy," Abraham, Haltiwanger, Hou, Sandusky and Spletzer, July 17, 2022**

Administrative Data Sources

A description of the Census Bureau's published nonemployer statistics can be found at https://www.census.gov/programs-surveys/nonemployer-statistics/technical-documentation/methodology.html. Davis et al. (2007) discusses the nonemployer microdata.

The data on wage and salary earnings used in our analysis come from the Longitudinal Household-Employer Dynamics (LEHD) data infrastructure and the data on individual characteristics come from the Census Bureau's Individual Characteristics (ICF) file. Both are described in Vilhuber (2018).

Modeling nonemployer entry requires identification of the population at risk for entry, which we define as individuals age 14-99 who had no NAICS 4853 nonemployer earnings in the previous year (for entry as a NAICS 4853 nonemployer) or who had no nonemployer earnings in any industry in the previous year (for entry as a non-NAICS-4853 nonemployer). For 2012-2016, we identify this population based on the Census Bureau's Resident Candidate File (RCF); for 2010-2011, we use the Composite Person Record (CPR) file (Graham, Kutzbach and Sandler 2017).These files list everyone with a PIK that the Census Bureau has identified as currently resident in the United States and provide a current state and county of residence. This information can be cross-walked to defined Core Based Statistical Areas (CBSA), allowing us to merge in locality-specific information that might help to explain nonemployer entry, exit or earnings.

Uber Entry Dates

A key variable in our analysis is the year in which Uber entered an individual's local labor market. For our purposes, a local labor market is a Core-Based Statistical Area (CBSA). Metropolitan CBSAs are urban clusters of at least 50,000 people plus counties tied to that cluster through commuting patterns; micropolitan CBSAs are defined similarly, but for urban clusters with a population of between 10,000 and 50,000 people (https://www.govinfo.gov/content/pkg/FR-2010-06-28/pdf/2010-15605.pdf). Because we would expect the effects of Uber entry to be small in the initial months after entry to a local area, we consider Uber to have entered a CBSA in a given year only if it operated there for at least half the year, i.e., if it entered before July of the year in question.

To identify the date that Uber entered a metropolitan CBSA, we started with a list of Uber areas provided by Jonathan Hall, Uber Chief Economist, in March 2018, that also includes the month and year Uber service began in each area. We updated this list of Uber areas to include additional areas that had been added to the Uber website as of November 2019. Maps showing the current boundaries of the various Uber areas can be found on the Uber website at https://www.uber.com/global/en/cities/. Uber areas can be large, sometimes spanning several metropolitan CBSAs, and entry into the metropolitan CBSAs within the current boundaries of an Uber area can occur at different dates. For example, as of November 2019, the Chicago Uber area included not only the Chicago-Naperville-Elgin, IL-IN-WI metropolitan CBSA, where Uber entered in September 2011, but also the Kankakee, IL metropolitan CBSA located some 60 miles away, where Uber did not enter until June 2015. To take another example, as of the same date, the Washington, DC Uber area included not only the Washington-Arlington-Alexandria, DC-VA-MD-WV metropolitan CBSA, where Uber entered in December 2011, but also the Winchester, VA metropolitan CBSA located some 75 miles away, where Uber did not enter until August 2016.

We examined the Uber area maps posted to the Uber website as of November 2019 to identify the metropolitan CBSAs each area included. This produced a list of 351 metropolitan CBSAs that had Uber service as of that date. Next, we searched for evidence on when Uber entered each of these metropolitan CBSAs. Where the name of the CBSA matched the name of an Uber area, absent evidence to the contrary, we accepted the entry date provided on the original Uber list. For other metropolitan CBSAs, we searched Uber press releases, news stories and other sources for positive evidence regarding an Uber entry date. Of the 351 metropolitan CBSAs we identified for which the maps on the Uber website indicated service was available as of November 2019, we were able to establish a documented month and year of Uber entry for 330 CBSAs. Of these, we code 108 CBSAs with Uber entry in 2017 or later (i.e., as having an entry date of July 2016 or later), meaning we do not observe Uber entry during our study period.

The 21 identified metropolitan CBSAs for which we were unable to determine an Uber entry date all are relatively small cities. Only three of these CBSAs—Vallejo-Fairfield, CA, Crestview-Fort Walton Beach-Destin, FL, and Elkhart-Goshen, IN—had populations of 200,000 or more in 2013; the average 2013 population in 2013 in the 18 remaining CBSAs was just under 140,000. Uber entry into smaller metropolitan CBSAs generally has lagged entry into larger metropolitan CBSAs. The average 2013 population for CBSAs where Uber entered in 2011 was 12.2 million in 2011; for CBSAs entered in 2012, 6.6 million; for CBSAs entered in 2013, 3.4 million; for CBSAs entered in 2014, 1.4 million; for CBSAs entered in 2015, 0.5 million in 2015; and for CBSAs entered in 2016, 0.3 million. As already noted, we consider Uber to have entered if it arrived in a given CBSA before July 1 of the indicated year. We treat the 21 metropolitan CBSAs for which we could not determine a definitive entry date as not having entered by the end of our sample period.

We attempted to determine Uber entry dates for micropolitan CBSAs included in an Uber area only in cases where the Uber area contained no metropolitan CBSA, such as the Boone, NC and Golden Triangle Uber areas. Following this approach, we identify Uber entry dates for 27 micropolitan CBSAs, but Uber had entered only two of these CBSAs by 2016 (i.e., by June 2016 or earlier).

Taxi Regulations

Another variable used in our analysis captures whether regulations in a metropolitan area limit the number of taxis on the road through a medallion system or vehicle cap. To create this variable, we obtained information on the regulations in place for the core city of each of the 103 metropolitan CBSAs with a 2013 population of 500,000 or more for which we had an Uber entry date. We did the same for the core city in a random sample of 20 the 254 smaller CBSAs included on our Uber entry list. For each of these cities, we searched online for definitive information regarding the regulatory regime and, if that was not successful, wrote to or called the relevant city office to obtain the information we needed.

Among the 103 CBSAs with a 2013 population of 500,000 or more for which we had an Uber entry date, 31 (30 percent) had regulations in place in their core city as of early 2020 that limited the number of taxis on the road. This included the core city in 20 of the 29 CBSAs with populations of more than two million (65 percent), the core city in 7 of the 21 CBSAs with populations between 1 million and 2 million (33 percent) and the core city in 4 of 51 CBSAs with populations between 500,000 and 1 million (8 percent). Among the 20 CBSAs with 2013 populations under 500,000 that we checked, none except Key West had regulations limiting the number of taxis and, given its unusual geography, Key West's situation is decidedly anomalous. We code CBSAs that had populations of less than 500,000 in 2013 as not regulating the number of taxis on the road. Taxi regulations change slowly, making it reasonable to use the information from early 2020 to capture the regime in place over our study period. We assign the regulation status for the core city in each larger CBSA to the CBSA as a whole.

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