NBER WORKING PAPER SERIES

DRIVING THE GIG ECONOMY

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Working Paper 32766
http://www.nber.org/papers/w32766

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
August 2024

Any opinions and conclusions expressed herein are those of the authors and do not necessarily represent the views of the Congressional Budget Office or the U.S. Census Bureau. We thank Judy Chevalier, Ron Jarmin, Lawrence Katz, Kristin McCue and participants in seminars at George Mason University, the University of Nebraska, the 2018 IZA World Labor Conference, 2018 NBER Summer Institute, 2019 Washington Area Labor Economist Symposium, 2019 Society of Labor Economists (SOLE) meetings, 2019 Comparative Analysis of Enterprise Data (CAED) conference, 2019 CESifo Summer Institute and 2022 NBER Summer Institute for helpful comments on earlier drafts. We also thank Nathalie Gonzalez for excellent research assistance. Support for the project was provided by the Russell Sage Foundation under grant 1908-17672. All results have been reviewed to ensure no confidential information is disclosed (CBDRB-2018-CDAR-041, DRB-B0045-CED-20190425, CBDRB-FY22-CE0006-0023, and CBDRB-FY23-0397). The views expressed herein are those of the authors and do not necessarily reflect the views of the National Bureau of Economic Research.

Driving the Gig Economy
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NBER Working Paper No. 32766
August 2024
JEL No. J20,J30,J40,J62

ABSTRACT

Using rich administrative tax data, we explore the effects of the introduction of online ridesharing platforms on entry, employment and earnings in the Taxi and Limousine Services industry. Ridesharing dramatically increased the pace of entry of workers into the industry. New entrants were more likely to be young, female, White and U.S. born, and to combine earnings from ridesharing with wage and salary earnings. Displaced workers have found ridesharing to be a substantially more attractive fallback option than driving a taxi. Ridesharing also affected the incumbent taxi driver workforce. The exit rates of low-earning taxi drivers increased following the introduction of ridesharing in their city; exit rates of high-earning taxi drivers were little affected. In cities without regulations limiting the size of the taxi fleet, both groups of drivers experienced earnings losses following the introduction of ridesharing. These losses were ameliorated or absent in more heavily regulated markets.

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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. The introduction of smartphone apps and other web-based applications that facilitate the acquisition of goods and services directly from individual providers is widely perceived to have accelerated the pace of change in the organization of work, with important effects on both workers and firms.

In this paper, we study the dramatic growth over the period from 2010 through 2016 of self-employment in the Taxi and Limousine Services industry (NAICS 4853) following the introduction of Uber and other ridesharing services. Our analysis rests on comprehensive tax records that allow us to observe both self-employment and wage and salary employment. 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 for the entire working age population on individuals' gender, age, race, ethnicity, and foreign-born status. These data allow us to track the patterns of entry into and exit from work as a sole proprietor, together with 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 Census data on sole proprietors 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. They capture both individuals for whom driving is a main job and individuals for whom it is a secondary source of income. Over the 2010-2016 period covered in our analysis, the number of people with NAICS 4853 self-employment income rose dramatically. The characteristics of the new entrants to the industry became increasingly different from the characteristics of those who had been working as taxi and limousine drivers at the start of the period—they became much more likely to be young, female, White, and U.S. born—and, in each new cohort of entrants, average earnings from driving fell. Entrants also were progressively 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 used this type of 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 rideshare companies 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, over our sample period, for each year that online platform ridesharing had been available in a metropolitan area, the pace of entry into solo self-employment in Taxi and Limousine Services rose by about 70% of the mean entry rate. Our estimates hint that this effect may have been larger in markets with regulations that had limited the expansion of the taxi fleet, though that finding is not statistically significant. In New York City, however, where rideshare drivers must jump through significant regulatory hoops before they can begin transporting customers, entry rates rose noticeably less than elsewhere.

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, we find a much larger proportional increase in the probability that a worker enters other types of solo self-employment after a displacement than in the probability of their becoming a taxi or limousine driver. For metropolitan areas in which online platform ridesharing has become available, however, we find the reverse. Similar to the pattern of diffusion for other technological innovations, it takes time for the full effects of the new rideshare apps to be realized, such that the probability of entering Taxi and Limousine services following a displacement continues to rise for several years following the introduction of ridesharing.

One significant advantage of our data infrastructure is that it allows us not only to examine the effects of the new ridesharing technologies on entrance to the industry but also its effects on incumbent taxi drivers. The large numbers of workers drawn into driving by the new technology created competition for traditional taxi drivers. All else the same, this might be expected to have caused traditional drivers' earnings to fall, pushing them out of the industry. By making it easier for customers to connect with a driver, however, rideshare apps have increased the demand for driving services. Depending on exactly how labor supply and labor demand shifted, the net effect on incumbent drivers could have been either positive or negative. We show that the introduction of rideshare apps in a local labor market accelerated the exit of traditional taxi drivers from the industry. This accelerated exit is concentrated among drivers who were earning less to start with; exit rates among high-earning drivers were little affected. Further, exit rates among low-earning drivers appear to have risen less in markets with regulations that had limited the number of taxis on the road and especially so in New York City. Among both low-earning and high-earning incumbent drivers in non-regulated markets who remained in the industry, the introduction of ridesharing led to a reduction in earnings. Earnings fell less if at all for drivers in regulated markets and appear to have risen slightly for drivers in New York City. In principle, incumbent drivers who were negatively affected by the introduction of ridesharing could have found work elsewhere and this appears to have occurred to some extent, but the introduction of ridesharing nonetheless was associated with higher rates of exit from working at all. The effects of ridesharing on overall earnings for people who had been traditional taxi drivers and continued with any sort of work were similar to the effects on earnings from driving among those who continued driving.

The paper contributes in several ways to the existing literature. First, building on the comprehensive data infrastructure we have developed—an infrastructure that includes information on the earnings and demographic characteristics of everyone working as either a sole proprietor or an employee in each year of our study period—we are able to paint a more definitive picture of how ridesharing transformed the Taxi and Limousine Services industry than has been possible in previous research based on convenience samples or survey data. Second, because our data infrastructure allows us to track the later labor market experiences of individuals who had been working in the Taxi and Limousine Services industry prior to the introduction of ridesharing, something no previous research has attempted, we are able to show how the arrival of rideshare platforms affected these traditional taxi drivers. Third, to our knowledge, we are also the first to explore the role of taxi industry regulation in mediating the effects associated with the introduction of rideshare apps.

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 accounted for the lion's share of the growth in platform work during that period (Abraham et al. 2019; Farrell, Greig and Hamoudi 2018; Garin et al. 2022), but a growing number of online platforms have offered opportunities for workers to earn money. The introduction of ridesharing offers an interesting case study of an industry that was profoundly affected by the development of platform technology.

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 can have significant value to workers and it is difficult to see how this flexibility could be fully preserved within the context of a traditional employment relationship. 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 or some other primary activity. The most common reason 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% of respondents). The three next most common reasons, however, were "to be my own boss and set my own schedule" (87%); "to have more flexibility in my schedule and balance my work with my life and family" (85%); and "to help maintain a steady income because other sources of income are unstable/unpredictable" (74%) (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 (Chen et al 2019; Chen et al 2020; Angrist, Caldwell and Hall 2021). 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 analyzed by Farrell and Greig (2016a) suggest that, in months when wage and salary income dips, online platform participants are able to offset much of the decline with platform earnings. In a sample of users of one company's personal financial management software who received regular bi-weekly paychecks, Koustas (2018) finds that work as an Uber driver mitigates week-to-week fluctuations in pay and allows drivers to smooth their consumption. Using data from the same source, Koustas (2019) concludes that platform participation more generally mitigates losses in income from other sources. One limitation of these papers is that the population covered by the data may not be representative of the population as a whole. In an analysis using tax data, Jackson (2020) finds that individuals who have access to platform work experience smaller short-term declines 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.

An important unanswered question about the growth of online apps that match riders with drivers is how the introduction of this technology affected the incumbent taxi driver workforce. The one study we know of that addresses this question is Berger, Chen and Frey (2018), which uses American Community Survey (ACS) data for the 50 largest U.S. metropolitan areas on workers in the Taxi Drivers and Chauffeurs occupation to measure drivers' wages and employment. They look 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. Based on an analysis spanning the period from 2009 to 2015, they conclude that Uber entry reduced average hourly earnings in the Taxi Drivers and Chauffeurs occupation in a metropolitan area by 10% to 17%, depending on the specification, but had no effect on the total annual hours supplied by these workers. An important limitation of the all-driver models is that they fold together incumbent drivers and rideshare drivers. The models restricted to wage-employed workers should in principle exclude rideshare drivers, but, assuming that drivers report their employment status correctly, they also exclude the majority of traditional taxi drivers.[1] An additional problem is that, according to Occupational Employment and Wage Statistics data, the majority of 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 drivers worked in some other 3-digit NAICS industry. The study's reliance on household survey data creates additional measurement issues. Even in a large survey such as the ACS, relatively few drivers are observed in any given Metropolitan Statistical Area (MSA)-year cell. Further, household survey responses commonly suffer from errors of measurement in the reporting of employment status and earnings (see, for example, Bound, Brown and Mathiowetz 2001 and Abraham et al. 2013). Using comprehensive administrative data that allow us to follow incumbent drivers over time, we can look directly at how the introduction of rideshare apps affected those who had been working as traditional taxi drivers.

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 may 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

[1] Occupational Employment and Wage Statistics data show that in 2010, prior to the advent of rideshare apps, there were about 42 thousand wage and salary drivers in the Taxi and Limousine Services industry. Published Census Bureau data on nonemployer businesses for the same year indicate there were about 160 thousand solo self-employed drivers in the industry. Taken together, these figures imply that about 80% of Taxi and Limousine Services drivers were self-employed.

deregulation in the early 1980s commonly led to the entry of new taxi firms providing additional taxi capacity (Teal and Berglund 1987). Similarly, we might expect larger proportional increases in the inflow of new drivers in regulated markets following the introduction of rideshare apps. To the extent that there previously had been more untapped potential demand for driving services in the regulated markets, however, incumbent drivers might still be less affected by growth in the number of new drivers than incumbent drivers in unregulated markets. We know of no prior empirical evidence on differences across cities with regulated versus unregulated taxi markets in the labor market effects associated with the introduction of ridesharing.

III. Data and Measurement

Individuals engaged in gig work should report themselves as self-employed in standard household surveys such as the monthly Current Population Survey (CPS), the Annual Social and Economic supplement to the CPS and the ACS, but in practice, the growth in gig employment documented elsewhere is not visible in these data. Whether counting only those who are primarily self-employed or everyone who reports having self-employment income, self-employment rates in these household surveys were stable or fell between 2000 and the late 2010s (Katz and Krueger 2019; Abraham, Haltiwanger, Sandusky and Spletzer 2021). In contrast, administrative tax data have shown 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; Garin, Jackson and Koustas 2022). Much of the discrepancy is related to self-employment among people for whom self-employment is not their only or primary activity (Abraham, Haltiwanger, Sandusky and Spletzer 2021; Abraham, Haltiwanger, Hou, Sandusky and Spletzer 2021). These findings regarding the limitations of household survey data for studying the growth of the gig economy motivate our use of administrative data.

We use the microdata underlying the Census Bureau's published nonemployer statistics to analyze the transformation of NAICS 4853, the Taxi and Limousine Services industry, during the years following the introduction of ridesharing. This is the industry where drivers for taxi, limousine and rideshare companies who file tax returns should be expected to report their self-employment earnings. 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). 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.[2]

Our analysis makes use of data for the years 2010 through 2016. While investigating the impacts of the ridesharing transformation over a longer period also would be of interest, there would be significant practical challenges to creating the internally consistent post-2016 data infrastructure needed to do so.[3] Beginning our analysis with data for 2010 allows us to identify people who were working as traditional taxi drivers prior to the advent of ridesharing and observing the industry through 2016 allows us to observe how it changed over the period of its most rapid growth.

Because we need to be able to identify the individuals to whom each nonemployer business belongs rather than simply that a nonemployer business exists, we focus on nonemployer sole proprietors. Each nonemployer sole proprietor 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).[4] The availability of a PIK for

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[2] 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 ridesharing but decide after a small number of rides that it is not for them—are excluded. The nonemployer microdata are a little used resource whose potential for better understanding the dynamics of labor market activity only recently has begun to be appreciated; see, for example, Garcia-Perez et al. 2013, Goetz et al. 2017, and Hyatt, Murray and Sandusky 2021.

[3] As will be described, our analysis required the integration of multiple administrative data sources. Because of ongoing changes in the content and structure of the underlying data files, the process of integrating them is complex and each year of data added poses distinct challenges. An additional consideration is that the wage record data needed for a portion of our analysis are missing for selected states in earlier and later years.

[4] In principle, most people with any significant net earnings from driving should file both a Schedule C, Profit or Loss from Business (Sole Proprietor), and a Schedule SE, Self-Employment Tax; in practice, the growth in the number of Schedule C filings since 2010 has been substantially greater than the growth in the number of Schedule SE filings. In part, this reflects the fact that, while sole proprietors with any gross receipts are required to file a Schedule C, only those with net earnings of $433 or more are required to file a Schedule SE. This is especially important for people working in the Taxi and Limousine Services industry since expense allowances for mileage are very generous. In addition, even

sole proprietors allows their data to be integrated with other administrative data.[5] 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 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 analyses, we use 2009 nonemployer data to identify people working as traditional taxi drivers, that is, people who were incumbent drivers in the Taxi and Limousine Services industry in 2010 before the advent of ridesharing.

Using the PIK of the business owner as a linking variable, we supplement the 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 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 information on wage and salary earnings for individuals in all 50 states plus the District of Columbia for each year from 2010 through 2016, with the exception of data for Alaska in the second half of 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 plus more limited information about education.[6] In merging the

among those with positive net earnings of more than $433 reported on a Schedule C, a nontrivial percentage do not file a corresponding Schedule SE (Abraham et al. 2023). The reasons for this discrepancy merit further investigation, but our analysis relies on the more inclusive Schedule C's.

[5] 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, Kim and McCue 2017). For our purposes, because essentially 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.

[6] The education variable on the ICF is imputed for about 80% of individuals and missing for about another five percent.

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 Appendix Table A-1, for the years for which we have nonemployer microdata, the trend in the number of NAICS 4853 nonemployer sole proprietors in our analytic sample is similar to the trend in the published numbers; the same is true for the trend in the overall number of nonemployer sole proprietors.

Being able to link individuals' nonemployer records over time allows us to identify all of the drivers who entered the Taxi and Limousine Services industry in each of the years from 2011 through 2016, where a year *t* entrant is anyone with nonemployer earnings in year *t* for whom we do not observe year *t-1* earnings. This allows us to look at how the characteristics of drivers who entered the industry changed after ridesharing began to spread. For comparison, we also have looked at the characteristics of entering nonemployers in other industries. Next, we estimate models that examine how the rate of nonemployer entry was affected by the introduction of ridesharing in a local labor market. To estimate these models, 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 either prior year NAICS 4853 nonemployer earnings (for the Taxi and Limousine Services entry models) or any nonemployer earnings in the previous year (for the all industry entry models). 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.[7]

Displaced workers are a group of particular interest, as they may be pushed into ridesharing or other nonemployer self-employment as a result of losing their wage and salary jobs. Using quarterly earnings data

[7] 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. To qualify as a metropolitan CBSA, the Census Bureau-defined urban cluster must have at least 50,000 people. Micropolitan CBSAs are based on smaller urban clusters with10,000 to 49,999 people.

from the LEHD, we identify 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.

Having linked data also allows us to examine the exit of traditional taxi drivers from the industry. For this purpose, we deem anyone who had NAICS 4853 nonemployer sole proprietor earnings in 2009 and was still working in the industry in 2010 to be a 2010 incumbent.[8] We are able to identify exits from among this 2010 incumbent population in each year from 2010 through 2015, where a year *t* exiter is anyone who had nonemployer earnings in year *t* but not year *t+1*. We also are able to use the information from the nonemployer files on self-employment earnings (receipts minus expenses) and from the LEHD on wage and salary earnings to study changes in the earnings of incumbent drivers over time. [9] Earnings are measured in constant 2015 dollars.

Our main objective is to better understand how the introduction of ridesharing affected the Taxi and Limousine Services industry. We use the year that Uber entered a local labor market as the year when ridesharing became available. 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.[10] We consider Uber to have entered a market in a calendar year if it began operations there after June 30 of the previous year and by June 30 of the current year. As described more fully in the data appendix, we carried out an exhaustive search of multiple sources of information to identify the Uber entry date for all the metropolitan CBSAs within existing Uber service areas and all of the micropolitan CBSAs in Uber service areas that do not

[8] Although the Census Bureau's published nonemployer estimates for 2009 are slightly larger than our estimates based on the underlying microdata, we can be sure that everyone who had NAICS 4853 nonemployer earnings in the microdata in both 2009 and 2010 was a 2010 incumbent and thus had been working as a traditional taxi driver. We cannot be sure, however, that everyone we first observe with nonemployer earnings from driving in 2010 was a new entrant. For this reason, our analysis of entrants begins with 2011 entrants while our analysis of exits begins with 2010 exiters.

[9] Nonemployer earnings, defined as receipts minus expenses, are similar but not strictly comparable to wage and salary earnings. On the one hand, a self-employed nonemployer may have the flexibility to deduct common expenses from her receipts, thereby reducing measured net earnings in a way that a wage and salary work cannot. On the other hand, both the employer and the employee portion of payroll taxes must be paid on any net nonemployer earnings. Because relatively few 2010 incumbent taxi drivers moved into wage and salary work as a result of the introduction of ridesharing, the conceptual differences between the two earnings measures should not be a major issue for our analysis.

[10] 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.

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, the introduction of ridesharing could have had larger effects on driver entry in cities where regulations restricted entry to the taxi industry, since the pre-existing barriers to entry would have been larger in those areas. The effects on incumbent drivers could have been either larger or smaller in regulated markets, depending on how the effective loosening of regulatory constraints due to the advent of ridesharing affected both the supply and the effective demand for driving services. To explore these issues, we construct an indicator variable for whether a CBSA's core city limits the number of taxis on the road through a medallion or other system. The majority of the largest cities have such systems (for example, Los Angeles, New York and Chicago), but others do not (for example, Washington, DC, Phoenix and Minneapolis). Regulations restricting taxi entry are less common in smaller cities.

Our expectation that the presence of taxi regulations might alter the effects of ridesharing in a local market assumes that the introduction of ridesharing significantly lowers the barriers to entry for potential drivers. This appears to have been less true in New York City than in other cities with regulated taxi markets. Over our study period, rideshare drivers in New York City were required to have a Taxi and Limousine Commission (TLC) driving license, meaning that they had to have completed a defensive driving course, a Wheelchair Accessible Vehicle course, and a 24-hour driver education course; passed an exam on the material covered in the driver education course; passed a drug test; gotten fingerprinted; and passed a TLC medical exam. In addition, the vehicles used by New York City rideshare drivers were required to be licensed as commercial vehicles.[11] Given the stringency of the requirements imposed on New York City rideshare drivers, our models allow the effects of Uber entry to be different in New York than in other cities with regulations that had limited the number of taxis.

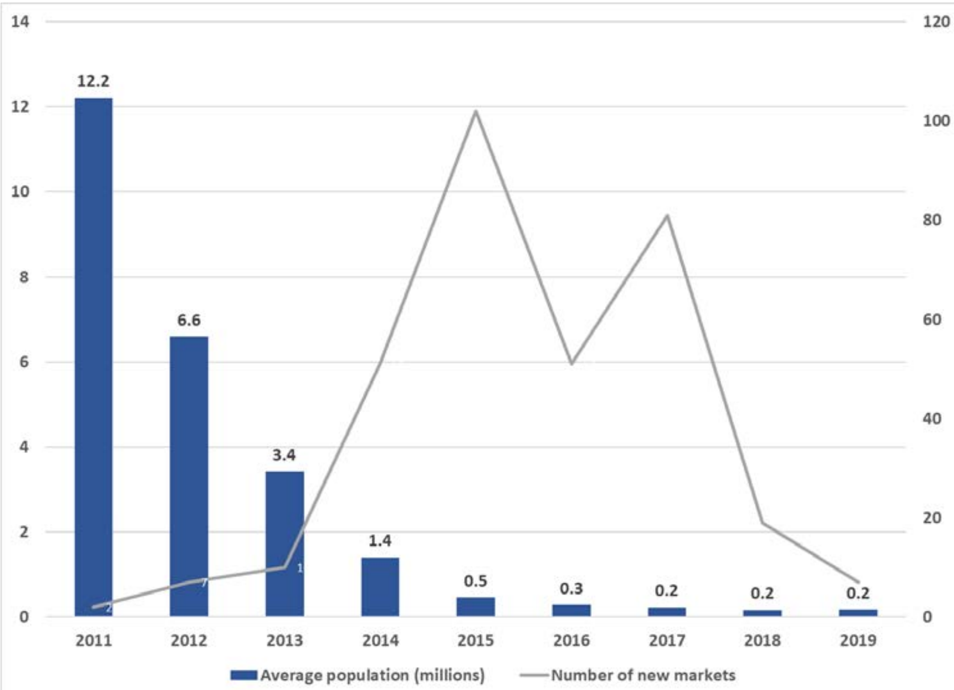
[11]The TLC paused licensing of most new for-hire vehicles in 2018 and additional rules regarding rideshare drivers were introduced in 2019, but these restrictions did not apply during our sample period.

IV. Entry and Growth in the Taxi and Limousine Industry Workforce

The advent of ridesharing dates to the early 2010s. Figure 1 depicts the number of metropolitan CBSAs that Uber entered each year from 2011 to 2019, where year of entry is as defined above, and the average population of those markets. After starting with entry into two very large CBSAs in 2011, Uber entered 7 CBSAs in 2012, 10 in 2013 and 51 in 2014, a cumulative total of 70 metropolitan CBSAs. Entry occurred in the largest markets first and the average size of newly entered markets was lower in each successive year, but the average population size in new markets remained above a million people through 2014. Over the next five years, Uber expanded into an additional 260 smaller metropolitan CBSAs.[12]

[12] As discussed in the data appendix, there are 21 small metropolitan CBSAs in which we believe Uber was operating as of the end of 2019 but for which we could not determine an entry date. These are not reflected in Figure 1.

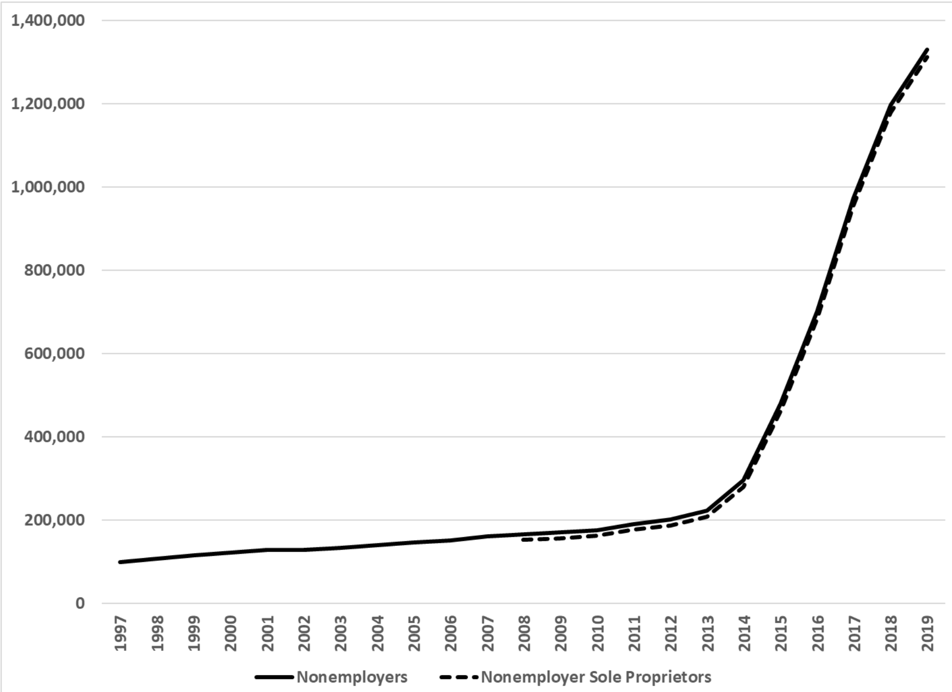
Figure 1: Number and Average Size of Markets Newly Entered by Uber, 2011-2019



Note: A market is defined as a Core Based Statistical Area (CBSA). Date of Uber entry determined by authors based on information supplied by Uber Chief Economist Jonathan Hall and other archival research described in the Data Appendix. Uber considered to have entered a CBSA in a year if it began operations there prior to July 1. Average CBSA size based on 2013 Census Bureau population estimates.

Figure 2 displays the total number of NAICS 4853 nonemployer businesses for each year from 1997 through 2019 and the number organized as sole proprietorships starting in 2008. After trending slowly upwards from 1997 through 2013, the number of nonemployers in this industry shot up sharply beginning in 2013. Almost all of these nonemployer drivers—more than 93% in 2013 and more than 98% by 2019—were unincorporated sole proprietors. The number of nonemployer sole proprietor drivers was more than three times as large in 2016 and more than six times as large in 2019 as in 2013, having grown from 208,692 drivers in 2013 to 683,135 drivers in 2016 and 1,312,413 drivers in 2019.

Figure 2: Nonemployer Businesses, NAICS 4853, Taxi and Limousine Services, 1997-2019



Source: Published Census Bureau 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, even as of 2013, over 80% percent of nonemployers in NAICS 485, Transit and Ground Passenger Transportation, were 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. The number of NAICS 485 nonemployer sole proprietors grew by 235% percent between 2013 and 2016, with nearly 600,000 nonemployer businesses added, and by 2019 was 463% larger than in 2013, with over 1.1 million more nonemployer businesses. As discussed by Abraham et al. (2019), although the number of nonemployers grew more generally, nonemployer growth in NAICS 485 has far exceeded the growth in any other 3-digit industry. Restricting our attention to 3-digit industries other than NAICS 485 with at least 100,000 nonemployers in 2013, none grew by as much as 50%

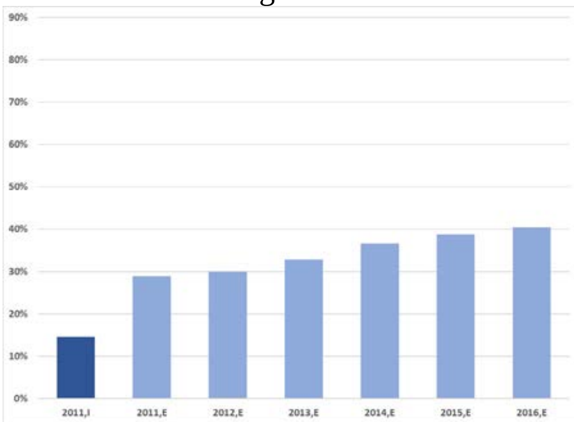
between 2013 and 2016 and only NAICS 492, Couriers and Messengers, did so between 2013 and 2019, adding 335,000 nonemployer sole proprietor businesses for an increase of 214% percent over the 2013 level.

The four panels of Figure 3 show selected characteristics of the nonemployer sole proprietors working in NAICS 4853. In each panel, the dark blue bar at the left refers to the 2011 NAICS 4853 incumbents, drivers who earned income as a NAICS 4853 nonemployer sole proprietor in both 2010 and 2011. The lighter blue bars refer to drivers who entered the industry in the years from 2011 through 2016. In every year, new entrants to NAICS 4853 are more likely than the 2011 incumbents to be young (Panel A), female (Panel B), White (Panel C) and native-born (Panel D). Starting in 2013, as the spread of app-based ridesharing services led to sharp growth in the number of 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 33% to 40%; the share who were female from 15% to 25%; the share who were White from 46% to 58%; and the share who were native-born from 31% to 58%. In contrast to the marked changes in the composition of the NAICS 4853 workforce, the demographic characteristics of new entrants to the nonemployer workforce in other industries, shown in Appendix Figure A-1, were little changed over the 2011-2016 period.[13]

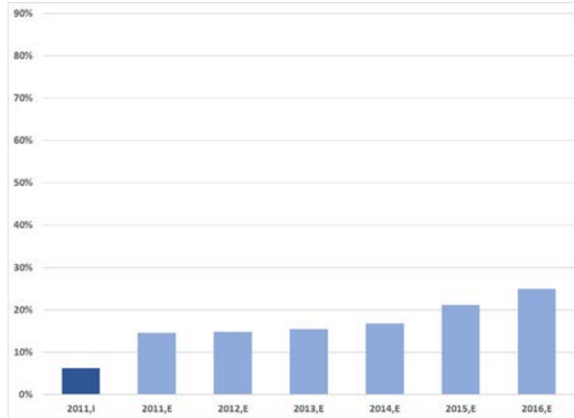
[13] The numbers underlying these figures are reported in Appendix Tables A-2A and A-2B.

Figure 3: Selected Characteristics of Nonemployer Sole Proprietors in NAICS 4853, 2011 Incumbents and 2011-2016 Entrants

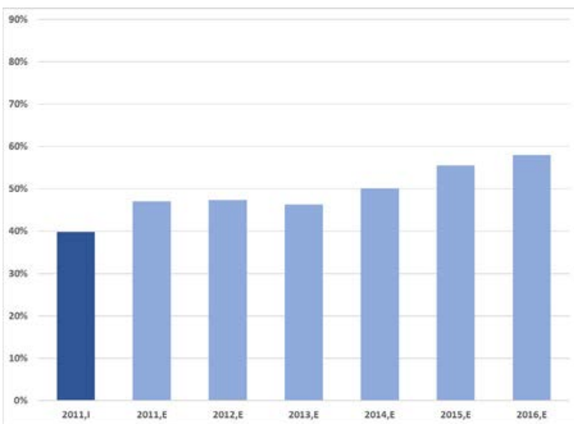
A. Percent under Age 35



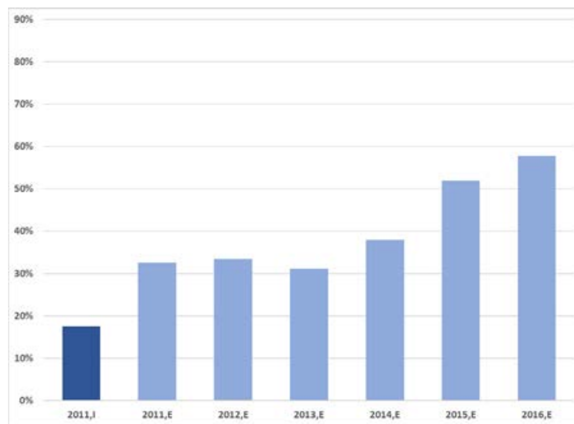
B. Percent Female



C. Percent White



D. Percent Native Born



Source: Estimates from authors' calculations based on data infrastructure described in text.

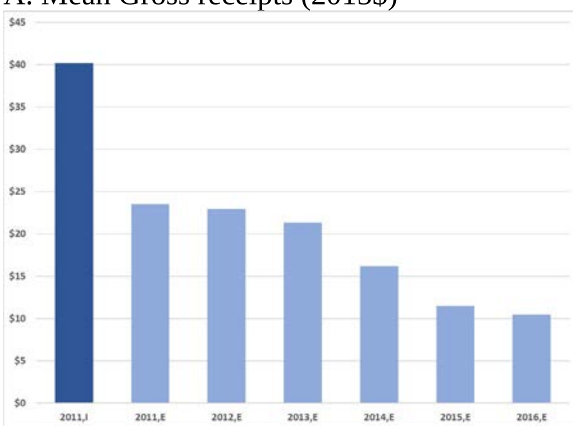
The first two panels of Figure 4 display the gross receipts and net earnings of the 2011 NAICS 4853 nonemployer incumbents and of entrants to the industry. NAICS 4853 incumbents had net earnings that averaged just $12,290 (in 2015 dollars) in 2011. Unsurprisingly given that they are both less experienced than the incumbents and less likely to have worked a full year, the 2011 NAICS 4853 entrants earned substantially less than the 2011 incumbents, with net earnings of just $7,190.[14] Beginning in 2013, however,

[14]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.

the net earnings of NAICS 4853 entrants begin to fall off sharply. By 2016, the average NAICS 4853 entrant had net earnings of just $2,110. As can be seen in Appendix Figure A-2, no such pattern is apparent among nonemployer sole proprietor entrants in other industries; as in NAICS 4853, nonemployer entrants in other industries earn less than incumbents, but entrants' earnings in other industries exhibit no particular trend from 2011 through 2016.

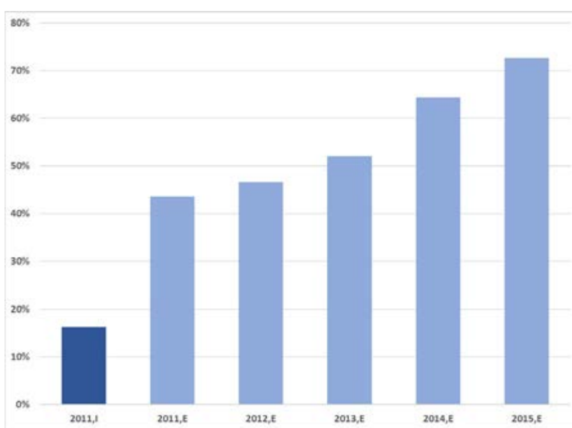
Figure 4: Selected Income-related Measures, Nonemployer Sole Proprietors in NAICS 4853, 2011 Incumbents and 2011-2016 Entrants

A. Mean Gross receipts (2015$)



B. Mean Net Earnings (Receipts-Expenses) (2015$)

C. Share with Wage and Salary Earnings



Source: Estimates from authors' calculations based on data infrastructure described in text.

One other message to be gleaned from Figure 4 is the large difference between the receipts of NAICS 4853 nonemployers (shown in Panel A) and their net earnings (receipts minus expenses, shown in Panel B). In 2016, for example, receipts among drivers entering NAICS 4853 averaged $10,460 and net earnings among these drivers averaged $2,110, meaning that average expenses were 80% of average receipts. Rideshare drivers' deductible expenses include any fees deducted from gross fares by a ridesharing company and the cost of operating the driver's vehicle, as well as 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. By comparison, calculated in the same manner, average 2016 expenses for nonemployers entering industries other than Taxi and Limousine Services, shown in Appendix Figure A-2, were just under half as large as average gross earnings.

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. 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 working as a rideshare driver to smooth temporary fluctuations in other income, gross earnings may be the more salient figure.

Finally, Panel C of Figure 4 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 changes beginning in 2013. In 2013, 52% of entrants combined self-employment income with wage and salary income during the year; by 2016, 75% of entrants did so, a more than 20 percentage point increase. As shown in Appendix Figure A-2, 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).

The baseline estimating equation for our more formal analysis of how the introduction of ridesharing affected entry into Taxi and Limousine Services is as follows:

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

In this equation, fit using person-year observations for the years 2011 through 2016 on all individuals aged 14-99 not already working in the industry, ENTER equals 100 if a person enters Taxi and Limousine Services as a nonemployer sole proprietor in the given year and otherwise equals zero. With this scaling, the estimated model coefficients represent percentage point changes in the entry rate associated with changes in the explanatory variables. YEAR is calendar year; YRSUBER 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, non-White, Hispanic and education group, together with indicator variables for missing demographic information; CBSAGROWTH is the percent growth in wage and salary employment in the CBSA from year *t-5* through *t-1* as measured in the LEHD; 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 first introduced in San Francisco, it has spread to other 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 YRSUBER better captures the effects of rideshare entry than a simple indicator for whether Uber has entered as of a particular year.[15] Demographic controls

[15] 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.

are included to account for cross-group differences in the likelihood of becoming a taxi or rideshare driver. Rideshare companies did not randomly select the markets in which they made their online platforms available, but rather, as noted earlier, entered the largest CBSAs first. Although there could be underlying differences in self-employment growth rates that are correlated with the availability of online rideshare 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.

The column (1) model in Table 1 establishes that Uber entry is associated with a significant surge in entry of Taxi and Limousine Services nonemployer sole proprietors. 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 grew very little, with the estimated coefficient not statistically significant. Following Uber's entry in a market, however, the average entry rate rose substantially in each of the next several years.

Table 1: Uber's Presence in a Market and Nonemployer Entry into NAICS 4853, Taxi and Limousine Services, 2011-2016

		(1)		(2)		(3)	
	Mean	Coef.	(SE)	Coef.	(SE)	Coef.	(SE)
Year	2014	0.0010	(0.0019)	0.0018	(0.0017)	0.0018	(0.0017)
YearsUber	1.143	0.0404	(0.0037)	0.0378	(0.0050)		
Years Uber * Regulation	0.7855			0.0078	(0.0052)	0.0071	(0.0051)
Years Uber * Regulation * NY CBSA	0.2230			-0.0150	(0.0035)	-0.0152	(0.0034)
{0,1} Wage and Salary only last year	0.5469					-0.0368	(0.0079)
{0,1} Nonemployer not 4853 only last year	0.0294					-0.0721	(0.0569)
{0,1} Both W&S and Nonemployer last year	0.0224					-0.0269	(0.0124)
{0,1} Displaced last year	0.0335					0.0023	(0.0017)
Years Uber * {0,1} W&S only last year	0.6409					0.0452	(0.0056)
Years Uber * {0,1} Nonemployer only last year	0.0339					0.1048	(0.0165)
Years Uber * {0,1} Both W&S and Nonemployer las	0.0283					0.1538	(0.0181)
Years Uber * {0,1} Not Employed last year	0.4402					0.0137	(0.0054)
Years Uber * {0,1} Displaced last year	0.0388					0.0109	(0.0029)
R-Squared		0.0015		0.0015		0.0019	

Note: Sample is person-year observations for individuals age 14 to 99 at risk for entry as a nonemployer sole proprietor 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. Regulation=1 if regulations in CBSA's core city limit taxi numbers, else=0; mean of Regulation=0.3884 and mean of Regulation*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. Standard errors clustered at CBSA level. N=1,514,000,000.

In a second model, shown in column (2), we add interactions of YRSUBER with dummy variables for the presence of regulations limiting the number of taxis in the CBSA's core city and for the New York City CBSA. These allow for differing effects of rideshare entry depending on the pre-existing regulatory environment. The coefficient on the interaction between YRSUBER and the regulatory dummy variable is positive, the anticipated sign, but modest in size and statistically insignificant. In contrast, the estimated coefficient on the interaction between YRSUBER and the New York CBSA dummy is negative and strongly significant. New York City had pre-existing regulations that limited the number of taxis on the road, but the requirements the city imposed on rideshare drivers also meant that the barriers to becoming a rideshare driver there were notably higher than elsewhere.

In the model reported in column (3), we allow the effects of ridesharing's introduction to differ with an individual's prior year work experience, including whether she experienced a prior year job displacement. This model adds 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, together with interactions of these variables with YRSUBER. In addition, the model includes a variable that captures whether the person experienced a mass layoff during the previous year, also interacted with YRSUBER. The coefficient estimates imply that Uber entry raised the probability of entry into NAICS 4853 substantially more for people who had worked in the prior year, especially those with prior year nonemployer earnings. Prior to Uber entry, few displaced workers found work as taxi drivers. Displaced workers in any market could potentially have entered NAICS 4853 by working as a traditional taxi driver, but in markets where ridesharing has been introduced, the barriers to entry generally are lower and the opportunities to work a flexible schedule greater. The estimated coefficients imply a substantial increase in the probability that a displaced worker enters NAICS 4853 after Uber began operations in a market.

For comparison with the results for NAICS 4853, in Table 2, we also report results for nonemployer sole proprietor entry into other industries. In these models, the population at risk for entry includes only individuals who did no work as a nonemployer sole proprietor in the previous year.[16] For completeness, the table shows models paralleling each of those reported in Table 1. As can be seen in column (1), non-NAICS-4853 nonemployer entry has trended upwards modestly over time and slightly more so in CBSAs where Uber has entered. A possible explanation for the latter effect is that increasing familiarity with online ridesharing platforms raised awareness of other self-employment opportunities, creating a spillover effect on workers who became more likely to seek out other online platform or self-employment work. If so, however, this effect is very small relative to the mean entry rate. The column (2) results indicate that the effect of Uber entry does not vary significantly by the city's taxi regulation regime. Column (3) 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, though again the proportional magnitude of the latter effect is small relative to the mean entry rate.

[16] This specification is slightly asymmetric with the specification in Table 1 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.

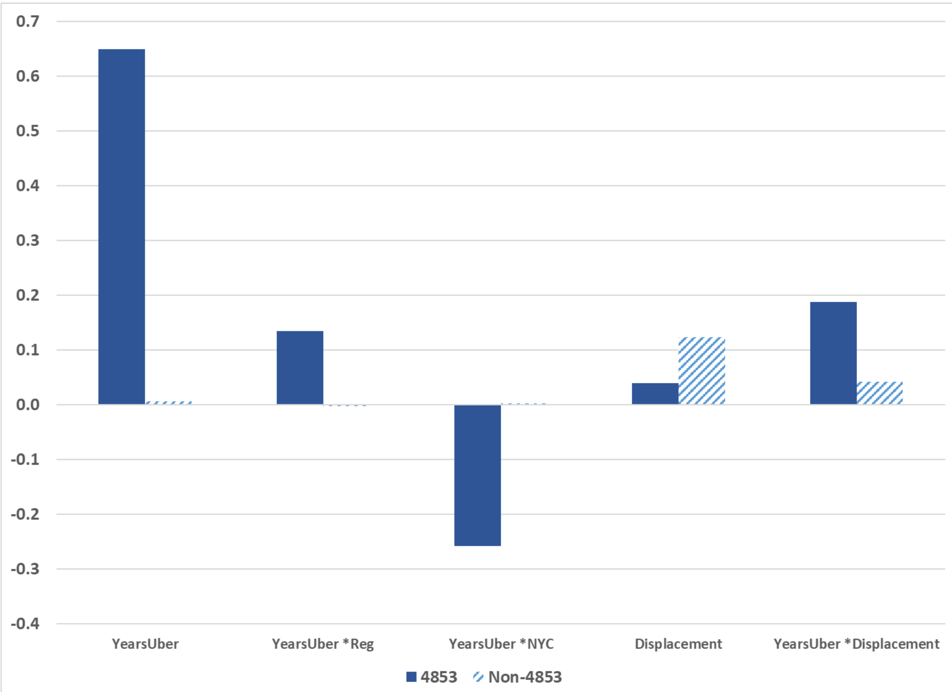
Table 2: Uber's Presence in a Market and Nonemployer Entry into Industries other than NAICS 4853, Taxi and Limousine Services, 2011-2016

		(1)		(2)		(3)	
	Mean	Coef.	(SE)	Coef.	(SE)	Coef.	(SE)
Year	2014	0.0086	(0.0026)	0.0081	(0.0026)	0.0085	(0.0025)
Years Uber	1.139	0.0137	(0.0057)	0.0161	(0.0090)		
Years Uber * Regulation	0.7814			-0.0054	(0.0100)	-0.0055	(0.0103)
Years Uber * Regulation * NY CBSA	0.2225			0.0071	(0.0070)	0.0052	(0.0070)
{0,1} Wage and Salary last year	0.5766					-0.2539	(0.0459)
{0,1} Displaced last year	0.0339					0.2966	(0.0336)
Years Uber * {0,1} W&S last year	0.6752					0.0354	(0.0115)
Years Uber * {0,1} Not W&S last year	0.4642					-0.0186	(0.0105)
Years Uber * {0,1} Displaced last year	0.0388					0.1014	(0.0293)
R-Squared		0.0086		0.0086		0.0087	

Note: Sample is person-year observations for individuals age 14 to 99 at risk for entry as a nonemployer sole proprietor 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. Regulation=1 if regulations in CBSA's core city limit taxi numbers, else=0; mean of Regulation=0.3871 and mean of Regulation*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 CBSA from year t-5 through year t-1; 919 CBSA dummies; and CBSA missing indicator. Standard errors clustered at CBSA level. N=1,435,000,000.

To help with visualizing and interpreting the contrasting results between Tables 1 and 2, Figure 5 shows selected estimated effects. To put these effects into context, they are scaled relative to the mean rate of entry into NAICS 4853 (for the Table 1 effects) or into other industries (for the Table 2 effects). The first three comparisons draw on the estimated coefficients reported in the tables' column (2). They imply that each year since Uber's introduction in a non-regulated city raises the NAICS 4853 entry rate by about 65% relative to the mean entry rate for the industry; in contrast, the proportional effect in the same set of cities on the entry rate in other industries is less than one percent and statistically insignificant. The estimated effect on NAICS 4853 entry is augmented in CBSAs other than New York City where taxi numbers are regulated; in New York City, however, additional years of Uber operations have *less* effect than elsewhere on entry into NAICS 4853. Accounting for 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 is estimated to increase entry into NAICS 4853 in New York City by about 53%, considerably less than the estimated 65% impact in non-regulated CBSAs and the estimated 78% impact in regulated CBSAs other than New York City. Not surprisingly, the same variables have a minimal effect in the corresponding entry rate equation in Table 2.

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



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

The final two comparisons rest on the column (3) estimates from the two tables. In CBSAs where Uber has not entered, the proportional effect of displacement on entry as a nonemployer sole proprietor is more than three times as large in other industries as in NAICS 4853. This changes markedly following Uber entry. One year after Uber entry, taking into account both the base effect and the years-since-Uber entry effect, displacement is associated with a 23% increase relative to the mean entry rate in the probability of becoming a NAICS 4853 nonemployer versus a 17% increase relative to the mean entry rate in the probability of becoming a non-NAICS-4853 nonemployer; by four years after Uber entry, the corresponding figures are 79% for entry into NAICS 4853 versus 29% for entry into other industries.

V. Effects of Ridesharing on the Traditional Taxi Driver Workforce

The arrival of ridesharing clearly drew new workers into the Taxi and Limousine Services industry, many of whom combined wage and salary earnings with self-employment income. Less is known about the impact of the ridesharing transition on incumbent taxi drivers. Our data infrastructure allows us to follow drivers who worked in the industry prior to the introduction of rideshare apps and observe what happened to them subsequently. For this purpose, we focus on drivers who had nonemployer sole proprietor earnings in Taxi and Limousine Services in both 2009 and 2010. We examine how the introduction of ridesharing in a market affected exit of traditional taxi drivers from the industry and, for those who continued to work in the industry (either as a traditional taxi driver or as a rideshare driver), on their earnings. Even among incumbents, some are likely to be more attached to the industry than others. For that reason, in addition to estimating the overall effects on exit and earnings, we also look separately at low-earning drivers (those who had positive earnings of less than $12,000 in 2015 dollars in 2010) and high-earning drivers (those who earned $12,000 or more in 2010). The $12,000 threshold splits the group of 2010 incumbents roughly in half.

Table 3A reports on models of the factors affecting the rate of exit from the Taxi and Limousine Services industry among 2010 incumbent drivers (those with NAICS 4853 earnings in both 2009 and 2010). The sample for these models consists of worker-year observations for years in which a 2010 incumbent who had not previously exited the industry reported nonemployer receipts in NAICS 4853. The value of the dependent variable in the models is one if a driver exited in year *t* and zero otherwise, where a driver is coded as exiting in year *t* if she had positive receipts in year *t* but not in year *t+1*. The explanatory variables in the model include year; years since Uber entry; an interaction of an indicator for restrictive taxi regulations with years since Uber entry; and an interaction of a New York City CBSA dummy with years since Uber entry, along with all of the additional control variables included in the Table 1 entry models, including a full set of CBSA dummy variables.

Other research has found that turnover rates generally fall with tenure, especially in the early years on a job (Farber 1999). The negative and significant coefficient on the year variable in the model for low-earning drivers is consistent with this general finding. The presence of ridesharing in a market raises low-earning drivers' exit rates significantly relative to their baseline exit rate. All else the same, outside of cities with regulated taxi markets, a low-earning 2010 incumbent who had not already exited is 6.6 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 effect is smaller in CBSAs that regulate taxi numbers and especially so in the New York City CBSA. The implication of the estimated coefficients is that the effect of rideshare introduction on the exit rate for low-earning taxi drivers in regulated markets other than New York City is about 33% smaller than the average effect in nonregulated markets and the estimated effect in the New York City CBSA is about 80% smaller.

In contrast, perhaps because higher-earning drivers are almost by definition more attached to the industry, the baseline exit rates of high-earning drivers do not fall over time. These drivers' exit rates also do not appear to be affected by the introduction of rideshare apps in their cities.

Table 3A: Uber's Presence in a Market and Exit of NAICS 4853 Incumbents from NAICS 4853, Taxi and Limousine Services, 2010-2015

	All 2010 incumbents (1)		Incumbents with <$12,000 NAICS 4853 net earnings in 2010 (2)		Incumbents with ≥$12,000 NAICS 4853 net earnings in 2010 (3)	
	Mean [SD]	Coef. (SE)	Mean [SD]	Coef. (SE)	Mean [SD]	Coef. (SE)
Year	2013	-0.0200	2013	-0.0271	2013	-0.0004
		(0.0023)		(0.0030)		(0.0021)
YearsUber	2.13	0.0131	1.88	0.0166	2.39	-0.0008
	[1.87]	(0.0026)	[1.81]	(0.0036)	[1.89]	(0.0025)
YearsUber * Regulation	1.82	-0.0031	1.53	-0.0055	2.12	-0.0003
	[1.93]	(0.0018)	[1.84]	(0.0029)	[1.98]	(0.0016)
YearsUber * Regulation * NY CBSA	1.26	-0.0030	0.95	-0.0077	1.58	-0.0018
	[1.88]	(0.0012)	[1.69]	(0.0018)	[2.01]	(0.0013)
R-Squared		0.0348		0.0408		0.0257
Dependent variable mean		0.1269		0.1566		0.0933
N		484,000		248,000		236,000

Note: Sample is person-year observations for individuals who were NAICS 4853 nonemployer sole proprietors in both 2009 and 2010 and remained a NAICS 4853 nonemployer sole proprietor through observation year. Dependent variable=1 if not a NAICS 4853 nonemployer in following year, implying observation year exit, else=0. 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. 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; CBSA dummies (778 in model 1, 504 in model 2 and 743 in model 3); and CBSA missing indicator. Standard errors clustered at CBSA level.

In principle, an incumbent driver who leaves NAICS 4853 could find other employment. To explore the extent to which this happens, we estimate models similar to those reported in Table 3A, but with a dependent variable that captures whether a 2010 incumbent driver exits employment altogether as opposed to exiting from work as a NAICS 4853 nonemployer sole proprietor. In these models, reported in Table 3B, we count a person as employed if they have positive nonemployer sole proprietor receipts in any industry or any wage and salary earnings. Similar to the Table 3A models, exit in year *t* is defined as having positive receipts or positive wage and salary earnings in year *t* but not in year *t+1*. Because a driver is not dropped from the sample until she experiences a year without earnings from any source, the sample sizes in Table 3B are somewhat larger than the sample sizes in Table 3A. Although Uber entry into a local labor market raises the rate of exit from employment for low earning drivers in these models, the effects appear to be somewhat smaller than the effects on exit from working as a NAICS 4853 nonemployer. Whereas the rate of exit from NAICS 4853 rises by 1.7 percentage points per year among low-earning drivers following Uber entry, the corresponding effect on exit from any employment is 1.3 percentage points or about 25% smaller, suggesting that some of the drivers pushed out of NAICS 4853 found employment elsewhere. As in the Table 3A models, however, Uber entry does not appear to affect the rate of exit among high-earning drivers.

Table 3B: Uber's Presence in a Market and Exit of NAICS 4853 Incumbents from Any Employment, 2010-2015

	All 2010 incumbents (1)		Incumbents with <$12,000 NAICS 4853 net earnings in 2010 (2)		Incumbents with ≥$12,000 NAICS 4853 net earnings in 2010 (3)	
	Mean [SD]	Coef. (SE)	Mean [SD]	Coef. (SE)	Mean [SD]	Coef. (SE)
Year	2013	-0.0136	2013	-0.0202	2013	0.0043
		(0.0018)		(0.0027)		(0.0024)
YearsUber	2.17	0.0092	1.92	0.0127	2.42	-0.0041
	[1.87]	(0.0021)	[1.83]	(0.0032)	[1.89]	(0.0024)
YearsUber * Regulation	1.85	-0.0018	1.56	-0.0040	2.15	0.0006
	[1.95]	(0.0014)	[1.86]	(0.0023)	[1.99]	(0.0014)
YearsUber * Regulation * NY CBSA	1.27	-0.0026	0.97	-0.0067	1.59	-0.0013
	[1.90]	(0.0010)	[1.72]	(0.0014)	[2.02]	(0.0013)
R-Squared		0.0286		0.0329		0.0214
Dependent variable mean		0.1078		0.1347		0.0769
N		510,000		263,000		247,000

Note: Sample is person-year observations for individuals who were NAICS 4853 nonemployer sole proprietors in both 2009 and 2010 and remained a nonemployer sole proprietor or had wage and salary earnings through the observation year. Dependent variable=1 if not a nonemployer and had no wage and salary earnings in following year, implying observation year exit, else=0. 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. 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; CBSA dummies (778 in model 1, 504 in model 2 and 743 in model 3); and CBSA missing indicator. Standard errors clustered at CBSA level.

Anecdotally, in addition to there being drivers who were pushed out of the industry by the introduction of ridesharing, incumbent taxi drivers who continue to drive may have suffered significant earnings losses. We turn next to models that estimate the effects of Uber's presence in a market on earnings (receipts minus expenses) from driving among those who continue to drive (Table 4A) and on the total earnings (nonemployer receipts minus expenses plus wage and salary earnings) of those who continue to work in any capacity (Table 4B), all measured in 2015 dollars. In the first three columns of Table 4A, the dependent variable is the change in the level of earnings from driving. A 2010 incumbent taxi driver is included in the sample in a given year as long as she had positive gross receipts from driving in that year. Because the sample begins in 2011 (the first year for which we observe a post-2010 change in earnings) rather than 2010 (the first year that exit from the sample may occur), the number of observations in these models is smaller than in the exit models reported in Tables 3A and 3B. As with the exit equations, we differentiate between the effects on low-earning and high-earning drivers. In addition to the variables included in the exit models reported in Table 3A, the earnings models include a dummy variable that captures whether the observation is the final year in which a driver had NAICS 4853 earnings; this is important because earnings are mechanically lower if a driver only works for part of the year.

Both low-earning and high-earning drivers saw their earnings fall following Uber entry into their local labor market. For a low-earning driver in a city without restrictive taxi regulations where Uber entered four years earlier, estimated annual earnings are a little more than $600 lower than they otherwise would have been; for a high-earning driver, they are about $1,200 lower. In cities other than New York with regulated taxi markets, these effects are erased for low-earning drivers and only about a third as large for high-earning drivers. Perhaps surprisingly, in New York City, Uber entry was associated with slightly *higher* annual earnings for both groups of drivers.

The final column of the table reports results for high-earning drivers using a different dependent variable, the percentage change in a driver's real earnings compared to their 2010 real earnings.[17] For a high-earning driver, living in a non-regulated city where Uber had entered four years earlier is associated with real earnings that are almost 7% lower relative to the driver's 2010 earnings than they otherwise would have been. As in the earnings level change model for the same group, however, this effect is smaller in regulated markets and reversed in New York City.

[17] Because some low-earning drivers had negative or very small positive amounts of income from driving, the percentage change results for that group are hard to interpret and we report the percentage change model only for high-earning drivers.

Table 4A: Uber's Presence in a Market and Changes in NAICS 4853 Net Earnings of NAICS 4853 Incumbents, 2011-2015

	Net Earnings in t - Net Earnngs in 2010						(Net Earnings in t - Net Earnings in 2010)/ Net Earnings in 2010	
	All 2010 incumbents (1)		Incumbents with 2010 NAICS 4853 net earnings <$12,000 (2)		Incumbents with 2010 NAICS 4853 net earnings ≥$12,000 (3)		Incumbents with 2010 NAICS 4853 net earnings ≥$12,000 (4)	
	Mean [SD]	Coef. (SE)	Mean [SD]	Coef. (SE)	Mean [SD]	Coef. (SE)	Mean [SD]	Coef. (SE)
Year	2013	84.4	2013	479.6	2013	-379.3	2013	-0.0132
		(65.9)		(53.5)		(92.1)		(0.0041)
YearsUber	1.82	-221.9	1.62	-159.0	2.03	-298.8	2.03	-0.0166
	[1.60]	(65.6)	[1.56]	(53.2)	[1.61]	(103.4)	[1.61]	(0.0054)
YearsUber * Regulation	1.58	127.3	1.33	160.5	1.82	195.7	1.82	0.0136
	[1.66]	(84.8)	[1.59]	(61.0)	[1.69]	(131.3)	[1.69]	(0.0059)
YearsUber * Regulation * NY CBSA	1.12	138.8	0.85	227.3	1.39	332.9	1.39	0.0163
	[1.63]	(76.2)	[1.48]	(53.9)	[1.72]	(110.5)	[1.72]	(0.0045)
R-Squared		0.0168		0.033		0.0385		0.0386
Dependent variable mean		-202.7		1998.0		-2393.0		-0.0800
N		371,000		185,000		186,000		186,000

Note: Sample is person-year observations for individuals who were NAICS 4853 nonemployer sole proprietors in both 2009 and 2010 and remained a NAICS 4853 nonemployer sole proprietor through observation year. Dependent variables defined based on net earnings in 2015 dollars. 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. 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; CBSA dummies (713 in model 1, 674 in model 2 and 457 in models 3 and 4); CBSA missing indicator; and an exit dummy =1 if person exited NAICS 4853 during year, else=0. Standard errors clustered at CBSA level.

These estimates could paint an incomplete picture of how traditional taxi drivers fare with respect to their earnings following the introduction of ridesharing, in that drivers may have been able to obtain other work to offset the loss of their NAICS 4853 earnings. As can be seen in Table 4B, however, the pattern of overall earnings changes is very similar to the pattern for earnings from driving alone. Although some drivers find work elsewhere, our qualitative conclusions are unaffected by taking that into account.

Table 4B: Uber's Presence in a Market and Changes in Net Earnings from All Sources of NAICS 4853 Incumbents, 2011-2015

	Net Earnings in t - Net Earnngs in 2010						(Net Earnings in t - Net Earnings in 2010)/ Net Earnings in 2010	
	All 2010 incumbents (1)		Incumbents with 2010 NAICS 4853 net earnings <$12,000 (2)		Incumbents with 2010 NAICS 4853 net earnings ≥$12,000 (3)		Incumbents with 2010 NAICS 4853 net earnings ≥$12,000 (4)	
	Mean [SD]	Coef. (SE)	Mean [SD]	Coef. (SE)	Mean [SD]	Coef. (SE)	Mean [SD]	Coef. (SE)
Year	2013	203.5	2013	465.2	2013	-130.7	2013	0.0033
		(85.9)		(97.5)		(121.3)		(0.0059)
YearsUber	1.83	-218.9	1.63	-128.3	2.04	-318.4	2.04	-0.0193
	[1.60]	(88.7)	[1.56]	(86.4)	[1.62]	(159.5)	[1.62]	0.0080
YearsUber * Regulation	1.59	153.0	1.35	152.8	1.83	256.2	1.83	0.0166
	[1.66]	(130.2)	[1.60]	(93.2)	[1.69]	(189.2)	[1.69]	(0.0090)
YearsUber * Regulation * NY CBSA	1.12	75.3	0.86	218.6	1.39	173.5	1.39	0.0062
	[1.64]	(115.1)	[1.50]	(79.8)	[1.73]	(147.0)	[1.73]	(0.0070)
R-Squared		0.015		0.0265		0.0262		0.0192
Dependent variable mean		486.8		2,509.0		-1,569.0		-0.0300
N		396,000		200,000		197,000		197,000

Note: Sample is person-year observations for individuals who were NAICS 4853 nonemployer sole proprietors in both 2009 and 2010 and remained a nonemployer sole proprietor or had wage and salary income through observation year. Dependent variables defined based on net earnings in 2015 dollars. 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. 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; CBSA dummies (734 in model 1, 691 in model 2 and 474 in models 3 and 4); CBSA missing indicator; and an exit dummy =1 if person exited employment

One caveat regarding these findings is that, although we have good information about traditional taxi drivers' annual earnings, we do not observe the hours that they work. There are anecdotal reports that, in some cases, taxi drivers in markets where ridesharing had been introduced ended up working longer hours to preserve their incomes (see, for example, Hu 2017). This would imply that the earnings changes documented in Tables 4A and 4B may understate the adverse effects of ridesharing on the earnings opportunities for traditional taxi drivers who continued to work.

VI. Conclusion

The favorite example in both the popular media and academic research of the rise of the gig economy is the now-ubiquitous presence of rideshare companies. Our findings suggest that the Taxi and Limousine Services industry (NAICS 4853) stands out not only with respect to the growth in the number of nonemployer sole proprietors in the industry following the advent of ridesharing, but also with respect to the changing characteristics of the nonemployer entrants and the nature of their participation in the industry. The people who entered NAICS 4853 after 2013 were increasingly more likely than the taxi drivers who had been working in the industry prior to the introduction of ridesharing to be young, female, White and U.S. born. The new drivers earned substantially less from driving and were more likely to combine wage and salary income with income from driving. In contrast, the characteristics of entrants to nonemployer activity in other industries changed little over the years following the introduction of ridesharing.

Several findings emerge from our more formal analysis of the factors associated with entry into NAICS 4853 self-employment. First, entry rates grew significantly in the years following the introduction of ridesharing in a local labor market. Second, this effect may have been larger in the typical city with a regulated taxi market, but not in New York City, where the effect of rideshare entry on driver entry rates was smaller than in cities with unregulated taxi markets, a finding we attribute to the relatively stringent entry requirements New York city imposed on rideshare drivers. Third, time since the advent of online rideshare platforms in a local labor market has a proportionally large and positive effect on the probability that a displaced worker will become a NAICS 4853 nonemployer.

These findings are consistent with ridesharing platforms providing new opportunities for flexible income-generating activity to a wide range of individuals. Given new entrants' relatively modest average net earnings from driving, however, there is little evidence that ridesharing in the gig economy is a primary means of support for the typical worker. 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, essentially all of whom would have been traditional taxi drivers, averaged net earnings (receipts minus expenses) of just $12,290 (in 2015 dollars). Those who entered driving in 2011 earned substantially less, just $7,190 on average, no doubt partly reflecting the fact that many entrants would not have worked a full year. By 2016, however, entrants' average net earnings had fallen to just $2,110, far below the average net earnings of the 2011 entrants.

The data infrastructure we have developed allows us to examine the impact of ridesharing on the people who had been working as traditional taxi drivers prior to the introduction of ridesharing. Ridesharing entry into a metropolitan area produced a substantial increase in the rate of exit of these traditional taxi drivers from the industry that grew as the rideshare companies become more established, though the increase in exits was concentrated entirely among drivers who had low initial earnings. The increase in exits was perhaps somewhat mitigated in the typical city with a regulated taxi market, but not in New York City, where the effect of Uber entry on exits of traditional taxi drivers was smaller than elsewhere. Traditional taxi drivers in markets without restrictive taxi regulations who remained in the industry experienced notable losses in their earnings from driving after rideshare companies arrived in their local labor market and these losses cumulated over time. The losses in total earnings among incumbent drivers in unregulated markets who remained employed in any capacity were similar to the losses in earnings from driving among incumbents who continued to drive. In cities with regulated taxi markets, in contrast, the introduction of ridesharing appears to have been associated with smaller or no declines in the earnings of incumbent taxi drivers, though our data do not allow us to say whether this is because hourly earnings held up well or because drivers increased their working hours.

This case study of how ridesharing technology transformed the Taxi and Limousine Services industry provides valuable insights for thinking about the potential effects of online platform technology more generally. In considering the generalizability of our findings, both the similarities and the differences in the use of online platform technologies in the ridesharing setting as compared to other settings should be noted. An important commonality across different applications of online platform technology is that the technology has made it easier to match buyers and sellers. In the ridesharing industry, as in food and grocery delivery services, both of which have experienced growth in the post-pandemic economy, this matching occurs in real time. Another important characteristic of the ridesharing platforms is the enormous flexibility that a driver has with respect to the times of day, week, and year that she engages in the activity, again something that they have in common at least with food and grocery delivery services.

In contrast to many other activities that can be mediated through online platforms, ridesharing services require direct contact between the seller (driver) and the buyer (passenger). For many other types of work, online platforms could in principle make it possible for sellers (providers) to do their work remotely.

Prior to the pandemic, there was considerable discussion of how gig work facilitated by online platforms might broaden the pool of workers available to carry out work and free workers to live where they liked. At least through 2019, however, there is little evidence in the data of rapid growth in the number of nonemployer sole proprietors consistent with this having come to pass. Indeed, the ridesharing industry has been the component of the gig economy with by far the most rapid growth. It remains an interesting and open question whether the increased prevalence of remote work more generally in the post-pandemic economy will be accompanied by the long-projected surge in gig activity that involves the remote provisions of goods and services. Growth in gig employment in what effectively would be a national (or even international) labor market rather than, as in the rideshare case, a local labor market could well have effects on workers that differ substantially from those documented here.

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Data Appendix

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. (2009) 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 aged 14-99 who had no NAICS 4853 nonemployer sole proprietor earnings in the previous year (for entry as a NAICS 4853 nonemployer sole proprietor) or who had no nonemployer sole proprietor earnings in any industry in the previous year (for entry as a non-NAICS-4853 nonemployer sole proprietor). 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 (CBSAs), 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 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 after June 30 of the previous year and by June 30 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 included 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. At that time, maps showing the current boundaries of the various Uber areas were available 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 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 a CBSA if it arrived 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 the end of June 2016 or earlier).

<u>Taxi Regulations</u>

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%) 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%), the core city in 7 of the 21 CBSAs with populations between 1 million and 2 million (33%) and the core city in 4 of 51 CBSAs with populations between 500,000 and 1 million (8%). 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.

References

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Graham, Matthew R., Mark J. Kutzbach and Danielle H. Sandler. 2017. "Developing a Residence Candidate File for Use with Employer-Employee Matched Data," Center for Economic Studies Working Paper No. 17-40, U.S. Census Bureau. May.

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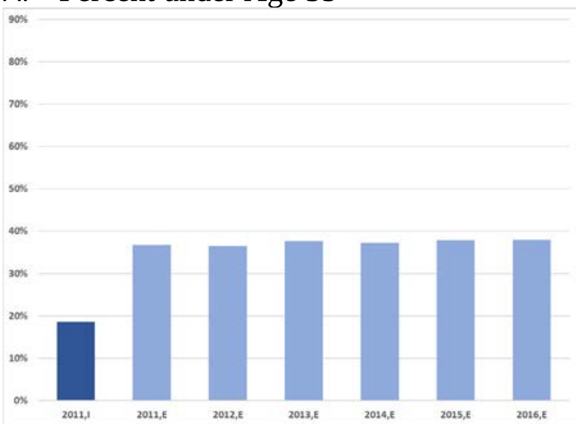
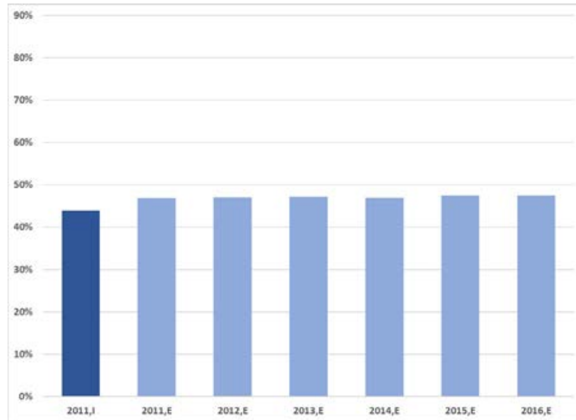
Appendix Figure A-1: Selected Characteristics of Nonemployer Sole Proprietors not in NAICS 4853, 2011 Incumbents and 2011-2016 Entrants

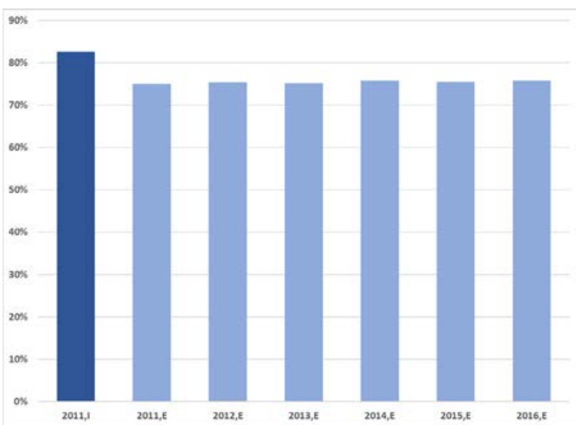
A. Percent under Age 35



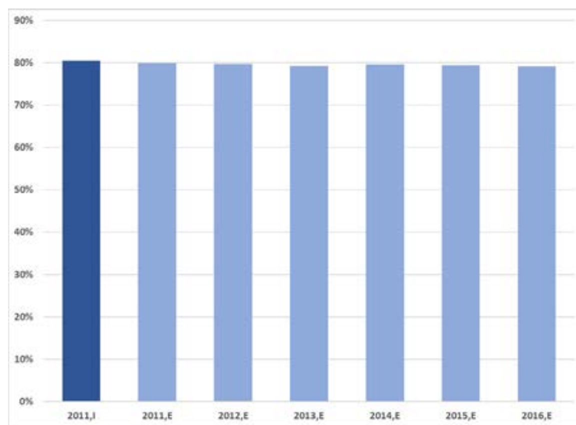
B. Percent Female



C. Percent White



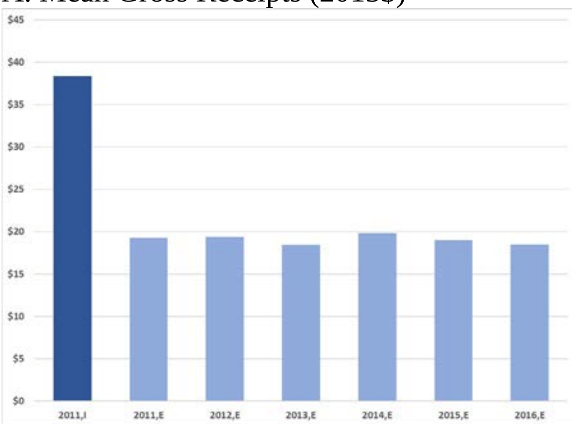
D. Percent Native Born



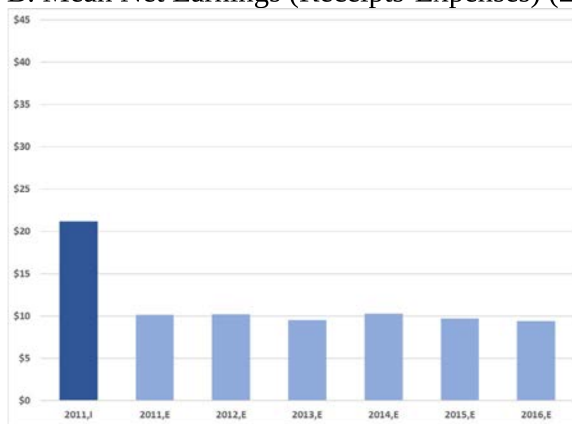
Source: Estimates from authors' calculations based on data infrastructure described in text.

Appendix Figure A-2: Selected Income-related Measures, Nonemployer Sole Proprietors not in NAICS 4853, 2011 Incumbents and 2011-2016 Entrants

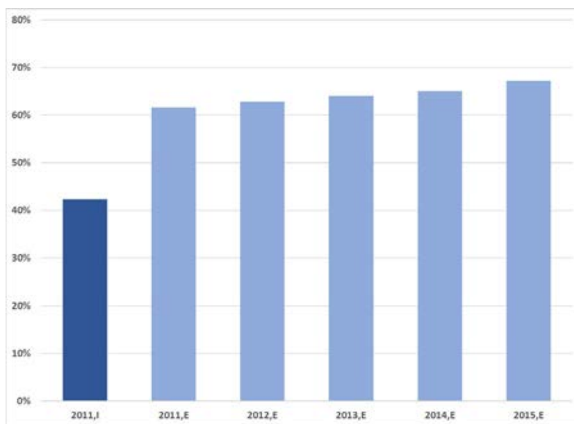
A. Mean Gross Receipts (2015$)



B. Mean Net Earnings (Receipts-Expenses) (2015$)



C. Share with Wage and Salary Earnings



Source: Estimates from authors' calculations based on data infrastructure described in text.

Appendix Table A-1: Nonemployer Sole Proprietors, Published and Analytic Sample

Year	NAICS 4853 Nonemployer Sole Proprietors, Published	Indexed Value (2013=1.00)	NAICS 4853 Nonemployer Sole Proprietors, Analytic Sample	Indexed Value (2013=1.00)
2008	153,628	0.74		
2009	156,905	0.75		
2010	162,732	0.78	156,000	0.79
2011	177,392	0.85	169,000	0.86
2012	187,788	0.90	178,000	0.90
2013	208,692	1.00	197,000	1.00
2014	279,417	1.34	263,000	1.34
2015	462,906	2.22	437,000	2.22
2016	683,135	3.27	638,000	3.24
2017	956,467	4.58		
2018	1,179,167	5.65		
2019	1,312,413	6.29		

Year	All Nonemployer Sole Proprietors, Published	Indexed Value (2013=1.00)	All Nonemployer Sole Proprietors, Analytic Sample	Indexed Value (2013=1.00)
2008	18,808,725	0.95		
2009	18,701,855	0.94		
2010	19,112,075	0.96	18,140,000	0.97
2011	19,438,914	0.98	18,450,000	0.99
2012	19,634,605	0.99	18,540,000	0.99
2013	19,850,941	1.00	18,710,000	1.00
2014	20,592,806	1.04	19,320,000	1.03
2015	21,023,170	1.06	19,690,000	1.05
2016	21,490,556	1.08	20,010,000	1.07
2017	22,247,406	1.12		
2018	22,933,726	1.16		
2019	23,434,804	1.18		

Source: Published Census Bureau nonemployer statistics and authors' calculations.

Appendix Table A-2A: 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

Source: Estimates from authors’ calculations based on data infrastructure described in text.

Appendix Table A-2B: 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

Source: Estimates from authors' calculations based on data infrastructure described in text.