A Tale of Two Cities: An Examination of Medallion Prices in New York and Chicago*

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Abstract

This paper examines the institution of taxicab medallions in two of the largest cities of the U.S. -- New York and Chicago -- and changes in the prices of those medallions during the period 2009-2016 (for New York City) and 2007-2016 (for Chicago). We document a drop of roughly 50 percent in the prices of these medallions in New York and roughly 80 percent in Chicago from their peak in 2013/2014 to the present. We also find that medallion prices are positively correlated with taxicab revenues (for New York City) and negatively correlated with proxies for the intensity of adoption of Uber and Lyft and interest rates in both cities.

Keywords: Lyft; Taxicab medallions; Transportation Network Company; Uber.

JEL codes: L43 (Legal Monopolies and Regulation or Deregulation); L51 (Economics of Regulation); G14 (Information and Market Efficiency); M13 (New Firms & Startups)

1 Introduction

Government regulation is a ubiquitous feature of life in a modern economy. Governments at various levels - federal, state, and local - regulate industries, primarily through a host of regulatory agencies. Such regulation, while often conceived of as a response to market failures, may end up being subject to capture by the regulated industry (Stigler, 1971; Posner, 1975; Peltzman, 1976, 1993). Technological change may also interact with the regulatory regime and make some forms of regulation obsolete, or less relevant, than when the regulations were originally conceived.

This paper focuses on an industry where technology has interacted with the regulatory regime in ways that were unanticipated until recently: the taxicab industry. It examines the effects that the entry of "transportation network companies" (TNCs) -- such as Uber and Lyft -- have had on the prices of taxicab medallions in two of the largest cities of the U.S.: New York and Chicago. Medallions are small metal plates that are attached to the hood of a taxi and that confer (for that vehicle) the right to pick up street-hail passengers anywhere within the boundaries of a city.[1] By law, taxicabs with medallions are the only vehicles that are authorized to pick up passengers by street hail within city limits.

In New York and Chicago, affixing a medallion continues to be a requirement for operating a taxicab. Given the constraints on the number of medallions outstanding, prices of medallions had shot up to $1.2 million in New York and $360,000 in Chicago as of 2013. Since then, prices have fallen by about 50% in New York and about 80% in Chicago. Using data on average daily revenues of taxicabs for New York, we find that the observed drop in taxicab revenues explains a part of this drop in medallion prices. Medallion prices in New York City are also negatively correlated with the intensity of Google searches for keywords such as "Uber" and "Uber driver" and the interest rate at which medallions are financed. Similar results are obtained for Chicago.

Although there has been significant interest in the business press in TNCs, to the best of my knowledge there has not been any academic research of how the entry of firms such as Uber and Lyft has affected the economics of the taxicab industry. This paper attempts to bridge that gap by analyzing how the price of taxicab medallion transactions has evolved since the rise of TNCs. This setting also offers an example of how technological shocks can affect traditionally regulated

[1] As defined in the New York City 2014 Factbook, http://www.nyc.gov/html/tlc/downloads/pdf/2014_taxicab_fact_book.pdf.

industries and the economic rents that accrue to producers in these industries.

The paper proceeds in seven sections: The second section provides a brief literature review while the third section provides some institutional background. The following two sections describe the data that are used in the analysis and present the results of that analysis. Given the differences in the institutional characteristics of the New York and Chicago markets, those are analyzed separately in these two sections. Section 6 discusses these results while Section 7 offers some concluding remarks.

2 Literature review

The rise of Uber has received some attention in recent years. Papers that examine various facets of Uber include Hall and Krueger (2016), who provide a comprehensive analysis of the labor market for Uber's driver-partners, and Cohen et al. (2016), who exploit features of Uber's surge pricing algorithm to estimate the elasticity of demand for Uber (~0.4 - 0.6) and the consumer surplus generated (~ $6.8 billion for the U.S.). Building on earlier work (Farber 2015), Brodeur and Nield (2016) document that since Uber's entry in New York, it has become easier to find a ride during rainy weather and attribute that to the use of "surge pricing": passengers pay a higher rate for the Uber service during times of high demand.

Papers that examine the interactions between the taxicab industry and Uber include Cramer (2016), who finds no evidence that the entry of Uber affects the wages of taxi drivers and chauffeurs (either positively or negatively), and Cramer and Krueger (2016), who find that in five cities of the U.S., on average, the capacity utilization rate[2] is 30 percent higher for UberX drivers than taxi drivers when measured by time and 50 percent higher when measured by miles. However, they also find similar capacity utilization rates of taxi and UberX drivers in New York and speculate that this may result from the city's high population density. Finally, Gabel (2016) focuses on how the entry of Uber impacts the earnings of incumbents, while Wallsten (2015) documents how the increasing popularity of Uber has been associated with a decline in consumer complaints about taxis in New York and Chicago.

One of the challenges of conducting research on TNCs is the absence of data that pertain

[2]Obtained by comparing the fraction of time that drivers have a fare-paying passenger in their car.

to the adoption of Uber and Lyft, both of which are private entities. We therefore turn to a novel source of data to proxy for the popularity and likely adoption of TNCs: Google Trends.[3] Wu and Brynjolfsson (2015), who use Google Trends data to demonstrate how online search can be used to predict future economic trends, provide evidence that queries that are submitted to Google's search engine are correlated with the volume of housing sales *and* the Case-Shiller house price index. Google Trends has also been used by Berge and Jordà (2011) to examine the utility of the index in classifying data on economic activity into recessions and expansions, by Mayer et al. (2014) to document that Internet searches for the term "Countrywide Modification" spiked following announcement of a settlement involving the firm, and by Kumar et al. (2015) to quantify the extent to which the U.S. public seeks information about macroeconomic conditions online.

3 Institutional Background[4]

New York City's taxi industry originated in 1907 and experienced rapid growth in the following decades. Easy entry into the industry, however, led to an abundance of taxis, which resulted in traffic congestion, fare-cutting wars, and other unsafe and sometimes illegal activities. The Great Depression worsened these problems by generating an influx of unemployed workers. To address some of the problems posed by this industry, the City Board of Aldermen enacted an ordinance in 1937 that froze the number of taxi licenses at 13,595: the number then outstanding. Some licenses were unused, and the number shrunk to 11,787 by the early 1940s.

Even though there was rapid growth in economic activity and population in New York City subsequently, the number of NYC medallions stayed at 11,787 from the 1940s until the 1990s. As of 2015, there were only 13,587 taxi medallions in the city (2016 Taxicab Factbook).

One unique feature of the New York medallion system is the existence of two different types of medallions: independent, and corporate (fleet). The owner of an independent medallion may own only one medallion and is required to drive a minimum number of shifts annually.[5] There

[3]Wallsten (2015) and Cramer (2016) also include a similar approach in their papers.

[4]This section draws on Schaller (2006).

[5]Independent taxicab medallions who bought their medallions after January 6, 1990, were required until mid-2011 to drive their taxicabs a minimum of 210 nine-hour shifts per year. In mid-2011, those rules were changed to allow drivers to meet the requirement by driving 180 nine-hour shifts per year and allowing individual owners who

are no corresponding requirements that owners of corporate medallions serve as drivers of vehicles on which these medallions are attached. These must be owned in groups of at least two, and typically owners of corporate medallions own multiple medallions and maintain a fleet of vehicles that are leased to drivers on a daily or weekly basis. The 1937 Act also set up a nominal "60/40" ratio of corporate to independent medallions. While in its early years the taxi industry was regulated by the New York City Police Department, the Taxi and Limousine Commission (TLC) was created in 1971 and has been regulating taxi service in the city since then.

Chicago regulates the taxicab industry through its Department of Business Affairs and Consumer Protection (BACP). Unlike New York, the city does not impose restrictions on owners of any of its medallions that they also operate the cabs themselves. The total number of medallions for the city is capped at 6,904.[6]

4 Medallion prices in New York City

While the overall number of medallions is capped, medallions can trade on a secondary market. Data on medallion sales are available from the New York Taxi and Limousine Commission's website. Before we present the summary statistics, it is worth describing the construction of the sample that is analyzed. In total we observe 3,237 medallions that were traded between May 2009 and December 2016. However, most trades do not take place at arms-length; many involve transfers within a family or the splitting of a partnership or estate sales and are recorded at prices of $0 or $1. Eliminating such trades, we obtain a sample of 1,163 medallion trades that plausibly occur at arms-length.

Trades can take two forms: asset sales, or stock transfers. We consider only asset sales because: "Stock transfers are typically partial sales for a percentage of ownership. Sometimes, these are just smaller components of larger or more complex transactions that don't even necessarily involve medallions."[7] Dropping all stock transfers from the sample of trades results in a sample of 1,103 asset sales. Within each category of medallions - independent and corporate

were 62 (or older) and had driven for at least 10 years to reduce their work schedule to 150 seven-hour shifts per year. (http://www.nyc.gov/html/tlc/downloads/pdf/owner_must_drive_version_10.pdf)

[6] https://www.washingtonpost.com/news/wonk/wp/2014/06/20/taxi-medallions-have-been-the-best-investment-in-america-for-years-now-uber-may-be-changing-that/?utm_term=.835c57fec233

[7] Personal communication with Mr. Allan J. Fromberg of the TLC on 01/18/2017.

- we have three sub-categories: "Unrestricted"; "Accessible" (a vehicle that can transport persons using wheelchairs or other mobility aids); and "Alternative Fuel" (a vehicle that is powered by natural gas or a hybrid electric vehicle). Given the lack of comparability across these three sub-categories, this paper (similar to most TLC tabulations on the topic) analyzes only the 1,078 trades that involve "Unrestricted" medallions. As independent and corporate medallions operate under a somewhat different set of rules, we analyze these two medallion classes separately.[8]

Table 1 presents the sample summary statistics: Panel A for all transactions that involve independent medallions; Panel B for all transactions that involve corporate medallions; and Panel C for all control variables.

[Table 1 about here.]

As Panels A and B of Table 1 suggest, independent medallions traded at a median price of $980,000 as recently as 2014, while corporate medallions hit their high mark of $1.2 million a year earlier in 2013. The importance of technological disruption to the industry is illustrated by the significant drop in medallion prices from their peak values. Between 2014 and 2016, medallion prices decreased by 42% for independent medallions and 47% for corporate medallions. Finally, we also note that corporate medallions trade at a premium -- averaging about $200,000 -- over independent medallions, which reflects their greater flexibility in use.

We dig deeper into our finding that there was a large drop in the prices of medallions and examine what may have contributed to that drop. The entry of Uber and Lyft in the market are obvious explanations but it is not clear to what degree that suffices. Uber entered the New York City market in May 2011 with its product, UberBLACK, and rolled out a cheaper version, UberX, in September 2011.[9],[10] However, prices kept rising in the market for independent medallions until 2014 and in the market for corporate medallions until 2013.

Other events also occurred during our sample period: for example, the announcement of a "Five Borough Taxi Plan" by Mayor Bloomberg in January 2011. The program was targeted towards residents of New York City's boroughs who live outside of Manhattan. Under this pro-

[8] A Chow test of whether the samples of individual and corporate medallions should be separated or pooled suggests examining the two classes separately. In the test of whether the coefficients on the control variables are identical for the two classes, we obtain a p-value of 0.0175 and hence reject the null hypothesis.

[9] https://newsroom.uber.com/uber-nyc-launches-service/

[10] Lyft entered the market only in 2014 but considerably fewer rides were taken on Lyft relative to Uber in New York City. http://www.cnbc.com/2014/07/29/lyfts-sacrifice-for-the-sake-of-its-nyc-launch.html

posal, a new class of vehicles would be allowed to pick up street-hail passengers in all parts of the city except the airports and the Manhattan core.[11] In December 2011, Governor Cuomo signed the bill into law; but the TLC did not begin issuing new licenses until June 2013 when the law was upheld by the state's highest court: the Court of Appeals. Finally, in September 2015, the Queens Supreme Court ruled that for-hire vehicles (including vehicles on the Uber and Lyft platforms) could use "electronic hails" (as opposed to "street hails") to operate in the city.

Given these numerous legal and political developments, it would be challenging, if not impossible, to identify cleanly the effect of any one development on the value of these medallions -- especially in the absence of a clearly defined control group. Instead, we first examine a plot of prices and the number of transfers, to see if any clear patterns emerge from these data. Conducting such an examination calls for us to aggregate the data, since the monthly data are noisy and there are 9 (30) months for which no arms-length transactions occur during the sample period for independent (corporate) medallions. Aggregating the data at an annual level is also not useful as considerable fluctuations occur within the course of a year. Therefore in our graphical analysis, we aggregate the data at a quarterly level and examine the median price of "Independent Unrestricted" and "Corporate Unrestricted" medallions traded in Panel A of Figure 1.

[Figure 1 about here.]

Figure 1 reveals that the prices for independent medallions were rising from the start of the sample period until the second quarter of 2013. Prices then stayed in a relatively narrow band until the second quarter of 2014 before starting to fall. Prices fell sharply from $960,000 to $840,000 in the fourth quarter of 2014 and subsequently from $690,000 to $550,000 in the first quarter of 2016. The median price at which six independent medallions traded in the fourth quarter of 2016 was $525,000: a price drop of roughly 47% relative to their peak of $1 million.

The prices of corporate medallions also rose steadily between 2010 and 2013, plateaued in 2013-2014, and then recorded their sharpest drop in the fourth quarter of 2014 when prices fell from $1.2 million to $950,000. Prices have continued to fall since then; as of the fourth quarter of 2016, eight corporate medallions were traded at a median price of about $625,000: nearly half of the peak as of the third quarter of 2014.

The second approach we adopt for understanding the factors that influence medallion prices

[11] Core: south of West 110th St. and East 96th St.: http://www.nyc.gov/html/tlc/html/passenger/shl_passenger_background.shtml.

is to conduct a series of reduced-form regressions that examine the relationship between medallion prices and a number of factors that are likely to have a bearing on the medallion market. First, we are able to obtain data on farebox collections (and the number of trips taken) by taxicabs from the New York TLC[12] for the period January 2010 to November 2016, which largely overlaps the period for which we have medallion transactions data (between May 2009 and December 2016). The farebox revenues are monthly averages; hence we collapse our transactions data to a monthly level and examine if there is a positive relationship between the average transaction price and farebox collections in that month. The other variables included are:

1. Proxies for the adoption of TNCs: Uber and Lyft were not required to provide detailed information on rides and ridership to the TLC until recently. However, following Wallsten (2015) and Cramer (2016), we can use a novel source of data to proxy for the popularity and likely adoption of TNCs: Google Trends. In our context, we look for searches from New York City for the keywords "Uber" and "Uber driver", as these are likely to capture interest among riders and drivers in joining the Uber platform. The numbers that are available through Google Trends represent search interest *relative* to the highest point for a given region and a given time period. A value of 100 denotes the period during which searches for that term peak in popularity.[13] Figure 2 gives us a sense of the rapid increase in interest in the search terms "Uber" and "Uber driver" in recent years.[14]

   [Figure 2 about here.]

2. Interest rate charged to buyers of medallions: We are able to obtain a measure of the interest rate that has been charged to borrowers through annual financial reports of one of the largest lenders (and the only public company)[15] in this space: Medallion Financial (MFIN). In these reports, the firm provides data on the interest rate on all outstanding medallion loans at the end of each calendar year in its major markets, including New York

[12]The TLC makes available monthly metrics that include average daily trips and fares collected, active vehicles and drivers, and credit card usage in yellow taxis tabulated from yellow taxi trip data that are collected through the Taxi Passenger Enhancement Program (TPEP).

[13]A value of 50 means that the term is half as popular. Likewise a score of 0 means the term was less than 1% as popular as the peak.

[14]The terms "Lyft" and "Lyft driver" exhibit similar patterns and offer similar results to those in the paper.

[15]http://reason.com/blog/2014/06/17/is-uber-undermining-new-york-citys-taxi

and Chicago.[16]

3. The cost of labor: Owners of corporate medallions do not drive their vehicles and instead lease cabs to drivers. While owners of independent medallions are required to operate their vehicles a minimum number of shifts per year, they too lease their vehicles for a second shift, and it serves as an important source of revenue for them (Gabel, 2016). Although these lessees serve as independent contractors (and do not appear in the Occupational Employment Statistics (OES) data collected by the Bureau of Labor Statistics (BLS)), the OES data are likely to capture the tightness of the labor market for drivers. In the regressions that follow, I therefore include the average hourly wage for the New York-Jersey City-White Plains Metropolitan Division for "Taxi drivers and chauffeurs", as reported in the OES.

To summarize, we use four independent variables in our analysis: (1) the farebox collections of taxicabs; (2) the intensity of Google searches for "Uber"; (3) interest rates on medallion loans; and (4) average hourly wages for taxi drivers and chauffeurs. Of these factors, the first two focus on revenues while the last two capture variations in the costs of owning a medallion. Because the medallion is a financial asset whose price should equal the expected present value of future profits, focusing on these factors should help explain some of the variation in medallion prices. Also, while farebox collections and the intensity of Google searches for "Uber" are available on a monthly basis, data on interest rates and wages are available only on an annual basis given the respective data sources.[17]

Before presenting the regression results, two features of the data deserve a mention as they influence our choice of an estimation strategy. First, the number of transactions that takes place each month (and on the basis of which we construct our average price measure) varies over this sample period, which creates a potential heteroskedasticity problem. Second, inspection of the data suggests the presence of serial correlation.[18] In order to address these issues, we use the estimation procedure developed by Newey and West (1987) as the Newey-West standard errors

[16]Between 2006-2016, loans in New York and Chicago were 88 percent of all medallion loans in MFIN's portfolio.

[17]We also experimented with additional control variables: the price of gasoline, and the level of economic activity; but the inclusion of these variables resulted in issues of multicollinearity and high partial correlation with other variables.

[18]The Durbin-Watson test statistic for the sample of "Independent Unrestricted" medallions varies between 1.02 and 1.18, which indicates the presence of positive serial correlation; whereas the test statistic for the sample of "Corporate Unrestricted" medallions varies between 1.41 and 1.58, where the Durbin-Watson test is inconclusive.

are robust to autocorrelation and heteroskedasticity. The choice of a lag is based on the guidance that is provided in the literature (e.g. Newey and West (1994) and Datta and Du (2012)) and set at $[4(T/100)^{2/9}]$. Thus, for the data that involve New York taxicab medallions, we choose a lag length of three months, although results are stable to different choices of lags between 0 (no autocorrelation) and 12.

Table 2 presents our first set of regression results. While Panel A examines the variation in prices of independent medallions, Panel B examines the variation in prices of corporate medallions. In columns (1) and (3), we include the search intensity for "Uber" whereas in columns (2) and (4), we include the search intensity for "Uber driver." While Table 2 presents the results that are obtained with the use of farebox revenues, results that use trips per day as an alternative measure of the intensity of taxicab usage are generally similar and are available on request. Results that use the intensity of Google searches for "Lyft" and "Lyft driver" are included as Appendix Table A1.[19]

[Table 2 about here.]

The results that are presented in Table 2 confirm the patterns that we would expect to see in the data: There appears to be a positive relationship between medallion prices and farebox revenue collections. Medallion prices are negatively correlated with the intensity of Google searches for both terms, "Uber" and "Uber driver", which likely capture the extent of adoption of this service in the city. They are also negatively correlated with the interest rate that is charged on medallion loans and the average hourly wage for taxi drivers and chauffeurs. As suggested by the R-squared -- which averages 0.79 for independent medallions and 0.62 for corporate medallions -- we are able to explain a substantial fraction of the variation in medallion prices.[20]

We can go further in trying to get a sense of the magnitude of the coefficients on two of the variables. For 2013 -- the year when taxicab revenues peaked -- the average score for searches

[19] In another robustness check, I lag the farebox revenues and the variables that proxy for TNC penetration by 1-6 months. The results are similar to what we obtain in the base specification. However, depending on the variable being lagged, the number of observations in the estimation goes down. In light of that, the fact that there is no theoretical guidance on lag structure, and the fact that the results are similar, I simply report results from the base specifications that use current values. These results, like other additional results, are available on request.

[20] In an alternative approach, I analyze medallion prices by looking at price-to-sales multiples. Using a regression framework, I find that the adoption of Uber and an increase in interest rates are associated with declines in the price-to-sales multiple. While an increase in the average hourly wage for taxi drivers and chauffeurs is associated with a decline in medallion prices, those declines are statistically significant only for the sample of independent medallions.

for "Uber" stood at 9; whereas by 2016, the average score had risen to 86. Multiplying this increase in score for searches for "Uber" with the coefficients in column (1) of Table 2, we estimate a decline in prices of about $275,000 for independent medallions and about $400,000 for corporate medallions.[21] The interest rate is also quantitatively important: A one-standard deviation increase in interest rates is associated with a drop in prices of about $200,000 in both markets.[22]

5 Medallion prices in Chicago

As in New York City, while the overall number of medallions is capped in Chicago, medallions trade on the secondary market. Data on medallion sales are available for the period from 2007 through 2010 from a monthly trade magazine, The *Chicago Dispatcher*, while data from 2011 through 2016 are available through the city's Department of Business Affairs and Consumer Protection which regulates taxicabs in the city. Chicago does not impose restrictions on the owner of medallions that they drive the cab themselves; thus there is no distinction between independent and corporate medallions, which is contrary to the case in New York City.

For our analysis we start with the entire universe of 3,457 medallion transactions that occurred between 1/1/2007 and 12/31/2016. We drop all transactions that do not occur at arms-length (e.g. transactions taking place at artificially low prices such as $0, $1, etc.) On dropping such transactions, we are left with a sample of 3,278 transactions, which represent 94.8% of all transactions and 98.4% of all transaction dollars. Panel A of Table 3 presents the summary statistics for all arms-length transactions that occur during this 10-year period between 2007 and 2016 and Panel B presents the summary statistics for the control variables that are included in the analysis.

[Table 3 about here.]

A few observations based on the summary statistics presented in this table: First, while medallion prices rose rapidly during the period under study, they never reached the valuations that we observe in New York, likely reflecting the differences in the profitability of a medallion in these two cities. The maximum price at which a medallion traded in Chicago was $390,000 (in

[21] For independent medallions: -35.64 (from col. (1), Panel A, Table 2) * (86-9) * 100 = -$274,453. For corporate medallions: -51.09 (from col. (1), Panel B, Table 2) * (86-9) * 100 = -$393,370.

[22] For independent medallions: -25.96 (from col. (1), Panel A, Table 2) * 0.7729 * 10,000 = -$200,624. For corporate medallions: -24.13 (from col. (1), Panel B, Table 2) * 0.8121 * 10,000 = -$195,951.

2012) whereas the maximum price observed in New York City was $1.32 million (in 2013). Second, we see that regardless of the measure used, medallion prices in Chicago peaked in 2013 at about $350,000. Medallion prices declined modestly in 2014 to about $325,000, before declining materially to about $250,000 in 2015 and eventually crashing to a price of $60,000 in 2016.[23]

As in New York, the taxi industry in Chicago has been affected by the entry of TNCs, although attributing exactly how much of the decline is due to that is challenging. Uber arrived in Chicago in 2011 with its UberBLACK product and launched UberX in 2013.[24] Lyft launched in 2013 and has competed aggressively with Uber since.[25] In September 2013, Chicago announced an auction of 50 new medallions to raise revenue and set a minimum price of $360,000; but the city failed to attract buyers at that price, which led to nervousness among some in the industry.[26]

There were numerous legal and regulatory developments during this period under consideration. In May 2014, the Illinois State Senate passed ride-sharing rules requiring that ride-sharing companies carry primary commercial liability insurance that is equal to taxis and that drivers who work more than 18 hours per week get public chauffeurs licenses and undergo the same criminal background checks and drug testing as taxi drivers.[27] However, the Governor of Illinois vetoed the bill, arguing against "a one-size-fits-all approach to a service that is best regulated at the local level."[28] In 2014, the Chicago City Council adopted regulations that govern TNCs, but they were challenged by a coalition of taxi owners in the U.S. District Court for the Northern District of Illinois for being too lax. In April 2016, the court rejected an attempt by the city to dismiss the lawsuit and allowed it to proceed. However, following an appeal by the city, the 7th U.S. Circuit Court of Appeals in October 2016 ordered the suit's dismissal.[29]

[23]While we do not focus on the number of transactions in the paper, we do note that this has shrunk much more than the drop in prices. The number of transactions was highest in 2007 at the start of the sample period. After reaching a relative high of 507 medallions that were traded in 2012, the number of transactions dropped in 2013 to 361, before slowing down further to only 89 in 2014. Thus, even though prices held steady between 2012 and 2014, this was based on very few transactions. After only 12 transactions took place in 2015, we observe 30 transactions occur in 2016.

[24]https://newsroom.uber.com/us-illinois/area/chicago/

[25]https://techcrunch.com/2013/05/09/zimride-no-more-lyft-chicago/ &
http://www.chicagobusiness.com/article/20161209/NEWS10/161209857/lyft-looks-to-dethrone-uber-starting-in-chicago.

[26]https://www.washingtonpost.com/news/wonk/wp/2014/06/20/taxi-medallions-have-been-the-best-investment-in-america-for-years-now-uber-may-be-changing-that/?utm_term=.4e009a3b9a44

[27]https://www.wbez.org/shows/wbez-news/illinois-senate-passes-ride-sharing-rules/3792c944-fb01-4ab6-aae0-3d27a356891b

[28]http://www3.illinois.gov/PressReleases/ShowPressRelease.cfm?SubjectID=2&RecNum=12553

[29]http://www.chicagotribune.com/news/local/politics/ct-rahm-emanuel-uber-taxi-ruling-1008-20161007-story.html

Given these numerous developments, it would be difficult to identify cleanly the effect of any one development on the value of these medallions. Instead, what we first do is examine a plot of prices and determine whether any clear patterns emerge from these prices. When doing so, we aggregate the data at the quarterly level, since monthly data may be noisy and no transactions occur during 13 months within the span of this 10-year period. A plot of those data are presented in Panel B of Figure 1.

What emerges as we examine this figure echoes our impressions from the summary statistics that were presented in Table 3. As in New York City, medallion prices increased during much of the sample period, then held steady, before declining. The sharp decline in prices around 2015-2016 is notable, with median prices declining from $194,000 in the fourth quarter of 2015 to $50,000 in the first quarter of 2016. Prices recovered somewhat to $67,500 in the fourth quarter of 2016 but the median price for all of 2016 was $60,000, roughly 80% lower than their peak value.

Having examined the quarterly data, we attempt to examine the relationship between prices and the factors that are likely to affect the profitability of owning a medallion with the use of reduced-form regressions. However a challenge is that -- unlike New York City -- data on taxicab farebox revenues and rides taken are unavailable for Chicago for our period of study between 2007 and 2016. Data on farebox collections for the city are available only for the period between January 2013 and June 2016. Given this limitation, we drop farebox revenues as an independent variable and include only proxies for the adoption of TNCs, interest rate, and the hourly wage for taxi drivers and chauffeurs. As before, we look for searches that originate from Chicago for four sets of keywords: “Uber”, “Uber driver”, “Lyft”, and “Lyft driver”. Figure 3 gives us a sense of the rapid growth in interest in searches for the terms “Uber” and “Uber driver.” Patterns for the terms “Lyft” and “Lyft driver” are similar and are available on request.

[Figure 3 about here.]

We now use these data obtained from Google Trends to examine the effect that the adoption of these apps had on medallion prices. In particular, in Panel A of Table 4 we regress the average price for all arms-length transactions that occurred over a month against the intensity of searches for Uber in that month, the interest rate, and hourly wages of taxi drivers. Because Lyft has competed more vigorously with Uber in Chicago relative to New York City, we include

results using the intensity of searches for Lyft in Panel B of Table 4.[30] As before, we use Newey-West standard errors and, based on the guidance in the literature, choose a lag length of four months.

[Table 4 about here.]

The results that are presented in Table 4 confirm the patterns that we would expect to see in the data: Medallion prices are negatively correlated with the intensity of Google searches for the terms, "Uber" and "Uber driver", which likely capture the extent of its adoption in the city. Similar results are obtained in Panel B, when we examine the intensity of Google searches for the terms, "Lyft" and "Lyft driver". Medallion prices are also negatively correlated with the interest rate that is charged for loans. The relationship between medallion prices and average hourly wage for taxi drivers and chauffeurs is tenuous, but the coefficient is negative in most specifications.

In terms of quantifying the magnitude of these impacts, we note that the increasing adoption of TNCs seems to have significant predictive power. Considering Uber, the average score for Google searches for "Uber" stood at 10 in 2013 and had increased to 88 in 2016. Using the coefficient on the term "Uber" in col. (1) of Panel A of Table 4, we see that the increased search intensity for "Uber" could be thought of as explaining about $320,000 of the price drop.[31] Given that the average price of a medallion declined from $357,000 in 2013 to $60,000 in 2016, the increasing adoption of Uber perhaps accounts for the entire drop in medallion prices in Chicago.[32]

6 Discussion

6.1 Appropriateness of using Google Trends to proxy for the adoption of TNCs

The decision to use the search intensity for terms such as "Uber" and "Lyft" as proxies for the adoption of TNCs is driven by the lack of data on the ridership or revenues of Uber and Lyft. Being private entities, they were not required to provide ridership data to city regulators until

[30] As was noted in fn. (19), results obtained by lagging the variables proxying for TNC penetration by 1-6 months were very similar to what we obtain in the base specification and are available on request.

[31] -41.36 (from col. (1), Panel A, Table 4) * (88 - 10) * 100 = -$322,569. We find similar results with the other terms.

[32] In fact, interest rates on medallions loans decreased from 5.11 percent in 2013 to 4.625 percent in 2016 in Chicago and that movement in interest rates would have induced a higher price of medallions, *ceteris paribus*.

relatively recently. However, since 2015 the New York TLC has required all For-Hire Vehicle (FHV) firms (which include Uber and Lyft) to provide monthly reports with data on total dispatched trips and number of unique dispatched vehicles.[33] In light of that, we can examine how closely the data on search intensity for Uber and Lyft that are available through Google Trends line up with the data on number of trips and vehicles as reported by these entities themselves.

In order to do so, we aggregate the data that are available for each FHV base at a weekly level to the monthly level for each TNC.[34] Having aggregated the data, we first examine a scatter plot of the number of trips per month on Uber and Lyft against the intensity of searches on Google for those services in Figure 4. We also examine this more formally in Table 5 by regressing the log of number of trips per month and number of unique vehicles dispatched on each service against the search intensity on Google for those services in that month. Cols. (1) and (2) of Table 5 presents the results for Uber, while Cols. (3) and (4) present the results for Lyft.

[Figure 4 about here.]

[Table 5 about here.]

Figure 4 suggests a moderate-to-high correlation between TNC activity as reported to the New York TLC and searches on Google, with a correlation coefficient of about 0.75 for Uber and about 0.95 for Lyft. This observation is supported by the results in Table 5: There is a positive relationship between the log of trips (or log of unique vehicles) per month on Uber and the search intensity for the terms, "Uber" and "Uber driver", with the coefficients statistically significant at the 5% level (or better). Results are similar, and in fact stronger in both statistical and economic significance, for Lyft. The estimates also appear plausible and suggest that an increase in search intensity by 1 point translates to a 1.2 - 3.2 percent increase in number of trips that are taken on these platforms.

6.2 Looking ahead for the taxicab industry

While the prospects for the taxicab industry may appear dim, a number of changes are being made by incumbent taxicab companies in various cities across the U.S., often with the support of their regulators. Three of the more interesting developments in this area are:

[33] http://rules.cityofnewyork.us/sites/default/files/proposed_rules_pdf/fhv_dispatch_rules_final_9_12_14.pdf

[34] While all Lyft dispatches happen out of a single base, "Tri-City, LLC", Uber uses as many as 28 different bases such as "Danach-NY, LLC", "Dreist NY LLC", and " Schmecken LLC" and we need to aggregate across all its bases.

1. Improving the technology that is associated with dispatching: A key challenge that is experienced by the taxi industry is that its dispatching system is less efficient than that of TNCs. The more efficient software that has been developed by TNCs results in a higher utilization of vehicles (Cramer and Krueger, 2016), which leads to higher incomes for drivers, which entices new drivers to sign up or cab drivers to defect. As the number of drivers on these platforms increases, it makes the platforms more attractive to riders who benefit from lower wait times. Thus, there is a virtuous cycle where riders and drivers complement each other on the platforms, with the largest network being generally able to offer the shortest wait times. A development by cab companies has been to offer the flexibility of being hailed (and in some cases, paid) through apps that they have developed such as Curb and Arro.[35],[36]

2. Engaging in branding: Although taxi regulations vary from city to city, they stress uniformity across all cabs within a city. Regulations in Chicago, for example, require the car's medallion number to be painted in plain black Gothic figures on the driver's-side hood, on both passenger doors, and on the rear. Within the car itself, regulations require that a camera be mounted over the rear-view mirror and a credit-card reader fixed to the passenger headrest.[37] The net result is that it is challenging for owners of multiple medallions to gain distinctiveness or establish their own brand and attract consumer loyalty to respond to Uber and Lyft.[38] Tentative steps are, however, being taken in a number of cities: In Pittsburgh, for example, Yellow Cab, the parent company of the Pittsburgh Transportation Group, launched a new app-driven service, zTrip. As part of the branding exercise, the firm retired 75 Yellow Cabs and repainted 80 other cars silver and branded them with the zTrip logo. In doing so, Yellow Cab of Pittsburgh joined the ranks of other cities -- such as Denver,

[35]However, these apps are not yet widely adopted. Curb and Arro had between 500,000 - 1 million and 10,000 - 50,000 downloads, respectively, on the Google play store, in contrast to Uber, which had between 100 - 500 million downloads.

[36]The adoption of these apps by cabs could be viewed as an improvement to the dispatching technology that leads to higher driver productivity. Improvements in dispatching technology in the past have enhanced productivity of drivers and even resulted in increases in the proportion of taxicabs under fleet ownership (Rawley and Simcoe, 2013).

[37]https://www.washingtonpost.com/news/wonk/wp/2014/06/20/taxi-medallions-have-been-the-best-investment-in-america-for-years-now-uber-may-be-changing-that/?utm_term=.4e009a3b9a44

[38]Lyft, for example, in its early years, attempted to use the pink mustache as a source of differentiating itself from Uber. http://www.theverge.com/2016/11/15/13624152/lyft-amp-led-display-replace-pink-mustache-logo

Kansas City, Phoenix, Tampa, and Orlando -- which have all made similar changes.[39]

3. Flexibility in fares: One of the complaints that is voiced most commonly by stakeholders in the taxicab industry was the ability of services like Uber and Lyft to engage in surge pricing, whereby prices could go up during periods of high demand. In contrast, cabs have historically been restricted to charging fixed rates, although there are some exceptions to this practice: New York City introduced a $1 surcharge for trips beginning between 4 p.m. and 8 p.m. in May 2004 (Schaller, 2006). In an attempt to provide some flexibility, the City Council in Long Beach, California, allowed the city's exclusive cab franchise to offer variable, discounted fares, free rides, and other price promotions to lure customers, in addition to letting them rebrand themselves and update the appearance of their fleet.[40]

Regulators in New York and Chicago have also taken steps in response to the challenges that are faced by the taxicab industry, and relaxed some rules. In March 2017, the New York TLC changed its rules to allow owners of an independent medallion to sell their medallion to a fleet owner, whereas previously they could have sold only to a buyer who did not already own a medallion.[41] Likewise, Chicago lowered the transfer tax that is paid when one owner sells the medallion to another.[42]

7 Conclusions

As we look at the valuation of taxicab medallions over time, it is natural to reflect on whether medallions were over-valued, especially during their peak in 2013 and 2014, relative to their underlying true valuations. That is not an easy question to answer. One can look at the price-to-sales multiple; and while that appears high in relation to other assets,[43] the taxicab industry had also been insulated from market forces until recently given, the institution of medallions.

[39] http://www.post-gazette.com/news/transportation/2016/06/28/Yellow-Cab-gives-into-new-market-introduces-zTrip/stories/201606280135?pgpageversion=pgevoke

[40] http://www.latimes.com/local/california/la-me-long-beach-uber-20150514-story.html

[41] http://www.crainsnewyork.com/article/20170411/TRANSPORTATION/170419978/have-taxis-finally-hit-rock-bottom

[42] http://www.chicagotribune.com/news/ct-chicago-taxi-driver-decline-met-20161214-story.html

[43] The median price-to-sales multiple among stocks in the S&P 500 was 2.2 in mid-2016 (http://www.marketwatch.com/story/by-this-measure-us-stocks-are-more-expensive-than-ever-2016-05-27). In contrast, the median price-to-sales multiple peaked at 5.5 (6.7) for Independent (Corporate) medallions in New York City in 2014. They peaked in Chicago a year earlier in 2013 at 6.8.

Moreover, there were numerous attempts to slow the growth of TNCs, and it was unclear what form the new regulations would take. As was seen recently, following an ordinance by Austin's city council (reaffirmed by an election) that all drivers be fingerprinted and undergo criminal checks, Uber and Lyft decided to exit Austin in 2016.[44] Apart from legal and regulatory uncertainty, there were differences in opinion with regard to the pace of technology adoption and how fast TNCs could grow. A well-known commentator (for example) noted in June 2014 -- after Uber had raised money from investors at a valuation of $17 billion -- that his best estimate for Uber's risk-adjusted value was $5.9 billion;[45] only two years later, Uber raised money again from investors at a valuation of $66 billion.[46] Clearly, owners of taxicab medallions were not the only individuals unable to anticipate the sharp growth in the rise of Uber; and the drop in medallion prices may be viewed as a response to Uber's faster-than-expected growth.

The differential decline in the price of medallions in Chicago relative to New York is surprising, especially given that taxi revenues have gone down *less* in Chicago relative to their peak than in New York. Two tentative arguments can be offered for this puzzle: First, the capacity utilization rate of taxis is significantly higher in New York as compared to other cities, possibly because New York's high population density supports efficient matching of taxis and passengers through street hailing (Cramer and Krueger, 2016).[47] In that case, as long as the right to hail a vehicle off the street is limited to taxicabs, medallions in New York City will retain value. Gabel (2016) suggests as much when he notes that, "While an electronic hail has its advantages...the convenience of walking to a corner and hailing a ride from a yellow cab remains important."

The second explanation that may play a part in the differential price response is the regulatory environment in the two cities. New York City mandates drug testing and fingerprinting of all commercial drivers and requires them to obtain a chauffeur license and undergo a 24-hour education course prior to driving for TNCs.[48] Requirements in Chicago appear more modest in that regard, as they do not require any one of those four elements.

This paper highlights the significant effects that technological innovations can have on the fortunes of an established industry, especially one that was the beneficiary of government regu-

[44] http://fortune.com/2016/05/08/uber-lyft-austin-fingerprints/
[45] https://fivethirtyeight.com/features/uber-isnt-worth-17-billion/
[46] http://www.wsj.com/articles/uber-raises-3-5-billion-from-saudi-fund-1464816529
[47] This is likely as 90.3% of taxi pickups occur in Manhattan, the city's densest borough. (Taxicab Factbook, 2014).
[48] http://www.nyc.gov/html/tlc/html/industry/drivers.shtml

lation for an extended period of time. However, we have only scratched the surface in terms of what the future holds: With more moderate prices of medallions, the cost of leasing one should also decrease, and the economics may improve for cab drivers, which may cause them to shy away from TNCs. As has been noted elsewhere, the lack of drivers who are willing to lease medallions and drive taxicabs (relative to driving their personal vehicle on the Uber and Lyft platforms) seems to have played a significant role in the drop in medallion prices.[49] Beyond the impact on medallion prices, one can examine the change in service levels and quality that is experienced by users of regular taxicabs and of TNCs, especially now that TNC data are being made available to regulators. All of those questions should be of interest to economists and remain ripe areas for further exploration.

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[49] http://gothamist.com/2015/08/21/why_yellow_cabs_are_taking_up_all_o.php

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Figure 1: Price of taxicab medallions trading in New York City and in Chicago

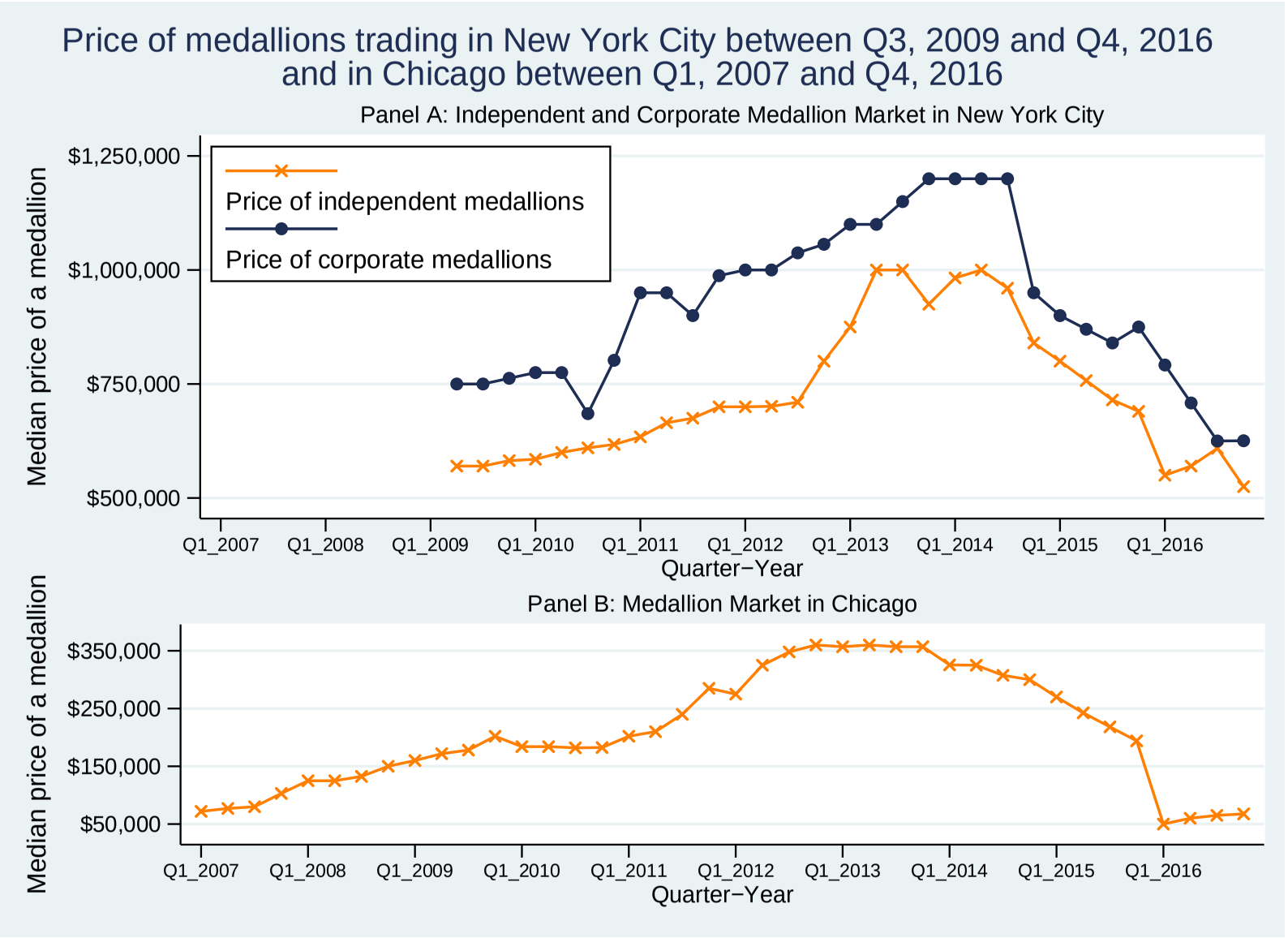
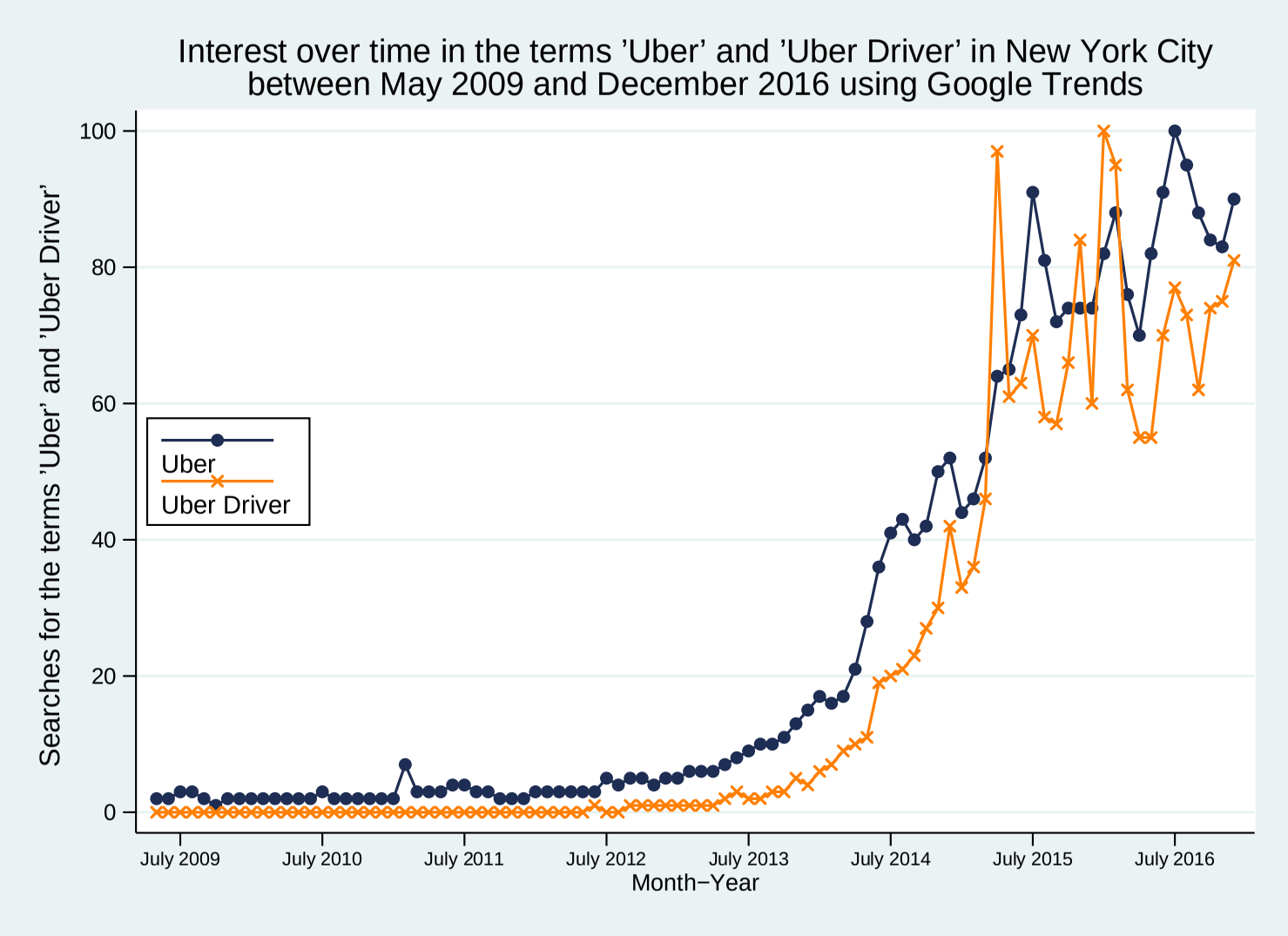
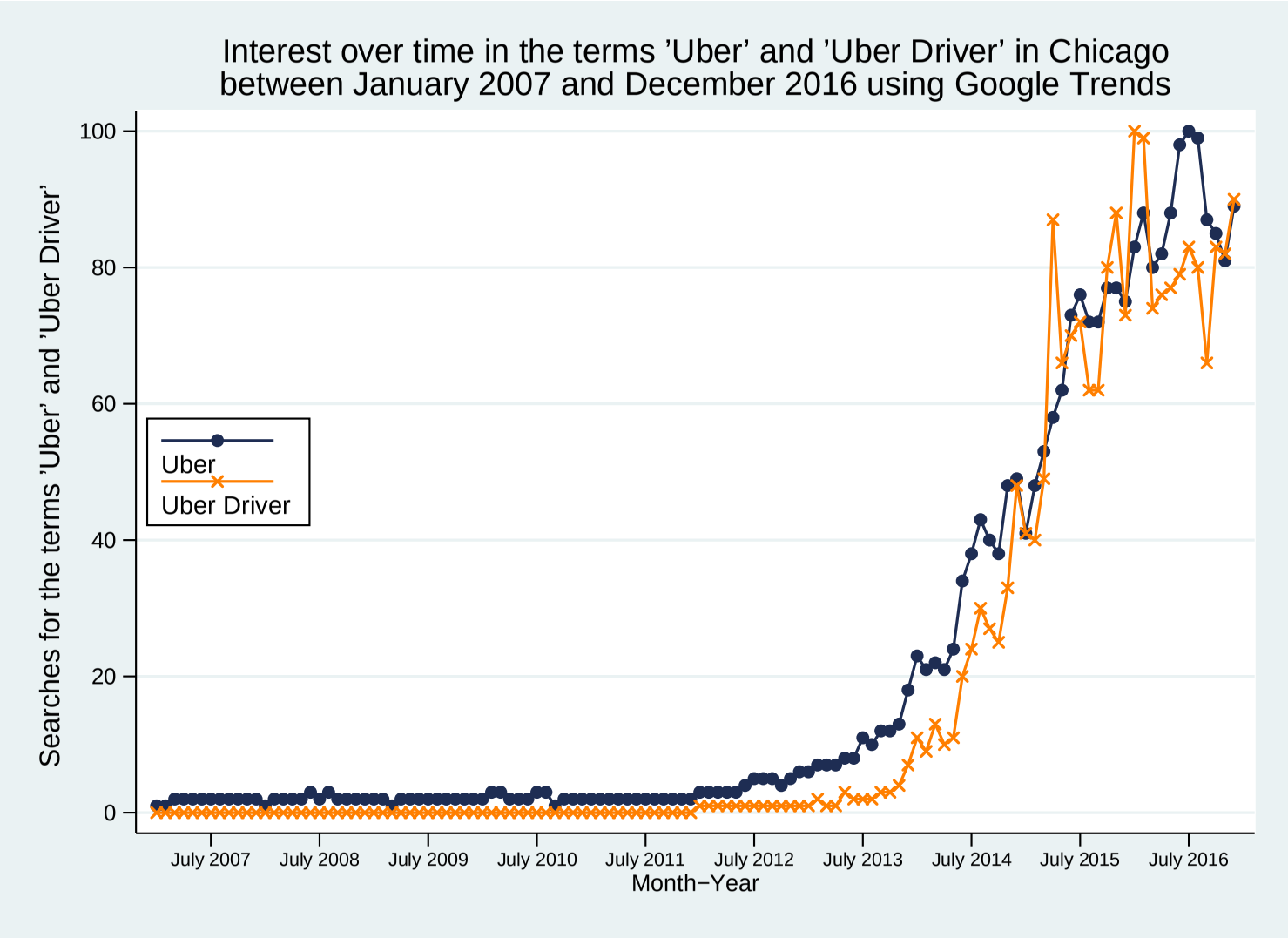


Figure 2: Interest over time in the terms "Uber" and "Uber Driver" in New York City (based on Google Trends)



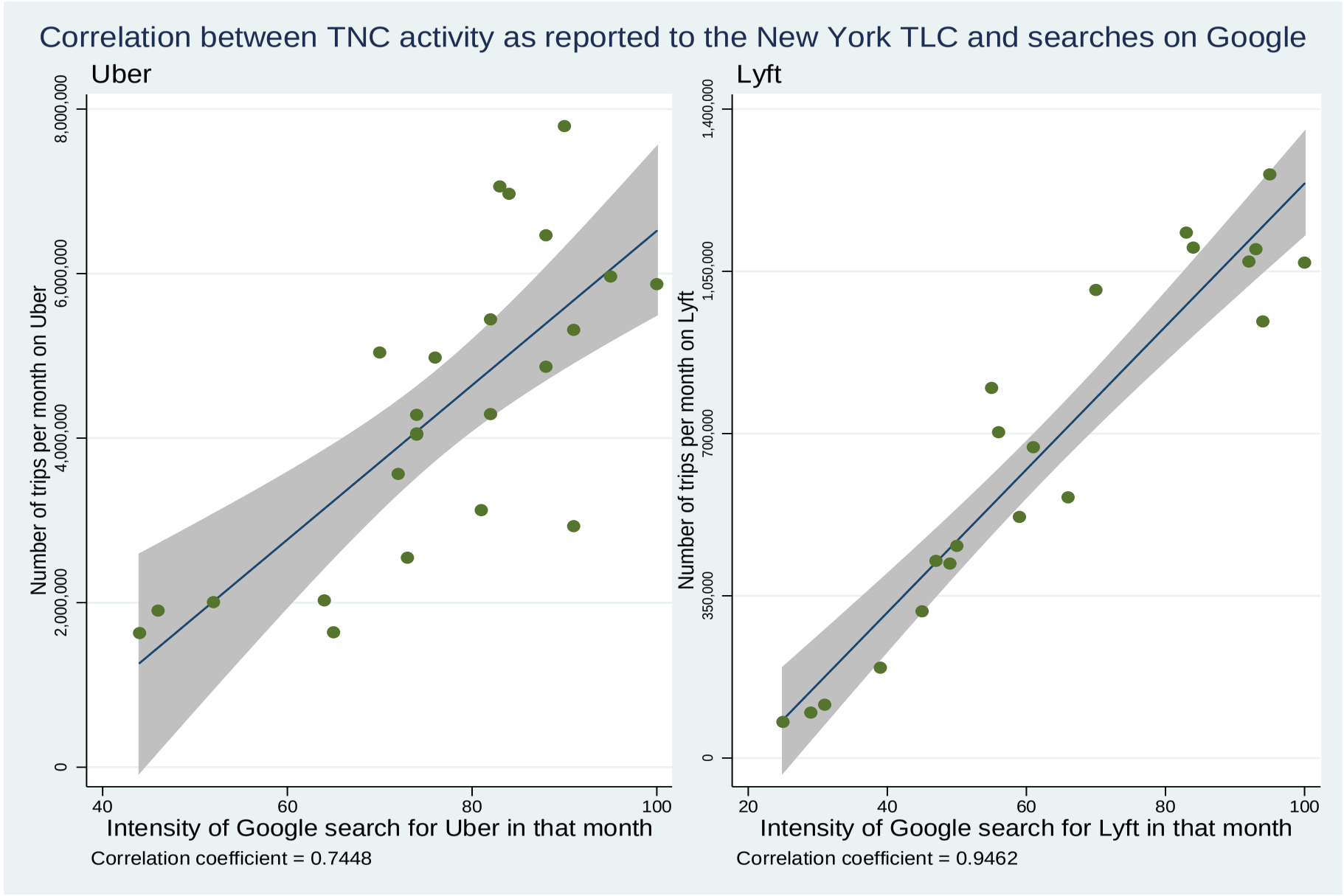
The numbers made available through Google Trends represent search interest relative to the highest point on the chart for the given region and time. A value of 100 is the peak popularity for the term. A value of 50 means that the term is half as popular. Likewise a score of 0 means the term was less than 1% as popular as the peak. The data were obtained for New York City, NY for the period between May 2009 and December 2016 to correspond with the data from the New York TLC with regard to medallion transactions.

Figure 3: Interest over time in the terms "Uber" and "Uber Driver" in Chicago (based on Google Trends)



The numbers made available through Google Trends represent search interest relative to the highest point on the chart for the given region and time. A value of 100 is the peak popularity for the term. A value of 50 means that the term is half as popular. Likewise a score of 0 means the term was less than 1% as popular as the peak. The data were obtained for Chicago, IL for the period between January 2007 and December 2016 to correspond with the data with regard to medallion transactions from The *Chicago Dispatcher* (2007-2010) and the Department of Business Affairs and Consumer Protection (2011-2016).

Figure 4: Correlation between TNC activity as reported to the New York TLC and search intensity on Google for the terms, "Uber" and "Lyft"



Data on TNC activity are drawn from monthly reports that are filed by For Hire Vehicle (FHV) firms (including Uber and Lyft) with the New York Taxi and Limousine Commission since 2015. The numbers made available through Google Trends represent search interest relative to the highest point on the chart for the given region and time. A value of 100 is the peak popularity for the term. A value of 50 means that the term is half as popular. Likewise a score of 0 means the term was less than 1% as popular as the peak. The gray shaded region indicates the 95% confidence intervals for the line of best fit.

Table 1: Summary statistics for all arms-length transactions that involve asset sales of unrestricted medallions in New York City between May 2009 - December 2016 and control variables that are included in the analysis

Year	Number of medallions	Average	Median	Minimum	Maximum
Panel A: Prices of Independent Medallions					
2009	88	$571,602	$570,000	$520,000	$600,000
2010	169	$603,360	$610,000	$465,317	$700,000
2011	186	$666,390	$670,000	$600,000	$710,000
2012	107	$713,368	$705,000	$592,357	$850,000
2013	58	$899,638	$925,000	$305,000	$1,050,000
2014	50	$948,186	$980,000	$800,000	$1,050,000
2015	16	$723,662	$715,000	$603,000	$800,000
2016	25	$556,729	$570,000	$387,718	$620,000
Overall	699	$683,309	$660,000	$305,000	$1,050,000
Panel B: Prices of Corporate Medallions					
2009	59	$754,224	$750,000	$700,000	$775,000
2010	105	$735,451	$775,000	$500,000	$850,000
2011	63	$900,083	$950,000	$650,000	$1,000,000
2012	55	$1,003,241	$1,000,000	$500,000	$1,125,000
2013	21	$1,160,500	$1,200,000	$1,000,000	$1,320,000
2014	34	$1,102,441	$1,175,000	$950,000	$1,254,000
2015	18	$852,500	$875,000	$700,000	$950,000
2016	24	$648,005	$625,000	$475,000	$750,000
Overall	379	$860,895	$800,000	$475,000	$1,320,000
Panel C: Control variables included in the analysis					
Variable	Time period	Average	Median	Minimum	Maximum
Daily farebox revenues	Jan. 2010 - Nov. 2016	$5,649,435	$5,687,581	$3,011,750	$6,744,373
Search intensity for:					
“Uber”	May 2009 - Dec. 2016	28	6	2	100
“Uber driver”	May 2009 - Dec. 2016	21	1	0	100
Interest rate	2009 - 2016	4.30	3.69	3.51	5.90
Hourly wage for taxi drivers	2009 - 2016	$15.75	$16.08	$13.16	$16.38

Notes: Data on medallion prices and farebox revenues are from the New York City Taxi and Limousine Commission; search intensity for “Uber” and “Uber driver” are from Google Trends; interest rate on medallion loans are from annual reports of Medallion Financial; and hourly wage for taxi drivers and chauffeurs are from the Occupational Employment Statistics (OES) that are collected by the BLS.

Table 2: Relationship between medallion prices in New York, taxicab usage, proxies for the adoption of Uber, interest rate, and average hourly wage between January 2010 - December 2016, with data aggregated at the monthly level

	(1)	(2)	(3)	(4)
	D.v.: Average price		D.v.: Log average price	
	Panel A: Independent Medallions			
Fares collected per day	21.48*	21.71**	29.83**	31.56**
	(1.96)	(2.20)	(2.04)	(2.40)
Searches for "Uber"	-35.64***		-48.10***	
	(-6.78)		(-6.78)	
Searches for "Uber driver"		-40.63***		-54.15***
		(-7.31)		(-7.12)
Interest rate	-25.96***	-24.86***	-33.43***	-31.68***
	(-6.43)	(-6.86)	(-6.46)	(-6.91)
Hourly wage for taxi drivers	-14.11***	-13.88***	-17.10***	-16.68***
	(-4.29)	(-4.51)	(-3.96)	(-4.13)
Constant	4.042***	3.940***	17.57***	17.40***
	(7.33)	(7.76)	(25.2)	(27.3)
N	74	74	74	74
R^2	0.78	0.80	0.78	0.80
	Panel B: Corporate Medallions			
Fares collected per day	42.00	42.19*	49.68	50.22*
	(1.63)	(1.68)	(1.67)	(1.72)
Searches for "Uber"	-51.09***		-57.08***	
	(-4.70)		(-3.90)	
Searches for "Uber driver"		-57.81***		-64.42***
		(-4.47)		(-3.64)
Interest rate	-24.13***	-22.66***	-25.15***	-23.44***
	(-3.73)	(-3.87)	(-3.41)	(-3.48)
Hourly wage for taxi drivers	-7.591	-7.222	-7.675	-7.230
	(-1.33)	(-1.33)	(-1.09)	(-1.07)
Constant	3.041***	2.894***	15.86***	15.68***
	(2.96)	(2.90)	(12.9)	(12.8)
N	53	53	53	53
R^2	0.64	0.67	0.57	0.59

Newey-West robust t statistics in parentheses; * p<0.10 ** p<0.05 *** p<0.01. Lag length = 3 months for both panels A and B.
Notes: Transaction data on medallions are available for the period May 2009-December 2016 from the New York TLC. The average price was computed across all arms-length transactions taking place during the course of a month. In columns (1) and (2) the dependent variable is the absolute purchase price (in dollars) at which a medallion is traded while columns (3) and (4) use the log of purchase price. For ease of presentation, the RHS variables were rescaled as follows: fares collected per day were divided by 1,000; the intensity of Google searches multiplied by 100; the interest rate multiplied by 10,000; the hourly wage multiplied by 10,000; and the constant multiplied by 1,000,000. In addition, the coefficients in columns (3) and (4) were rescaled by multiplying those with 1,000,000. The number of observations for "Independent medallions" is 74 because no arms-length transactions take place in 9 months between January 2010-November 2016, the period for which farebox numbers are available from the New York TLC. No arms-length transactions occur in 30 months in the market for "Corporate Medallions", which explains the number of observations for corporate medallions.

Table 3: Summary statistics for all arms-length transactions involving medallions in Chicago between January 2007 - December 2016 and control variables included in the analysis

Panel A: Prices of Medallions					
Year	Number of transactions	Average	Median	Minimum	Maximum
2007	605	$78,140	$78,000	$30,700	$126,750
2008	469	$127,785	$126,000	$68,000	$161,500
2009	479	$171,113	$173,000	$90,000	$202,000
2010	354	$182,016	$183,000	$150,000	$205,000
2011	372	$224,868	$235,000	$125,000	$326,000
2012	507	$337,210	$347,000	$145,000	$390,000
2013	361	$350,962	$357,000	$295,000	$370,000
2014	89	$330,581	$325,000	$250,000	$375,000
2015	12	$243,083	$252,000	$150,000	$290,000
2016	30	$61,717	$60,000	$38,500	$95,500
Overall	3,278	$204,121	$181,500	$30,700	$390,000
Panel B: Control variables included in the analysis					
Variable	Time period	Average	Median	Minimum	Maximum
Daily farebox revenues	Jan. 2013 - Jun. 2016	$995,789	$1,010,801	$609,827	$1,243,271
Search intensity for:					
“Uber”	Jan. 2007 - Dec. 2016	21	3	1	100
“Uber driver”	Jan. 2007 - Dec. 2016	17	0.5	0	100
“Lyft”	Jan. 2007 - Dec. 2016	16	0	0	100
“Lyft driver”	Jan. 2007 - Dec. 2016	13	0	0	100
Interest rate	2007 - 2016	5.99	5.95	4.63	7.31
Hourly wage for taxi drivers	2007 - 2016	$12.71	$12.54	$11.74	$13.91

Notes: Data on medallion prices for 2007-2010 are from The *Chicago Dispatcher* webpage, http://chicagodispatcher.com/chicago-taxicab-medallion-prices-p235-117.htm, while data from 2011-2016 and farebox revenues are from the Department of Business Affairs and Consumer Protection webpage: https://www.cityofchicago.org/city/en/depts/bacp/supp_info/medallion_owner_information.html. Search intensity for “Uber”, “Uber driver”, “Lyft”, and “Lyft driver” are from Google Trends; interest rate on medallion loans are from annual reports of Medallion Financial; and hourly wage for taxi drivers and chauffeurs are from the Occupational Employment Statistics (OES) that are collected by the BLS.

Table 4: Relationship between medallion prices in Chicago, taxicab usage, proxies for the adoption of Uber and Lyft interest rate, and average hourly wage between January 2007 and December 2016, with data aggregated at the monthly level

	(1)	(2)	(3)	(4)
	D.v.: Average price		D.v.: Log average price	
	Panel A: Including search intensity for the terms, "Uber" and "Uber driver"			
Searches for "Uber"	-41.36***		-237.5***	
	(-16.7)		(-11.0)	
Searches for "Uber driver"		-40.49***		-230.4***
		(-9.03)		(-6.64)
Interest rate	-12.73***	-11.60***	-64.46***	-57.63***
	(-14.9)	(-13.5)	(-9.22)	(-8.36)
Hourly wage for taxi drivers	-0.920	-0.203	-1.919	2.129
	(-1.05)	(-0.21)	(-0.29)	(0.30)
Constant	1.170***	0.991***	16.67***	15.62***
	(11.9)	(10.4)	(21.6)	(22.0)
N	107	107	107	107
R^2	0.88	0.85	0.76	0.72
	Panel B: Including search intensity for the terms, "Lyft" and "Lyft driver"			
Searches for "Lyft"	-45.77***		-269.1***	
	(-14.3)		(-14.3)	
Searches for "Lyft driver"		-46.35***		-271.8***
		(-10.8)		(-10.2)
Interest rate	-12.30***	-11.45***	-63.02***	-57.89***
	(-14.5)	(-12.5)	(-9.15)	(-8.45)
Hourly wage for taxi drivers	-0.740	-0.519	-0.783	0.505
	(-0.92)	(-0.56)	(-0.13)	(0.074)
Constant	1.109***	1.021***	16.37***	15.85***
	(13.4)	(11.5)	(26.6)	(22.9)
N	107	107	107	107
R^2	0.87	0.82	0.78	0.73

Newey-West robust t statistics in parentheses; * p<0.10 ** p<0.05 *** p<0.01. Lag length = 4 months for both panels A and B.
Notes: Transaction data on medallions are available for the period from January 2007 to December 2010 from a trade magazine, The *Chicago Dispatcher,* and for the period from January 2011 to December 2016 from the Department of Business Affairs and Consumer Protection of the city of Chicago. The average price was computed across all arms-length transactions taking place during the course of a month. In columns (1) and (2) the dependent variable is the absolute purchase price (in dollars) at which a medallion is traded while columns (3) and (4) use the log of purchase price. For ease of presentation, the RHS variables were rescaled as follows: the intensity of Google searches is multiplied by 100; the interest rate is multiplied by 10,000; the hourly wage is multiplied by 10,000; and the constant is multiplied by 1,000,000. In addition, the coefficients in columns (3) and (4) were rescaled by multiplying them by 1,000,000. The number of observations is 107 because no arms-length transactions take place in 13 months between January 2007-December 2016: the period for which medallion prices are available.

Table 5: Relationship between TNC activity in New York and search intensity for Uber and Lyft for the period January 2015 - December 2016, with data aggregated at the monthly level

	(1)	(2)	(3)	(4)
Panel A: D.v.: Log of dispatched trips per month on respective service				
Searches for "Uber"	0.0264***			
	(7.76)			
Searches for "Uber driver"		0.0119**		
		(2.09)		
Searches for "Lyft"			0.0323***	
			(5.24)	
Searches for "Lyft driver"				0.0267***
				(3.88)
Constant	13.16***	14.38***	11.12***	11.65***
	(51.8)	(36.4)	(23.8)	(21.4)
N	24	24	21	21
R^2	0.63	0.18	0.80	0.63
Panel B: D.v.: Log of unique dispatched vehicles per month on respective service				
Searches for "Uber"	0.0249***			
	(7.89)			
Searches for "Uber driver"		0.0120**		
		(2.11)		
Searches for "Lyft"			0.0241***	
			(6.49)	
Searches for "Lyft driver"				0.0202***
				(4.60)
Constant	8.153***	9.257***	7.266***	7.647***
	(36.4)	(23.4)	(26.6)	(22.0)
N	24	24	21	21
R^2	0.73	0.23	0.85	0.68

Newey-West robust t statistics in parentheses; * p<0.10 ** p<0.05 *** p<0.01. Lag length = 3 months for both panels A and B.

Notes: Data on Google searches for the terms "Uber", "Uber driver", "Lyft", and "Lyft driver" are available on a monthly basis from 2004 onward from Google Trends. Data on number of trips taken each week and number of unique vehicles dispatched each week for each FHV base are based on monthly reports that are filed by FHV firms (including Uber and Lyft) with the New York TLC from January 2015 onward. Although Lyft entered the New York market in 2014, no trips were reported for the first three months of 2015 which explains the number of observations for Lyft.

Table A.1: Relationship between medallion prices in New York, taxicab usage, proxies for the adoption of Lyft, interest rate, and average hourly wage between January 2010 - December 2016, with data aggregated at the monthly level

	(1)	(2)	(3)	(4)
	D.v.: Average price		D.v.: Log average price	
	Panel A: Independent Medallions			
Fares collected per day	33.57**	59.34**	42.05**	76.95**
	(2.20)	(2.20)	(2.29)	(2.24)
Searches for "Lyft"	-32.11***		-45.13***	
	(-5.98)		(-6.38)	
Searches for "Lyft driver"		-23.41**		-33.54**
		(-2.49)		(-2.65)
Interest rate	-20.07***	-16.63***	-26.11***	-21.50***
	(-6.31)	(-4.53)	(-6.83)	(-4.84)
Hourly wage for taxi drivers	-10.08***	-9.323***	-11.82***	-10.82***
	(-3.53)	(-3.19)	(-3.32)	(-3.00)
Constant	3.047***	2.619***	16.31***	15.73***
	(5.09)	(3.98)	(22.2)	(19.7)
N	74	74	74	74
R^2	0.70	0.61	0.72	0.62
	Panel B: Corporate Medallions			
Fares collected per day	50.20*	86.62*	51.38*	91.83*
	(1.80)	(1.95)	(1.73)	(1.96)
Searches for "Lyft"	-46.77***		-55.77***	
	(-4.76)		(-4.19)	
Searches for "Lyft driver"		-31.59*		-39.16*
		(-1.97)		(-2.01)
Interest rate	-17.96***	-11.80**	-19.60***	-12.81**
	(-3.71)	(-2.25)	(-3.66)	(-2.34)
Hourly wage for taxi drivers	-3.305	-0.772	-3.393	-0.574
	(-0.65)	(-0.15)	(-0.54)	(-0.094)
Constant	2.009**	1.111	14.89***	13.90***
	(2.07)	(1.06)	(13.0)	(11.9)
N	53	53	53	53
R^2	0.61	0.53	0.56	0.49

Newey-West robust t statistics in parentheses; * p<0.10 ** p<0.05 *** p<0.01. Lag length = 3 months for both panels A and B.
Notes: Transaction data on medallions are available for the period May 2009-December 2016 from the New York TLC. The average price was computed across all arms-length transactions that occurred during the course of a month. In columns (1) and (2) the dependent variable is the absolute purchase price (in dollars) at which a medallion is traded, while columns (3) and (4) use the log of purchase price. For ease of presentation, the RHS variables were rescaled as follows: Fares collected per day were divided by 1,000; the intensity of Google searches is multiplied by 100; the interest rate is multiplied by 10,000; the hourly wage is multiplied by 10,000; and the constant is multiplied by 1,000,000. In addition, the coefficients in columns (3) and (4) are rescaled by multiplying those with 1,000,000. The number of observations for "Independent medallions" is 74 because no arms-length transactions took place in 9 months between January 2010-November 2016, the period for which farebox numbers are available from the New York TLC. No arms-length transactions occurred in 30 months in the market for "Corporate Medallions", which explains the number of observations for corporate medallions.