An Analysis of the Individual Economics of Ride-Hailing: Passenger Costs & Driver Earnings

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Abstract

Ride-hailing companies are disrupting transportation at a large scale while also providing economic opportunities to millions of drivers. Companies such as Uber and Lyft constantly promote potential earnings on the order of $25 – $35 per hour. Yet, the advertised earnings do not account for factors such as time spent without passengers, the need to travel back-and-forth between areas of low and high ridership, driver residential location, or driving expenses. By examining a unique and detailed dataset collected using ethnographic methods – primary data collected by one of the authors who became an independent contractor to drive for both Uber and Lyft in the Denver area – we examine actual earnings and expense scenarios to answer the question of how much ride-hailing drivers actually earn.

This study first assesses the cost per mile to passengers – including fare, fees, tolls, and gratuity – and finds that the result follows a power law function (in relationship to trip distance) with a median cost of $2.50 per mile (not including value of time). We then assess driver earnings and estimate gross wages averaging $15.57 per hour. Given three common expense scenarios, we estimate net hourly wages ranging between $5.72 and $10.46 per hour before taxes. This suggests that most drivers in Colorado earn less than the state minimum wage during data collection ($10.20 per hour) and more would earn less than the new state minimum wage ($11.10 per hour). We also identify cruising and deadheading as a negative externality of ride-hailing and suggest per-mile ride-hailing fees, which start at zero passengers and provide discounts based on increasing vehicle occupancy, to help mitigate this issue. While our data collection focused on the Denver region, ride-hailing rates and cost of living adjustments to specific cities can be used for comparison, providing insight into the individual economics of ride-hailing.

Keywords

TNCs; Ride-hailing; Ridesourcing; Uber; Lyft; Sharing Economy; Minimum Wage

1. Introduction

Ride-hailing – as the service provided by Transportation Network Companies (TNCs) – has been called an economists' dream (Levitt, 2016), as it tests some of the most basic economic theories of demand (i.e. passengers) and supply (i.e. drivers). On the passenger side, ride-hailing offers a convenient, technology-based mobility option. Riders do not need to own a car, worry about parking, or even know how to drive. This can save time and effort, all in a mode that is similar but typically less expensive than traditional taxis. On the driver's side, ride-haling provides a convenient way to make money. With promises of high wages and flexible hours (see Figure 1), the growth of the industry is not surprising. Ride-hailing growth has also not shown any signs of plateauing with both drivers and passengers constantly signing-up and using these services on a regular basis. While mode share numbers for ride-hailing in the U.S. might seem small compared to the overall vehicles miles traveled (Conway et al., 2018; U.S. Department of Transportation, 2017), the percentage reaches double digits in urban areas with high density (Castiglione et al., 2017) and at airports (Henao et al., 2018; Uber I.P.O. Form S-1, 2019).

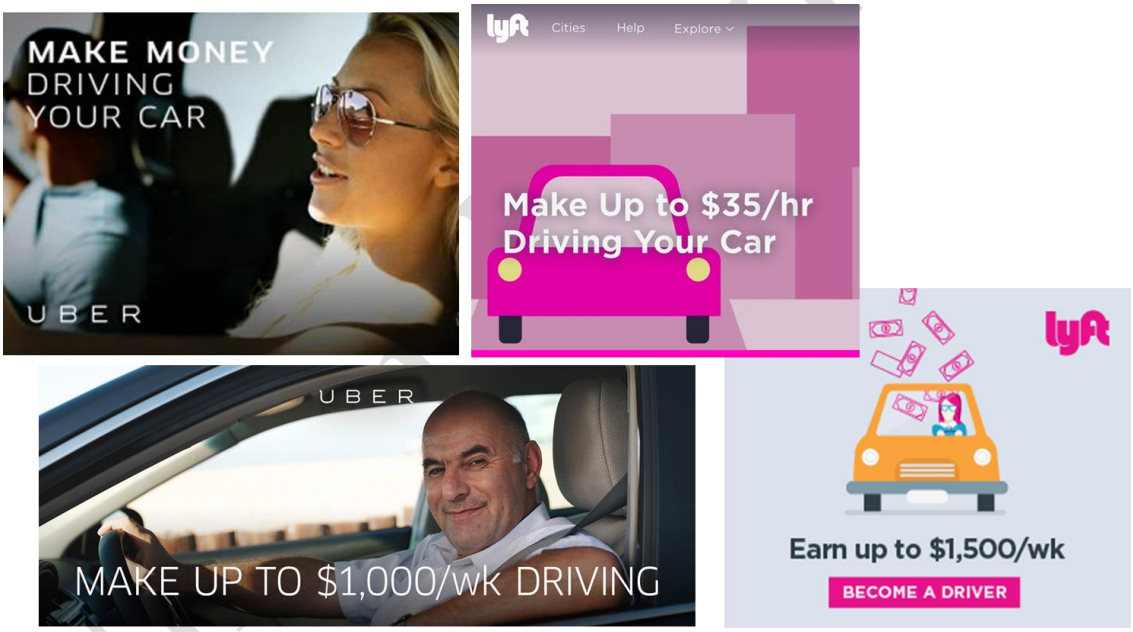


Figure 1 – Lyft and Uber Driver Advertisements

Academic studies on ride-hailing continues to grow covering several themes such as congestion (Erhardt et al., 2019; Tirachini and Gomez-Lobo, 2019), user characteristics, mode replacement and travel behavior (Alemi et al., 2018; Clewlow and Mishra, 2017; Gehrke et al., 2019; Young and Farber, 2019), impacts on public transportation (Hall et al., 2018; Schwieterman, 2019), and energy use impacts (Sui et al., 2019; Wenzel et al., 2019). More related to the focus of this paper, an analysis on 40 Uber drivers in the Washington, DC, area shows that Uber drivers do not know how much they actually make and that they experience financial risk and debt. Yet

despite such challenges, the Uber workplace remained attractive (Wells et al., 2019). There is also growing research on legal issues of ride-hailing including labor and antitrust law, since TNCs are fighting in court not to allow drivers to be classified as employers and for the companies to continue treating drivers as independent contractors. Yet, there is labor rights for independent contractors and setting price for their services (price-fixing paradox) is illegal (Paul, 2017; Steinbaum, 2019).

Lyft started trading on the stock market on March 28, 2019, while Uber went public on May 10, 2019. As of end of May 15, 2019, trading, Lyft market cap was $15.4B while Uber was $69.2B With such valuations, one might assume that these companies are highly profitable with millions of drivers making great incomes – or at least a decent living wage – but both profitability and driver earnings remain questionable. Uber and Lyft need to constantly recruit drivers to keep up with growing passenger demand and the inability to retain drivers. A study co-authored by an Uber employee and an Uber consultant using Uber data found that only half of its Uber-driver partners stay active after a year (Hall and Krueger, 2015), and a report from SherpaShare – an app platform for ride-hailing drivers – surveyed 963 drivers and found that the turnover rates for Uber and Lyft was notably high, with about only 35% of drivers remaining active for more than 6 months, and only 20% of drivers for more than 12 months (SherpaShare, 2015). Another study co-authored by Uber economists with access to Uber data for 1.87 million drivers shows that the 6-month retention rate for Uber drivers is 31.9% (Cook et al., 2018), which is similar to the SherpaShare report.

While there are different motivations for drivers to sign-up for ride-hailing, the main motivation is income (Hall and Krueger, 2015; SherpaShare, 2015). When it comes to Uber and Lyft, driver income has become a hot topic. For instance, a 2013 Wall Street Journal article stated that a typical Uber driver takes in more than $100,000 a year in gross sales (MacMillan, 2013). After this estimate was questioned, TNCs changed this income characterization to around $25 - $35 per hour. The previously referenced study by Hall and Krueger (2015) shows that in 2014, Uber drivers grossed approximately $17.40 an hour across 20 of the highly-population, early adopter cities. The other previous referenced study – co-authored by Uber economists and focusing on the gender wage gap – provided overall estimated gross hourly earnings of $15.80 (although the study misleads readers by stating $21.07 per hour while neglecting the ~25% service fee that Uber charges its drivers) for 1.87 million Uber drivers across 196 cities (Cook et al., 2018). An issue with the studies using Uber data is that the ride-hailing wage rates only includes the times when the Uber app is turned on or when the drivers are “active” for a specific time (Chen et al., 2017); thus, it ignores times when drivers are traveling at the beginning/end of shift, it ignores driving to reposition aiming for high demand (including with the app-off), and/or times when passenger requests are very low for an extended period. As a comparison, SherpaShare survey respondents working 21 to 25 hours a week collected, on average, $1,376 per month before expenses for an equivalent rate of ~$15 per hour (SherpaShare, 2015). Another survey of around 1,000 drivers from a blog called the “Rideshare Guy 2017 report” estimates hourly earnings of

$15.68 (Campbell, 2017). Early in 2018, there was a controversy over an MIT working paper entitled "The Economics of Ride-Hailing" where researchers used ride-hailing driver survey responses acquired via the "RideShare Guy blog" to estimate median net earnings of $3.37 per hour (Zoepf et al., 2018). Uber's chief economist criticized the report (Hall, 2018), and it eventually garnered a response from Uber CEO, Dara Khosrowshashi, who tweeted: "MIT = Mathematically Incompetent Theories". The main author of the report admitted fault and revised their estimations, finding the median profit to be on the order of $8.55/hour and $10/hour (Zoepf, 2018). On May 8, 2019, ride-hailing drivers organized a global strike protesting Uber and Lyft employment and pay practices (Conger et al., 2019). These examples show the delicacy and importance of this topic.

This paper seeks to investigate the individual economics of ride-hailing by assessing the monetary cost per mile for passengers and the monetary earnings per hour for drivers. Understanding actual costs per mile for passengers would help with transportation demand models by providing inputs, calibrating these models, and forecasting future demand. It will also help to understand future projections on car ownership and cost per mile of future autonomous vehicles, which are currently forecasted from $0.15 to $1.00 per mile ((Bösch et al., 2018). This study also seeks to provide clarity and answer the question of how much ride-hailing passengers pay per mile as well as how much drivers earn per hour, with a detailed breakdown of gross earnings, expenses, and net earnings by using primary data collected by one of the authors as an Uber and Lyft independent contractor. The next sections detail our dataset and methods before we present results and discuss the topic in more detail with recommendations and policy suggestions.

2. Data

Realizing the difficulty in obtaining data directly from TNCs, one of the authors signed up to drive for Uber and Lyft and conducted an ethnographic experiment that provided access to exclusive data and real-time passenger feedback. We submitted a research proposal to the Colorado Multiple Institutional Review Board (COMIRB) and obtained IRB approval in spring 2016 (COMIRB Protocol 16-0773, Exception APP001-3). Extensive work was performed prior, during, and after data collection to record and validate detailed information on ride-hailing. For example, the Uber and Lyft driver apps contain information on each ride, reporting pick-up and drop-off locations and time (HH:MM), ride mileage distance, ride duration time, and earnings. We also collected GPS locations, times, and distances using two additional apps (Google Maps and MyTracks) to validate TNC information. Through this process, we found a few errors on the TNC apps (mostly due to connectivity) where passenger fare and driver pay were miscalculated; these errors were confirmed by the companies after we reported our findings. More details on the data collection, including the survey instrument and a detailed methodology, can be found in previous publications (Henao, 2017; Henao and Marshall, 2018).

The Denver metropolitan region includes a variety of contexts, covering both urban and suburban areas. Our sample is random by design since the driver-author did not know who the passenger was or where each ride would end up. This led to providing transportation to passengers across a wide variety of socio-economic and socio-demographic levels (e.g. age, gender, race/ethnicity, income) and driving all over the study area. The only location that we had control over is where the app was turned on at the beginning of the shift. Thus, we varied the starting location from urban to suburban areas across the metropolitan region. Driving shifts ranged from as low as two hours to as high as nine hours. All seven days and all times were covered during the study period, but a higher number of rides were during high demand times –such as Friday and Saturday nights– representing typical ride-hailing services. Driving for both Uber and Lyft helped minimize the waiting times and cruising distances since the chances of getting a request from either service increased (it is also common that ride-hailing drivers work for both Uber and Lyft). For example, there were occasions where new requests came in even before finishing parking. We decided to conduct all the data collection by the driver-author to eliminate bias between drivers, to control travel without a passenger (i.e. deadheading minimization), to reduce surveyor errors, and to ensure data quality.

The final sample includes 416 rides (Lyft, UberX, LyftLine, and UberPool) from 69 shifts with unique and detailed information on how much passengers paid (including fare, tolls & fees, and tips) and driver earning (including mileage, times, surcharge, tolls, fees, and gratuity). Figure 2 presents the cumulative distribution based on distance for all rides in our sample data and what the Uber I.P.O. S-1 document says is representative of ride-hailing in the U.S. (Uber I.P.O. Form S-1, 2019)

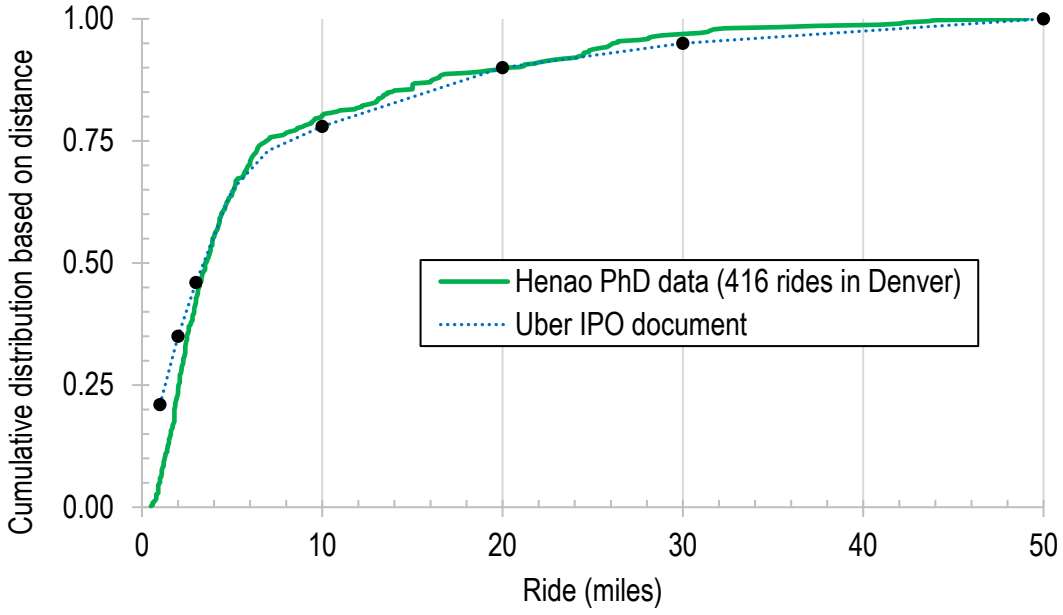


Figure 2 – Cumulative distribution (based on distance)

From the total paid by passengers, a percentage goes to the driver and most of the remaining goes to the TNC. The amount that Lyft and Uber pay their drivers is mostly based on the percentage offered at the time of signing the contract. While the percentage rate for this study is 80% to the driver (20% commission to the TNC), most recent drivers have a 75% rate (25% commission to the TNC). Uber increased its service fee from 20% to 25% in September 2015; however, drivers who joined before then were grandfathered in (Cook et al., 2018). This percentage rate is only applicable to the passenger fare (base, per minute, per mile, surcharge) since drivers do not receive any commission from the TNC fee, toll roads, and/or other fees. In times of high demand, ride-hailing companies use surge pricing (Uber) or Prime Time (Lyft) to entice more drivers onto the road and help ensure that the supply can meet demand. We encountered surge multipliers in 7.2% of our rides, and they ranged from 1.25 to 2.0 times the regular rate. Some routes (such as toll roads) or destinations (such as airports) also incur an additional fee. For example, the pick-up or drop-off fee at Denver International Airport is $2.15. The driver offered passengers to take the toll road with the mutual understanding that the customer pays the fee, which only occurred in a handful of rides. TNCs also offer driver incentives (e.g. guarantee bonus per hour) to work at certain times for a minimum number of rides or a minimum acceptance rate. Monetary incentives offered to the driver-author are reflected in this study.

After each ride ended, passengers had the option to provide a voluntary tip (all of which would go to the driver). At the time of our data collection, riders could tip in the Lyft app, but Uber did not provide that option until July 2017 (some Uber passengers tipped in cash). Thus, our Uber data underrepresents tips that a driver might currently earn (although it is worth pointing out that our driver's commission is 5% higher than most current drivers). Our overall dataset shows that 7.8% of driver earnings come from tips, but the subset for Lyft tips shows that it accounts for 11.8%.

Percentage distribution of payment is presented in Figure 3 with allocations to the driver (before tip), tip, and TNC/Toll/Fees. Gross revenues are usually calculated as the total income per number of working hours (Uber estimates based on when the app is on). Net income would include the cost incurred in driver expenses. All monetary values are in 2016 pre-tax U.S. dollars.

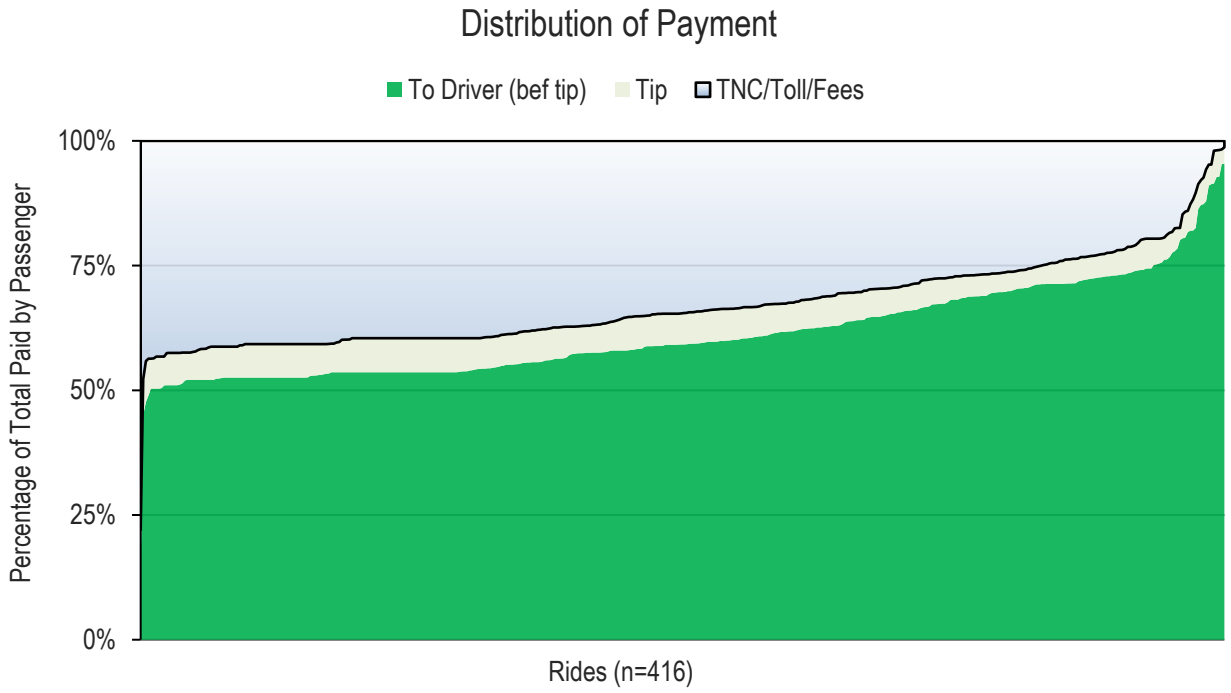


Figure 3 – Distribution of TNC Payments from Passengers

3. Methods

3.1. Driver Gross Earnings per Hour

As previously discussed, several factors affect driver earnings. Thus, the variation in our detailed dataset provides us the opportunity to estimate 416 different hourly wages. The time used to estimate wages is based on working time with passengers and without passengers – including cruising, over-heading (time from dispatch to pick-up), waiting, and traveling at the beginning/end of shift, as presented in Figure 4. Our study does not include the time spent traveling at the beginning of each shift since we designed the ethnographic research to vary the starting location (and time) among different geographical typologies on the metropolitan area (e.g., suburbs, central business district, college campus, etc.). The travel at end of shift (time and distance) was distributed randomly using mean and standard deviation after distributing the 69 shifts among the number of rides per shift. For each ride (either from Uber or Lyft), we know the total monetary value corresponding to the driver (including tips) as well as the time in minutes from end-of-previous ride to end-of-assigned ride (i.e., cruising + over-heading + waiting at pick-up + ride + fraction of travel at end of shift).

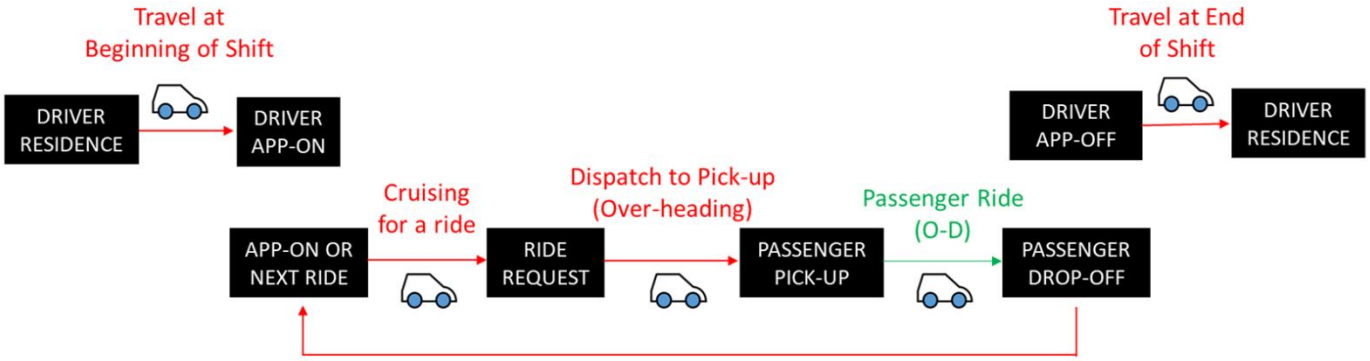
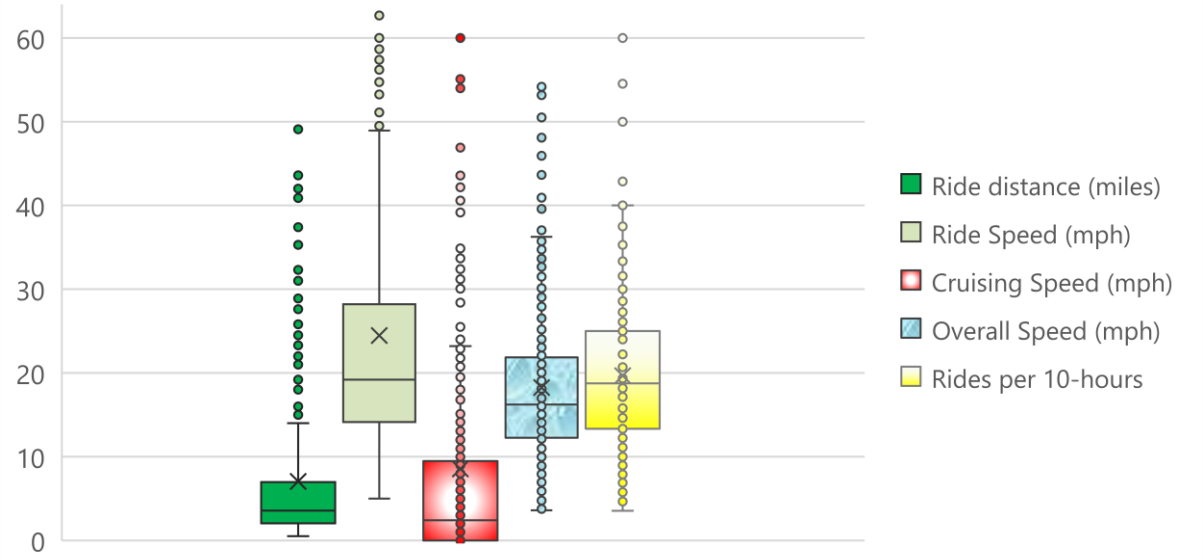


Figure 4 – Distribution of TNC Payment from Passengers

The variation in times, locations, and driving strategies between deadheading minimization, driving to strategic locations for high demand, and circulating around until getting an app request simulates different ride-hailing drivers in the network (Henao and Marshall, 2018). Table 1 presents statistics on ride distance, average speeds for actual rides, average speeds for in-between rides (cruising), average overall speed (all segments), and rides per hour.

Table 1 – Distance, Speeds and rides per hour (n=416)

	Ride distance (miles)	Ride Speed (mph)	Cruising Speed (mph)	Overall Speed (mph)	Rides per hour
Mean	7.04	24.47	8.54	18.25	1.97
s.d	8.60	21.52	14.57	8.82	0.86
Median	3.55	19.20	2.40	16.22	1.88



3.2. Driver Expenses and Net Earnings per Hour

Several factors affect driver expenses, including ownership or lease cost (e.g. finance, depreciation, license, insurance, registration, taxes) and operating costs (e.g. gas, maintenance, miscellaneous upkeep such as car washes and cleaning, mobile device and data fees, parking and traffic violations, risk of crash or injury). Expenses also depend on car value, driving mileage, and whether you own a car already and/or have already paid off some of these expenses. To account for the broad range of possibilities, we characterize three different expense scenarios (Table 2) covering different types of drivers, from occasionally part-time drivers to full-time drivers. In the basic added cost scenario, we assume a range of driving hours of 1-15 hours/week and around 11,000 miles per year. The next scenario included most of the drivers with 16-49 hours/week and around 33,000 miles per year, and the last scenario is based on the U.S. Federal Standard Mileage Rate.

The first cost scenario assumes that a driver already owns a car and has paid off basic ownership expenditures. Thus, we assumed most ownership costs are a sunk cost that drivers pay regardless of whether a person drives for ride-hailing or not; in other words, they are not considered an additional expense[1]. This scenario also includes conservative values for depreciation, maintenance, and other miscellaneous expenses. The cost expense for this scenario is $0.28 per mile.

The next scenario represents ride-hailing drivers working longer hours and driving more miles than the first scenario, and includes costs associated with owning a car and increasing other values according to the mileage per year. We used assumptions based on the American Automobile Association rates (AAA, 2015) and other sources but still trend toward the conservative end of the expense spectrum. In this scenario, expenses equal to $0.40 per mile.

In the third scenario, we used the 2016 U.S. standard mileage rate determined by Internal Revenue Service of $0.54 cents per mile, which is based on an annual study of all the fixed and variable costs of owning and operating a car (including vehicle depreciation).

[1] Most insurance companies require that ride-hailing drivers upgrade their insurance policy, and our driver did so. However, the popular press suggests that many drivers do not and put themselves at risk should an incident occur.

Table 2 – Ride-hailing Expenses

Item	Basic Added Cost 1-15hr/week, ~11k miles/year	Most Drivers 16-49hr/week, ~33K miles/year	U.S. Federal Standard Mileage Rate (2016)
Ownership			
Depreciation	$1,320.00	$3,960.00	
Finance Charge	-	$500.00	
License, Registration & Tax	-	$350.00	
Insurance	-	$1,500.00	
Operating			
Gas	$1,015.38	$3,046.15	
Maintenance	$589.60	$1,768.80	
Miscellaneous	$150.00	$2,000.00	
Total	$3,074.98	$13,124.95	
$/mile	$0.28	$0.40	0.54*

We then applied these rates to each of the 416 scenarios to discount driver expenses based on driving mileage (with and without passengers) in order to estimate net hourly wages. Driving expenses without a passenger is as important as mileage with passengers, since for every 100 miles carrying passengers, Uber and Lyft drivers in Denver travel an additional 69 miles without a passenger (Henao and Marshall, 2018). Drivers can discount driving expenses, but they still need to pay income taxes. Since income tax depends upon the driver's individual circumstances, we treat all earnings as pre-tax income.

4. Results

4.1. Passenger Costs per Mile

The rates that passengers pay for Lyft and Uber fluctuate based on city and market, but traditionally, they have been consistent over time. Table 3 presents the Lyft and UberX rates applicable to this study (Denver in 2016). As a price comparison, the website http://uberestimate.com provides Uber rates in different cities.

Table 3 – Uber and Lyft Cost to Passengers (Denver, 2016)

	TNC fee	Base fare	Cost per minute fare	Cost per mile fare	Minimum paid by passenger	Gratuity	Other
Lyft	$2.10	$0.50	$0.12	$1.01	$7.10	yes	surcharge, toll road, airport fee
UberX	$1.95	$0.75	$0.13	$1.00	$6.95	not in app	

Figure 5 presents the total passenger costs per mile (after accounting for all fares and fees) for all rides in our sample data The cost per mile for trips under 7-miles follows a power function ($y = 6.96x^{-0.79}$) with a cost of $6.9 per mile for a 1-mile trip, and ~$1.95/mile for a 5-mile trip. Cost for rides 7 miles or longer are estimated to be $1.50/mile. The median distance is 3.55 miles and median cost is $2.50/mile (mean statistics are: 7.04 miles and $3.19/mile). A clear distinction from previous assumptions in travel demand models is that the cost per mile for passenger varies based upon the trip distance (for 7 miles or less) given the set cost of specific fares/fees.

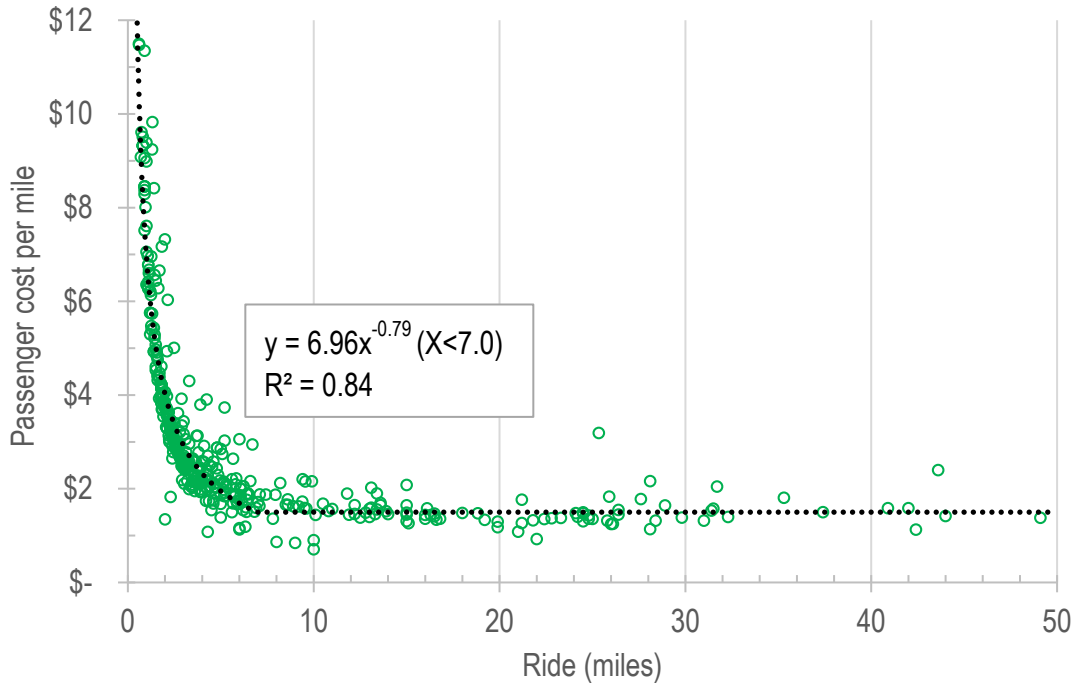


Figure 5 – TNC Passenger Cost per mile

4.2. Driver Gross Earnings per Hour

In terms of driver gross earnings, we first compare gross earnings for "time spent working" versus overall "time spent driving". In other words, the green line in Figure 6 represents the distribution of hourly wages based on gross earnings (including tips) based on time spent driving both with and without passengers. Since the location of the last passenger drop-off is unknown, we included the end of shift travel time in this calculation. An extreme example of this is the story of an Uber driver that drove an NFL player from Chicago, IL, to Buffalo, NY (Mays, 2017). After dropping the player off at training camp, the Uber driver had to drive 540 miles back to Chicago. While this time spent driving would probably not be considered time spent working by a ride-hailing company, it would be considered so by the driver. Also, a set commute is typically not considered to be time spent working in most jobs.

The blue line (triangles) represents the distribution of earnings (including tips) based on just the time spent with a passenger and the time spent over-heading (time spent from accepting the request until passenger pick-up). We hypothesize that the blue line might be the number that ride-hailing companies promote in terms of potential driver earnings while the green line (circles) represents a more realistic estimate of gross hourly earnings. The average gross earnings, including tips, for the under-estimated time (blue line) is $25.01 per hour (with a median of $22.13/hour) and more realistic average gross earnings (green line) is $15.57 per hour (with a median of $12.99/hour). These statistical means are comparable to the total gross earnings for all 416 rides of $4,068.08 divided by the working times (9,148 minutes from "dispatch to passenger drop-off" and 15,529 minutes for "time spent driving") for an equivalent rate of $26.68 and $15.72, respectively.

Figure 6– Cumulative distribution of gross earnings hourly wage (n=416)

4.3. Driver Net Earnings per Hour

Using three different scenarios of expenses per mile ($0.28, $0.40, $0.54), as described in the methods section, we calculated net hourly pre-tax wages (Figure 7) based on the specific driving mileage (with and without passengers) for each of the 416 scenarios. Some scenarios would be very efficient by earning high gross earnings with minimal driving expenses but only a fraction of drivers could experience this (only 7% would experience $15 or higher net hourly wage). In contrast, 8% would lose money (i.e., make $0 or less per hour).

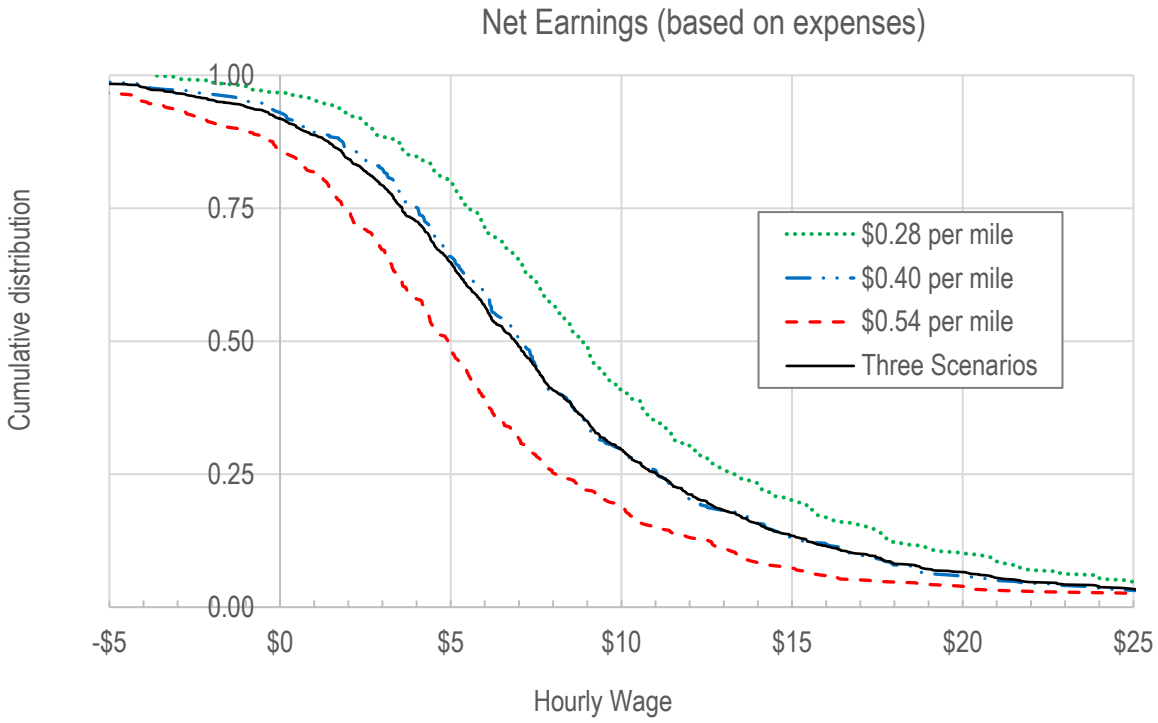


Figure 7 – Cumulative distribution of net earnings hourly wage (n=416)

The average hourly pre-tax ride-hailing wage is $8.15 with a median of $6.88 (not even minimum wage in Colorado) as shown in Table 4. These net earnings could be higher with increased tipping that is now available in the Uber app but lower due to the higher commission rate of 80% for our driver versus 75% for newer drivers. For a driver working full-time (40 hours a week, 50 weeks a year) driving over 40,000 miles a year, the annual net income would be around $16,000. These net numbers are all pre-tax earnings.

As a reference for the taxi and limousine services, the Bureau of Labor Statistics shows that the Occupational Employment and Wages hourly mean for taxi and limousine service in May 2017 was $13.68 (U.S. Bureau of Labor Statistics, 2017). An important distinction between ride-hailing and professional chauffeurs is that ride-hailing drivers tend to own their own vehicles and are considered independent contractor; this means that they are not reimbursed for driving expenses. While some taxi drivers also own their vehicles, professional drivers are more likely to be classified as employees and receive benefits and/or expense reimbursement.

Table 4 – Summary Statistics (Gross and Net Earnings) (n=416)

	Gross Earnings (n=416)	Net Earnings ($0.28 per mile) (n=416)	Net Earnings ($0.40 per mile) (n=416)	Net Earnings ($0.54 per mile) (n=416)	Average Net Earnings (n=1,248)
Mean	$15.57	$10.46	$8.28	$5.72	$8.15
s.d	9.96	8.45	7.95	7.52	8.21
Min	$1.37	-$3.80	-$7.54	-$12.75	-$12.75
1st Quarter	$9.43	$5.46	$4.03	$1.87	$3.57
Median	$12.99	$8.87	$7.05	$4.91	$6.88
3rd Quarter	$18.58	$13.20	$11.04	$8.01	$11.04
Max	$89.70	$74.82	$68.44	$61.00	$74.82

4.4. Waiting or Cruising for the Next Ride?

One of the most interesting dilemmas that drivers face is what to do once a ride ended: Do they try to find a parking spot and wait until next request? Do they start circulating around as traditional cabs? Or do they try to go to specific locations with high demand? This all depends on many factors, including driver strategy, experience, market, and times, but aiming at helping understand the dynamics of waiting versus cruising times, we experiment with the boundaries (two extremes) of different driving behaviors for "in-between" rides based on results and analysis from our dataset. The lower bound with speeds close to zero (0.5mph) include the drivers that tend to park as soon as the previous ride ends and wait until a new request. For the upper bound we used a speed of 25 mph (90-percentile of cruising speeds) for the drivers than tend to cruise or go to specific locations after each ride ends.

On one hand, driving low distances and waiting for the next request results in lower expenses for the driver, but it might take longer to get that new request. On the other hand, driving to specific places could lower the waiting times for a new request but involve additional driving expenses. Figure 8 presents the hourly wage based on minutes per hour (without a passenger) either waiting (0.5 mph) or cruising (25 mph), and using a driving expense of $0.40 per mile.

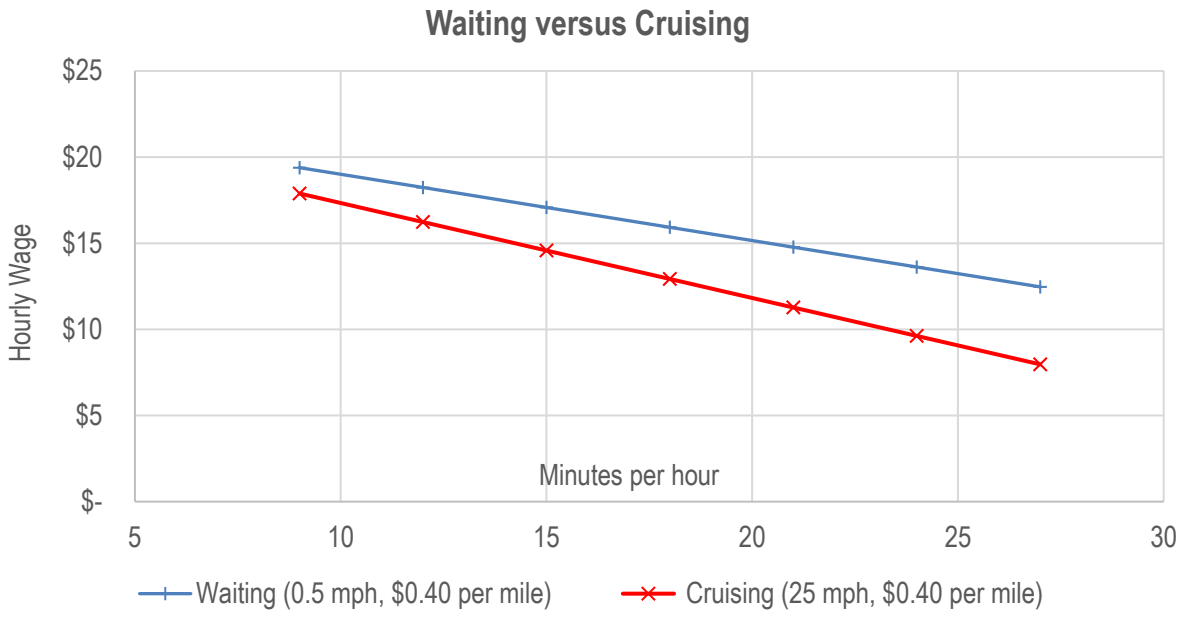


Figure 8 – In-between Rides: Waiting versus Cruising

Drivers could make the same hourly wage by either waiting or cruising. The equivalent waiting time versus cruising time is presented in Figure 9, with a relationship (slope) of 0.70. For example, driver A "waiting" (or speeding at a very low rate of 0.5 mph) for 20 minutes (y-axis) could be making the same money (approximately $15 per hour) as driver B, who cruises at 25 mph for 14 minutes until the next ride (x-axis). In the same comparison, if driver B gets a ride in less than 14 minutes, he/she would be making more money than driver A; but if driver B cruises longer than 14 minutes, then his/her hourly wage is lower than driver A. This is relevant as cruising represents congestion and influences wages for drivers. Another typical scenario is at airports, where drivers sometimes drop-off a customer there but do not immediately find a new passenger. Then, they are faced with the dilemma of waiting at the airport or driving back to the city for the next ride. In some cases, waiting up to 60 minutes at the airport could be better than driving all the way back to a busier location, since the driver waiting at the airport does not incur additional expenses, and the next ride typically requires a long-distance trip.

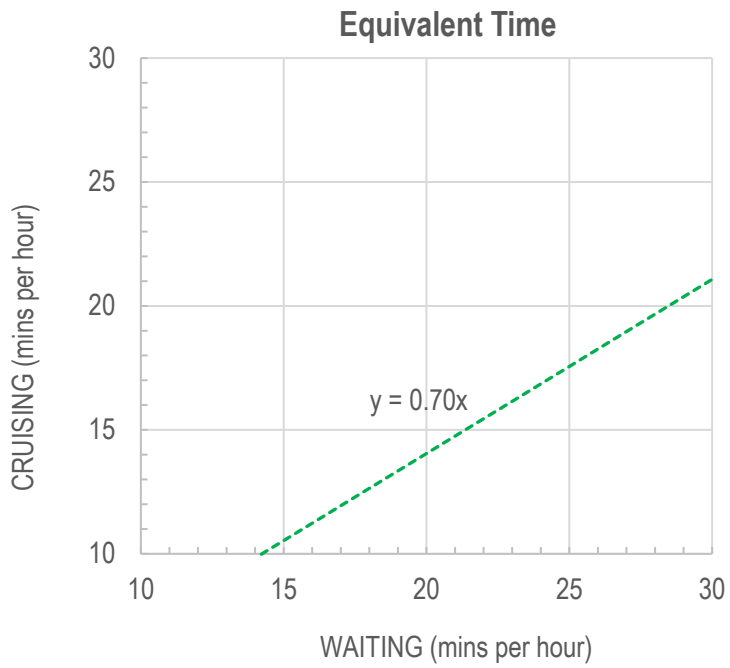


Figure 9 – Waiting versus Cruising Equivalent Time

5. Discussion

There has been widespread misunderstanding regarding passenger cost and driver earnings with ride-hailing services such as Uber and Lyft. Our study main limitation is that our dataset comes from a single driver in the Denver region for the year 2016, but given our unique and detailed data, we were able to account for variations in market rates, driver commissions, gratuity, number of rides per shift, and distances/times with/without a passenger. The ride-hailing pricing rates in Denver at the time of this study are included in Table 3. For comparison, readers can search online for ride-hailing rates in other cities and at different dates (such as http://uberestimate.com) and/or look up national cost of living indexes.

Our results show that the cost per mile for a passenger follows a power law function (contrary to a general assumptions of a set cost per mile regardless of trip distance) with lower costs per mile for longer rides (passengers pay in average $3.19 per mile with a median of $2.50 per mile after considering total fare, tolls, fees, gratuity, and travel distance). This cost does not include value of passenger's time.

While the "commission split" is 75% to 80% to the driver, when considering all fees paid by passengers, the payment is typically distributed as 66% to the driver (including gratuity) and 34% to the ride-hailing service. Using each of our 416 rides as different hourly wage scenarios, we

found the gross, pre-tax earnings average to be $15.57/hour (median: $12.99/hour). However, based on three driving expense scenarios per mile ($0.28, $0.40, $0.54), we found the mean pre-tax earnings to be $8.15 per hour (median $6.88/hour pre-tax) with a mean range of $5.72 and $10.46 per hour.

We hint at the dilemma of waiting versus cruising by explaining that cruising represents a driver expense. Most drivers receive higher net earnings by waiting rather than cruising, unless cruising is likely to cut at least 30% off from waiting time. From a city and region's perspective, drivers waiting rather than cruising is preferred, as it reduces congestion by minimizing deadheading. From a TNC perspective, deadheading minimization is also preferred as revenue is directly associated with paying passengers.

Uber and Lyft depend on the driver-partners labor market. They incentivize new drivers with bonuses and referrals, but retention rate is low. It is important to note that other motivations besides income might be weighing into this decision (Chen et al., 2017) (e.g., flexible hours, a means to car ownership, etc.), but one of the reasons for high turnover of drivers may be the eventual realization of driving expenses, and thus, lower than advertised income. For example, a person who makes $12-$15 per hour in an hourly wage job might think that they can make more driving for Uber or Lyft (such as advertised values of $35/hour). However, they may soon realize that – once accounting for expenses – it is not as profitable as once thought and may not even reach minimum wage. Cities like New York are starting to realize this issue and have initiated measures such as a minimum wage for ride-hailing drivers (O'Brien, 2018). However, detailed research on gross earnings, driver expenses, and net earnings is necessary to help cities make this type of decision. Uber and Lyft need to clarify to their drivers realistic numbers on gross and net hourly wages. Drivers can make more money by driving at certain times (e.g. surcharge or prime times), providing great customer service reflected in gratuity, and/or aiming at specific incentives. Drivers can also spend less money on driving depending on driving strategies (e.g., minimizing deadheading in-between rides, increasing the number of rides per shift) and the type of car (e.g., fuel efficient or electric vehicles). Given that the average travel distance per hour is 18.25 miles (Table 1), for every 10 cents per mile savings in car operations/maintenance, the driver hourly wage increases by ~$2. Based on the results of this study, we offer several recommendations:

- Better management of driver supply based on passenger demand, including specific and targeted network areas and drivers. Based upon the same way TNCs attempts to re-balance times of high passenger demand and low driver supply (Castillo et al., 2017), they should aim to re-balance times of low passenger demand and high driver supply.
- Better information to drivers about deadheading minimization, especially for circulating around in-between rides. For example, instead of a waiting queue at airports based on number of drivers, the companies can provide estimated waiting times. Or, instead of

generally promoting prime/surge areas, TNCs should target drivers closer to the desired zones.

- Uber and Lyft periodically test different driver options (such as the "destination filter" option, where drivers can input a desired destination for the algorithm to try and match passenger trip requests in the driver's direction). In principle these options have a goal in mind, but unintended consequences might occur given the field complexity (e.g., different driving behaviors and preferences). Balancing several priorities from different perspectives (TNC, drivers, passengers, cities) needs to be evaluated, especially when conflicts arise (oversupply of drivers and deadheading increase, undersupply of drivers and longer waiting times, and other labor and rider equity issues).
- Automatically match driver start and end desired location and time with the first few rides and last few rides per shift to avoid additional driving times without passengers at the beginning and end of shifts.
- Increase driver compensation by increasing passenger fees, increasing commission rates for drivers, providing better incentives, and/or helping defray some of the driving expenses such as recent opportunities in three U.S. cities (Hawkins, 2018), or partnering with third-party companies such as Maven – the carsharing service subsidiary of General Motors; whose customers include drivers renting electric vehicles to drive for Uber and Lyft (Hawkins, 2018).

Thus far, these companies seem to be moving in the other direction by increasing the TNC commission (from 20% to 25%), increasing the TNC service fee (which is not shared with the drivers), lowering passenger rates and changing driver payout rates.

Based on this paper and previous ride-hailing research, there is a clear common negative impact that everyone should be aiming to reduce/eliminate: deadheading. It is bad for drivers, as it represents more driving expenses, and it is bad for cities and the general public, as it means congestion. What can be done? We suggest per-mile ride-hailing fees that start at zero passengers and provide discounts based on increasing vehicle occupancy. Setting this in place would help everyone in the industry – TNCs, ride-hailing drivers, cities, passengers, the general public – work together towards the same goal of providing a more efficient transportation system. A later goal might be to apply this structured fee to any mode of transportation – including private cars, public transportation, taxis, and even future autonomous vehicles – under the same general policy (fees per mile discounted by vehicle occupancy) with zero passengers as the starting/highest fee. With the current passenger cost per mile versus forecasted estimations, there is plenty of room to include this type of fee and pay the true cost of transportation.

6. Conclusions

The results of this paper show that the total cost per mile to ride-hailing passengers varies per ride distance, which could help travel demand modelers adjust current and future projections in their models.

In terms of driver earnings, there are significant differences between the income that Uber and Lyft advertise to their drivers versus more realistic earnings – both before and after driving expenses – which in many cases do not even meet minimum wage. Cruising for a ride represents a significant driver expense, suggesting that drivers might be making more money waiting for the next ride than cruising around. The results of this study also provide insight into the passenger and driver economics of ride-hailing companies. Equity – and decent wages – for millions of drivers is at the core of this topic, and we hope that this study helps inform current and potential drivers (as well as the regulating transportation and labor entities) on the complicated issues of earnings and expenses in the shared, gig economy.

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