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ANALYZING TRIP PURPOSES AND USAGE PATTERNS: A COMPARATIVE STUDY OF NYC GREEN TAXI AND RIDE-HAILING USERS

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1. Introduction

In recent years, the landscape of urban transportation has evolved significantly, with online ride-hailing services like Uber reshaping how people travel within cities. In New York City, a unique comparison exists between ride-hailing services and Green Taxis, the latter being a segment of the city's traditional taxi system that serves areas outside of lower Manhattan. Understanding the behavioral differences between NYC Green Taxi users and ride-hailing services users provides valuable insights into urban mobility preferences and the factors influencing the rapid adoption of app-based services like Uber.

Existing research has extensively explored ride-hailing patterns and provided valuable insights. However, they typically fall short in one of the following ways: it either focuses exclusively on the transformative impact of ride-hailing on the taxi industry, examines demand patterns and user behavior for each service in isolation, or is constrained by limitations such as data or methodology.

Addressing the gap in comparing usage patterns between ride-hailing services and traditional taxi users, this study employs a unified spatio-temporal framework over a two-year period to reveal trends and patterns. It is examining the following hypothesis: *Ride-hailing users are more likely to use the service for spontaneous, social and leisure activities, whereas Green Taxi users predominantly use the service for routine, work-related commutes and errands.*

This is based on the theory that app-based ride-hailing platforms cater to non-routine travel needs through their convenient, on-demand features, making them an attractive choice for spontaneous trips. In contrast, Green Taxis, with their established presence and reliability, especially in certain key hotspots, are well-suited for predictable, structured travel patterns, such as daily commutes. Through the research question, "How do trip purposes and usage patterns differ between NYC Green Taxi users and ride-hailing users?", this study seeks to determine if and how these services meet these distinct consumer needs.

A comparative analysis of ride-hailing and Green Taxi usage reveals patterns that partially support the hypothesis. Ride-hailing trips occur more frequently during evenings, late nights, and weekends, catering to leisure travel demands. In contrast, Green Taxi trips are concentrated on weekday daytime hours, suggesting a preference for routine trips within the weekly work schedule. Spatially, Green Taxis show greater activity in the outer boroughs while ride-hailing trips are widely distributed across NYC, but these patterns neither strongly support nor contradict the hypothesis. Significant differences in trip attributes confirm that the two services cater to distinct user segments and serve different trip purposes.

This study utilizes an unprecedented dataset from the NYC Taxi & Limousine Commission—377 million ride-hailing trips and 7 million Green Taxi trips from 2019 to 2020, enabling robust statistical analysis and detailed insights. No previous research has examined this topic with such extensive data.

In summary, this research study finds that ride-hailing and Green Taxi services serve different travel needs in NYC. Ride-hailing usage peaks during evenings, late nights, and weekends, reflecting more flexible, social, and leisure-oriented trips. Green Taxis, in contrast, are used more frequently during weekdays and typical working hours, suggesting a focus on routine, work-related travel. While both services differ in timing, trip attributes, and locations, the spatial patterns alone do not strongly confirm the leisure vs. work-related travel hypothesis. Nonetheless, the results clearly indicate that ride-hailing and Green Taxis fulfil distinct roles in the urban mobility landscape.

The findings may contribute to product and strategic adjustments for both online ride-hailing services and Green Taxis, as they may help better understanding their respective user base. The research also helps understanding the widespread adoption of ride-hailing and informs policymakers on changing commuter preferences.

2. Literature Review

Existing research on the interaction between traditional taxi services and ride-hailing platforms, such as Uber, predominantly examines the transformative effects of ride-hailing on the taxi industry. A significant gap remains in comprehensively comparing usage patterns of ride-hailing and traditional taxi users, especially within a unified spatial-temporal context and on a dataset large enough to reveal trends and patterns.

A large body of studies examines ride-hailing's impact on the traditional taxi market, showing significant shifts in demand and service patterns. For instance, Nie (2017) examines the impact of ride-hailing on traditional taxi industry in Shenzhen, China by applying an econometric model finds a decline in demand for traditional taxis following the introduction of ride-hailing platforms. Similarly, an analysis of panel data from 44 Chinese cities by Zhong (2022) identifies that ride-hailing services have created considerable market pressure on traditional taxis by introducing convenient and often cheaper rides. Other research delves into how ride-hailing platforms modify spatial and temporal distribution patterns of rides. Using a queuing network model that incorporates both traditional and ride-hailing services, Zhang (2020) explores the role of dynamic pricing in managing supply and demand within the online ride-hailing sector. Real-time supply adjustments help reduce passenger wait times and thus make online-ride hailing services more convenient. Another study found that this competitive pressure from online ride-hailing platforms has led to reduced passenger wait times in the whole ride-hailing market, suggesting that online ride-hailing services improve urban transportation efficiency through better resource utilization and a lower empty load rate for taxis (Ma, 2022). However, even as demand for taxis decreases, they keep being relevant in certain contexts: traditional taxis maintain especially competitive in peak hours and specific high-demand areas, primarily because of their established presence and accessibility in these areas (Luo, 2024). While these studies offer valuable insights, their primary focus remains on the impacts online ride-hailing

has on the taxi industry rather than a direct comparative analysis of the two services.

Research on each service independently has yielded findings on spatial-temporal demand patterns and user behavior. He (2021) finds that ride-hailing demand in Beijing exhibits spatiotemporal patterns, with increased demand on Fridays and Saturdays and the majority of the regions showing relatively stable ride-hailing demands during a whole weekday.

Other studies focusing solely on traditional taxis also reveal significant spatiotemporal usage patterns. A combination of network analysis and community detection finds significant travel flow patterns and regional structure (Liu, 2015). In Shanghai for example, Taxi usage is clustered around specific urban sub-regions and high-activity zones, such as business districts and transportation hubs (Zhang, 2017). An analysis of the interaction of areas shows that certain areas play key roles in the travel network due to their high levels of interaction, making them central hubs for taxi or travel activity. A weighted degree distribution and community detection identified high-interaction zones, such as business districts and residential neighborhoods, which serve as nodes in the travel network (Xie, 2021). The interaction between areas exhibits distance decay effects, which means that the likelihood of interaction between two locations decreases as the distance between them grows, suggesting that people are less likely to take taxis for longer trips (Liu, 2012). A study analyzing the temporal distribution of taxi trips through geospatial mapping shows higher trip frequencies on weekdays than weekends and during rush hours compared to non-rush hours (Xie, 2021).

These findings demonstrate distinct patterns in both services, but their isolated analyses prevent any direct comparison of the mobility behaviors of taxi and ride-hailing users in shared urban spaces.

Studies, which attempt to compare traditional taxis and ride-hailing services have limitations due to data limitations, such as short observational periods that restrict the ability to capture long-term trends. Wang (2021) examines spatiotemporal distribution patterns for taxis and ride-

hailing services over a four-day period, finding that ride-hailing trips are spread more widely across urban areas. Temporal analysis in this study reveals different peak usage times between both services. While taxis experience higher demand at night, ride-hailing peaks more prominently in the morning on weekdays. However, with only a short time frame for data, this analysis provides a limited perspective on temporal dynamics and fails to detect broader patterns, such as patterns by weekday or differences between weekdays and weekends. This highlights the need for larger observational periods that enable a detailed comparison of both services.

Some studies carry out comparative analyses of both services focusing on the differences in user preferences. However, those studies use intercept surveys that may not capture the full scope of spatiotemporal usage patterns and are thus constrained by the applied methodologies. Rayle (2016) uses intercept surveys from the busiest districts in San Francisco and finds differences in user characteristics and ride preferences. Online ride-hailing services appeal to younger, more educated users seeking shorter wait times and point-to-point convenience. Similarly, a study in Nanjing, China surveyed user choice behavior for taxi versus ride-hailing services and identified that the choice is influenced by preferences like safety, comfort, cost, travel distance, and trip frequency. The study finds that infrequent users prioritize safety and are therefore more likely to choose online ride-hailing, moderately frequent users value comfort and cost, and frequent users are influenced by factors such as education and income levels (Wang, 2019). Despite offering insights into choice determinants, survey-based methodologies do not capture spatiotemporal usage patterns, which limits the relevance of the findings.

That said, we still lack a clear understanding of the similarities and differences in mobility patterns between taxis and ride-hailing services. The only existing comparative studies that exist are limited by data or methodology. As a result, the underlying patterns of these two services remain unclear. Although there is more in-depth research on taxis and ride-hailing

separately, direct comparisons between them – especially within a unified spatio-temporal framework – can not be drawn.

This research aims to address this gap by performing a comprehensive comparative analysis of the mobility patterns of taxi and ride-hailing users. Using a larger two-year dataset allows to capture of hourly and daily trends in both services. Statistical tests will be used to compare the means and distributions of trip attributes between ride-hailing and Green Taxis to determine whether observed differences in trip attributes are statistically significant. Additionally, geospatial and temporal analyses which map trip origins and destinations will identify spatial patterns and examine variations across different times of day and days of the week.

3. Data

TLC Trip Record Data

This research study utilizes two primary datasets of trip records from New York City, one representing Green Taxi rides and the other representing high-volume online ride-hailing services, such as Uber and Lyft. Both datasets capture geospatial and temporal information for each trip, which enables a comparative analysis of transportation patterns within the city.

Data Collection and Structure

The datasets were sourced from the New York City Taxi and Limousine Commission (TLC), which regularly publishes For-Hire Vehicle (FHV) data. This data is structured on a monthly basis and includes detailed records on trip characteristics such as pick-up and drop-off times, pick-up and drop-off locations, trip distances, itemized fares, payment methods, and passenger counts. The TLC mandates all FHVs to use automated technology systems that capture and transmit trip details, ensuring accurate and consistent data across different types of transportation services.

Green Taxi Dataset

The Green Taxi dataset is collected by technology providers authorized under the TLC's Taxicab and Livery Passenger Enhancement Programs (TPEP/LPEP), a program implemented in 2018. These initiatives require all taxicabs and Street Hail Liveries to be equipped with systems allowing credit card payments, automatic trip recording, driver communication with the TLC, and passenger information displays in the back seat. These standards aim to enhance the safety, accessibility, and overall passenger experience in NYC's taxis.

The dataset contains four tables about taxi trips, along with a geospatial map in TopoJSON and Shapefile formats. The four Taxi Trips tables contain a total of 28 million Green Taxi trips in New York City from 2017 to 2020. Each record represents one trip, with fields containing details about the pick-up/drop-off times and locations, distances, fares, passengers, among others. The geospatial map of the New York City Taxi Zones allows for geographic mapping of trip locations. The Green Taxi dataset contains 7.364.873 millions trip records.

On average, Green Taxi trips are 2.06 miles long and range up to 18.96 miles. The median duration of a trip is 12.0 minutes and the maximum duration is 189.0 minutes. Green Taxi trips had an average fare amount of 12.99 US dollars and a maximum of 151.61 US dollars.

Online Ride-Hailing Services Dataset

In 2018, New York City introduced a new licensing category specifically for high-volume FHV providers — companies dispatching over 10,000 FHV trips per day under a single brand name. This regulation, effective February 1, 2019, applies to companies such as Uber, Lyft, and Via. High-volume FHV providers are required to submit detailed trip records to the TLC, similarly to Green Taxis. These systems automatically capture and transmit comprehensive trip details, including pick-up and drop-off times and locations, fare breakdowns, and trip distances. Each record in this dataset represents a single trip dispatched by one of NYC's licensed high-volume FHV providers.

This online ride-hailing dataset includes geospatial and temporal attributes similar to those in the Green Taxi dataset, such as identification details of the HVFHS business, the date and time of the trip pick-up and drop-off, the TLC Taxi Zone in which the trip began and ended, details about the passenger requested the trip. The dataset also provides trip specific information about trip distance in miles, trip duration in seconds, total driver pay, and additional charges like surcharges, tolls, and taxes. The datasets are broken down by month and formatted in parquet. The datasets of 2019 and 2020 contain data on a total of 373.227.892 million trips. Some visualizations and calculations on the ride-hailing dataset are performed on a random sample of the ride-hailing dataset due to computational efficiency. The sample will consist of 2% of the ride-hailing dataset, or around 7.46 million records.

The median distance of each trip in the ride-hailing data is 2.88 miles and ranges from 0.0 to 27.49 miles. Ride-hailing Trips take on average 15.0 minutes with a maximum of 220 minutes. The median fare amount of ride-hailing trips is on average 12.99 US dollars and go up to 174.83 US dollars.

Combining the Datasets

To be able to conduct a comparative analysis of usage patterns between traditional Green Taxis and online ride-hailing providers, both datasets need to be aligned. Only the temporal intersection of both datasets, the years of 2019 and 2020, will be considered. Both datasets were cleaned and prepared following similar steps to ensure consistency and comparability.

4. Research Methodology

Comparative Analysis

A Comparative Descriptive Analysis is the base of the comparative analysis and focuses on comparing the distribution of attributes of both datasets. This approach helps identifying

differences in basic travel patterns between ride-hailing services and Green Taxis. Analyzing distributions of pickup/drop-off locations, trip distances, trip duration, the hour of the day and weekday of the pickup, and trip speeds can give insights into user behavior and preferences. Statistical testing helps to determine whether the observed differences in descriptive statistics (e.g., trip distances, durations, or fares) are statistically significant. If these differences align with the hypotheses and yield significant results, it supports the analysis. A t-test with log transformed variables will be used for continuous variables and a Mann-Whitney U test will be used for ordinal variables, since it is appropriate for comparing two independent samples when the data distribution is skewed.

Statistical Testing

For the analysis of continuous variables, specifically trip distance and trip duration, a t-test was applied to log-transformed data to compare the average values of these variables between two independent groups: ride-hailing trips and Green Taxi trips. This approach is appropriate because, while the original distributions share a similar right-skewed shape, they are not normally distributed. The log transformation was applied to reduce skewness, with a small constant (1e-6) added to avoid the error of taking the logarithm of zero. The two groups of ride-hailing and Green Taxi trips are independent because they represent distinct groups of trips taken by different users through different services, with no overlap between the groups. To determine whether Welch's t-test is necessary, the equality of variances for the variables is assessed using Levene's Test and Bartlett's Test. Both tests showed p-values of 0.0, indicating that the variances of the groups for both trip distance and trip duration differ significantly (Table 5). Thus, Welch's t-test was used to account for these differences in variance.

Table 1. Results of Test for Equal Variance

Test	Test Statistic	p-value

trip_distance	Levene's Test	8570.3035	0.0
	Bartlett's Test	23421.1065	0.0
trip_duration	Levene's Test	23421.1065	0.0
	Bartlett's Test	187048.3046	0.0

The Mann-Whitney U test for independent samples is applied to compare discrete trip characteristics between ride-hailing and Green Taxi services, specifically pickup and drop-off location, as well as the day of the week and hour of the day of the pickup. The Mann-Whitney U test is an appropriate choice because it does not require normally distributed data and can handle discrete variables, which is true for the mentioned variables. By comparing the relative ranks of the observations from ride-hailing and Green Taxi services, this test is able to determine whether there are statistically significant differences in their distributions without being affected by skewness.

Geospatial Analysis

Geospatial Analysis can reveal distinct patterns in the starting and ending locations of trips across service types, which may suggest different trip purposes. A set of two maps will display whether a region is dominated by either Green Taxis or ride-hailing services, comparing each service's trips relative to its own total trips. This will be broken down by pickup and drop-off in two separate maps. Each zone is colored based on which service has a higher percentage of its total pickups or drop-offs in that zone, relative to their own totals. This represents the respective relative presence in each zone. For example, if in one region Green Taxis have a higher proportion of its own trips starting than ride-hailing services relative to its own trips, the TLC Taxi Zone is colored green. For deeper insight, another set of maps will show, for each service separately, whether a TLC Taxi Zone has a higher concentration of pickups or drop-offs, by comparing the frequency of pickups and drop-offs for each service. Zones are colored as following for ride-hailing services (Green Taxis): light grey (light green) for zones with more

pickups and dark grey (dark green) for zones with more drop-offs.

5. Findings

Comparative Descriptive Statistics

Ride-hailing trips are in general distributed more evenly, which is evident from distributions of various attributes. Comparing pickup and drop-off locations of both services, ride-hailing services show a more uniform distribution (Figure 26). This could be attributed to the flexibility of ride-hailing services, allowing riders to be picked up and dropped off at any specific location, while taxis are more restricted by the location specific availability. Both services exhibit similarities in their respective distribution of pickup and drop-off location patterns. The distinct clusters of activity concentrated in similar areas reflect key hotspots within the city where Green Taxis and ride-hailing services are frequently used.

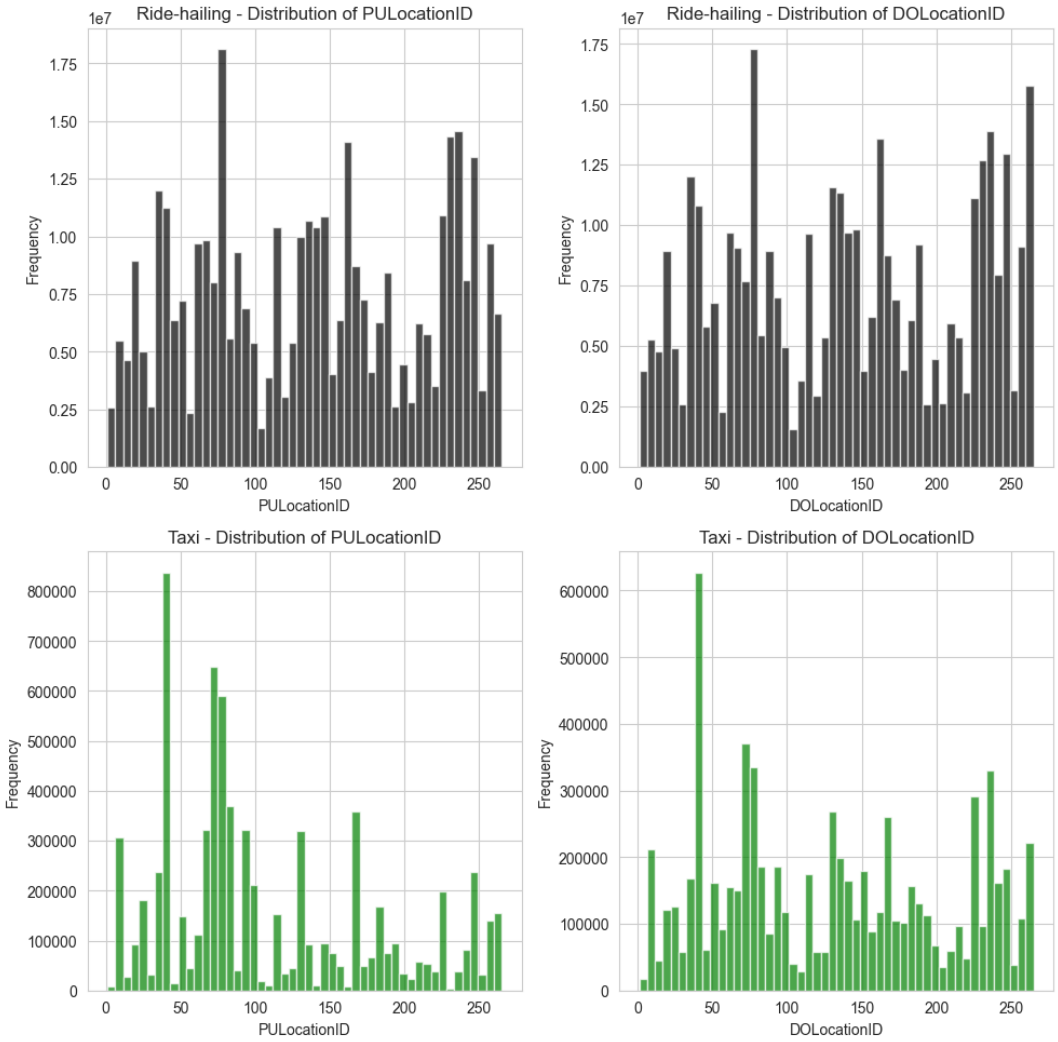

Figure 1. Distribution of Pickup & Drop-off Locations

When comparing the mean trip distances of both services, ride-hailing trip distances are longer and show greater variability in the middle 50% of the data, indicated by their larger interquartile range of 4.03 compared to 3.38 for Green Taxis (Figure 27). Similarly, ride-hailing trips exhibit greater average trip durations (17.98 minutes for ride-hailing and 15.39 minutes for Green Taxis) and a more even distribution, reflected by a larger interquartile.

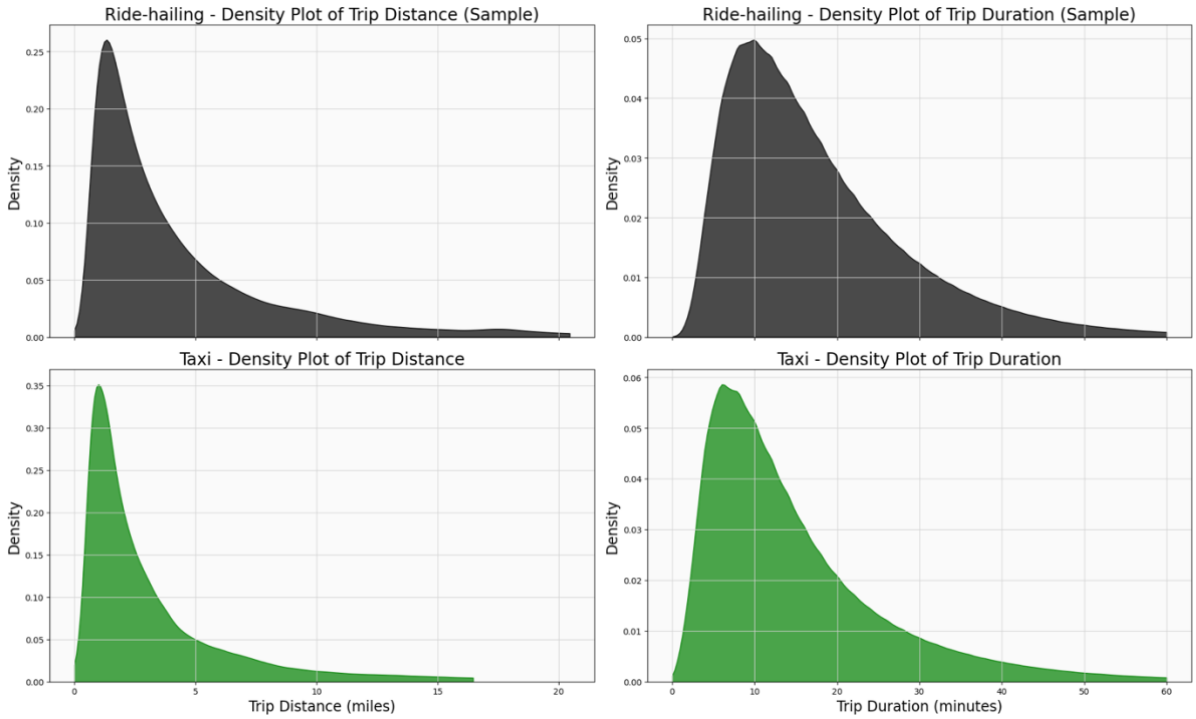

Figure 2. Distribution of Trip Distance and Trip Duration

Some clear patterns emerge in the trip distribution of day of the week and hour of the day of pickups, which support the hypothesis that ride-hailing is more likely used for social and leisure activities, while Green Taxi is predominantly used for work-related commutes.

The analysis of pickup times reveals distinct patterns in how ride-hailing and Green Taxi services are used across different hours and days, indicating different user needs and preferences. The metric used to compare both services is the proportion of each service's total trips.

Figure 28 shows that Green Taxi trips are dominant during the daytime, from 8 a.m. to 7 p.m., and during the week, likely reflecting regular, structured travel schedules for workdays and weekly routines, such as commuting to and from work. Conversely, ride-hailing trips are more frequent during nighttime hours, from 7 p.m. to 8 a.m., than Taxi trips and on the weekend, suggesting that ride-hailing caters more to evening and early morning travel. This trend suggests that ride-hailing may be the preferred choice for leisure and recreational travel common on weekends, such as social outings, events, or late-night commuting needs.

Together, these patterns suggest that ride-hailing is more frequently used for leisure or non-routine travel, whereas Taxis may be preferred for structured, predictable travel needs during the typical work week, supporting the hypothesis. This distinction highlights how each service plays a distinct role in urban mobility, catering to different trip purposes and passenger needs across both time and day dimensions.

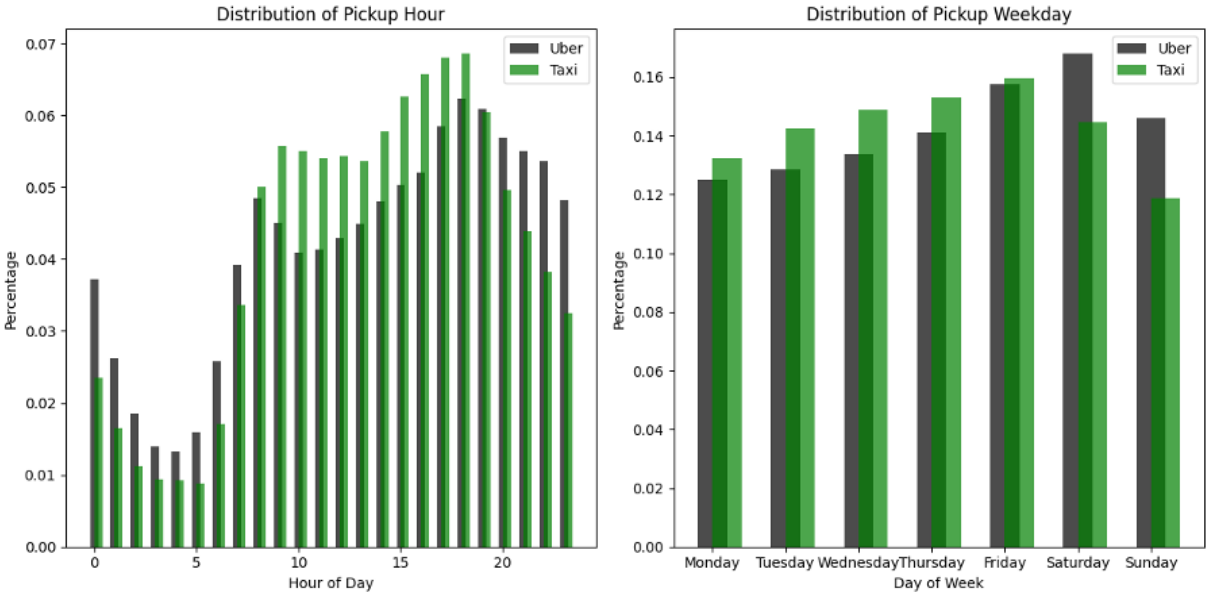

Figure 3. Comparison Distribution of Pickup Hour and Day of the Week

To explore these insights further, the pickup patterns will be examined in greater detail. By breaking down the pickup data into a heatmap segmented by days of the week and hours of the day, we can gain a more nuanced view of how ride-hailing and Green Taxi services are utilized across specific timeframes. This visualization will allow us to identify peak usage periods and highlight the distinct temporal trends for each service.

The heatmap analysis (Figure 29) reveals that Green Taxi trips are most concentrated on weekdays between 6 a.m. and 5 p.m., with noticeable peaks during early morning and late afternoon hours. In contrast, weekends show no consistent patterns, and trip durations are significantly shorter compared to weekdays. When looking at the trip times, these patterns, while still present, become even more pronounced. A comparison of both plots suggests that although fewer trips occur on weekends, they tend to be longer in duration.

Ride-hailing trips in contrast are spread out over the entire week, with distinct peaks of trips booked during evenings and nights as well as over the weekend. Average trip durations tend to be longer on weekdays, especially during peak hours such as between 6 a.m. and 7 p.m., with a notable spike on Friday afternoons from 3 p.m. to 5 p.m. This may be attributed to the high volume of trips and increased congestion during the early evening. The average count of trips peaks on Friday and Saturday evenings, extending into the early hours of Saturday and Sunday, suggesting that ride-hailing services are frequently used for social activities and night outings during weekends.

These observations support the hypothesis that taxis are primarily used for routine, predictable travel, such as work commutes, and less frequently for leisure trips. Ride-hailing, on the other hand, is commonly used during typical leisure hours, such as evenings, late nights, and weekends.

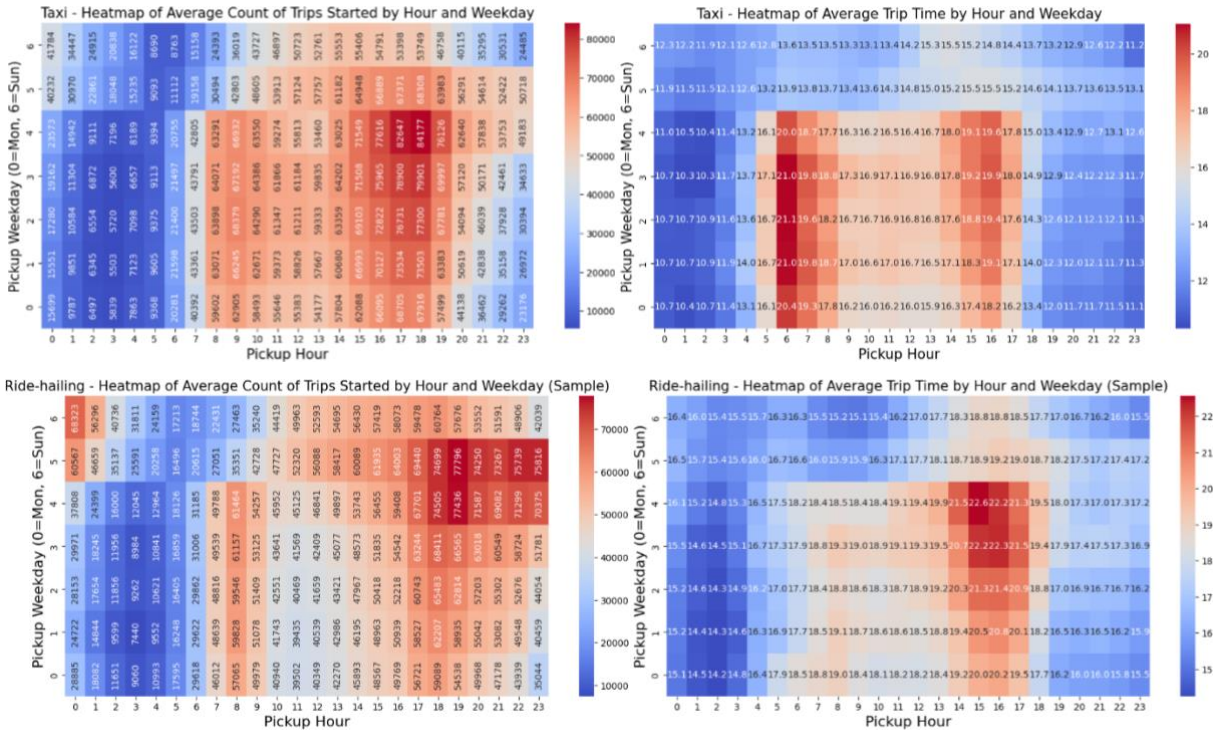

Figure 4. Heatmaps of Trip Distribution by Hour and Weekday

Statistical Testing

A t-test and a Mann-Whitney U test for independent samples were applied to compare trip

characteristics between ride-hailing and Taxi services, with the goal to determine whether the observed differences in trip attributes between these two groups are statistically significant.

The test results for the trip characteristics trip distance and trip duration suggest significant differences between ride-hailing and Green Taxi services regarding these variables, as indicated by the large U-statistics and p-values of 0.0 (Table 6). These results confirm that ride-hailing and Green Taxi cater to different types of trips. The substantial differences in trip distances and times suggest that ride-hailing may serve a wider variety of trips, including longer and more expensive trips and that Taxis may serve more routine, possibly shorter trips with different pricing dynamics. The statistically significant differences across all three variables underscore the hypothesis that the services are used for different trip purposes and patterns, which provides evidence that ride-hailing and Taxi play distinct roles in urban transportation.

Table 2. Results of two-sided T-Test (Ride-Hailing Mean!=Green Taxi Mean)

	Group	N	Mean	SD	t-cal	t-crit	p-value
trip_distance	Green Taxi	7364873	0.7784	0.9268	688.3729	1.96	0.0
	Ride-Hailing	7464557	1.1009	0.8761			
trip_duration	Green Taxi	7364873	2.4580	0.7593	623.4931	1.96	0.0
	Ride-Hailing	7464557	2.6866	0.6476			

The Mann-Whitney U test results indicate that the distributions of pickup hour, pickup weekday, pickup location ID (PULocationID), and drop-off location ID (DOLocationID) differ significantly between Green Taxi and ride-hailing services. Each comparison shows large U-statistics and p-values close to zero, suggesting that the observed differences are not due to random chance (Table 7). This means that the patterns of when and where trips occur, in terms of time and location, vary significantly between the two services. The rank means provide insight into which service tends to have higher values for each variable. For instance, if ride-hailing has a higher rank mean for PULocationID, it suggests that ride-hailing pickups are more

concentrated in areas with higher IDs than those of Green Taxi.

Table 3. Results of two-sided Mann-Whitney U Test (Ride-hailing Mean!=Green Taxi Mean)

	Group	N	Rank Mean	U-statistic	p-value
pickup_hour	Green Taxi	7364873	7405267.65	27557339381170.0	2.8e-17
	Ride-Hailing	7464557	7424037.18		
pickup_weekday	Green Taxi	7364873	7202425.96	29051242665006.5	0.0
	Ride-Hailing	7464557	7624170.06		
PULocationID	Green Taxi	7364873	6566867.68	33732056032017.5	0.0
	Ride-Hailing	7464558	8251241.78		
DOLocationID	Green Taxi	7364873	7102476.30	29787366581041.5	0.0
	Ride-Hailing	7464558	7722785.91		

Overall, the results of the statistical analysis support the hypothesis that ride-hailing and Green Taxi services cater to different trip purposes and fulfill distinct roles within urban mobility. The Welch's t-test and the Mann-Whitney U test reveal significant differences between ride-hailing and Green Taxi services across multiple trip characteristics.

Ride-hailing trips tend to be longer and more varied in distance and duration compared to Green Taxi trips, which are generally shorter and more routine. These findings support the hypothesis that ride-hailing serves a broader variety of trips, including social and leisure activities, while Green Taxis focus on work-related commutes and errands.

Significant differences were observed in the distributions of pickup hours, weekdays, and location IDs for both services. Ride-hailing pickups are more concentrated in areas with higher IDs and occur at times typical for social and leisure activities. In contrast, Green Taxis exhibit patterns associated with routine commuting.

The results confirm that ride-hailing and Green Taxi services fulfill distinct roles in urban transportation. Ride-hailing caters to diverse, often longer, and more expensive trips, whereas Green Taxis are more aligned with predictable, shorter trips. Overall, the findings strongly

support the hypothesis that the two services are used for different trip purposes and reflect contrasting user needs within urban mobility.

Geospatial Analysis

The goal of the geospatial analysis is to uncover the geographic usage patterns of ride-hailing and Green Taxis across New York City, helping us understand how each service serves different areas and trip purposes. By analysing pickup and drop-off locations across boroughs, this section aims to identify where each service is most active and infer whether usage patterns reflect leisure or routine travel. This spatial breakdown offers insights into the distinct roles that ride-hailing services and Green Taxis play.

Figure 30 compares the services based on the proportion of total pickups and total drop-offs of each service respectively.

Ride-hailing is the dominant service in most areas of NYC, particularly in Manhattan, and outer boroughs, as shown in Figure 30. Notably, the dominance of ride-hailing services increases further from the city centre, which suggests that users in less central areas prefer the convenience of online ride-hailing to call a ride, rather than having to rely on the chance availability of a passing taxi. The drop-off map shows more areas colored green, indicating that Green Taxi drop-offs are more widely distributed compared to pickups. This pattern suggests that while Green Taxi pickups are concentrated in specific areas, the trips tend to disperse into the outer boroughs, serving a broader range of destinations across the city.

The green zones in Queens and Brooklyn suggest that Green Taxis maintain significance in some areas outside Manhattan. This is consistent with the intention behind the Green Taxi program, which was meant to provide taxi services in the outer boroughs where traditional yellow taxis rarely go.

The comparison of the services based on the percentage of total pickups and total drop-offs shows that ride-hailing maintains dominance in most areas. However, Green Taxis are more

active in the outer boroughs, especially for drop-offs, showing that they keep being relevant to for people traveling to outer borough destinations like Queens and Brooklyn.

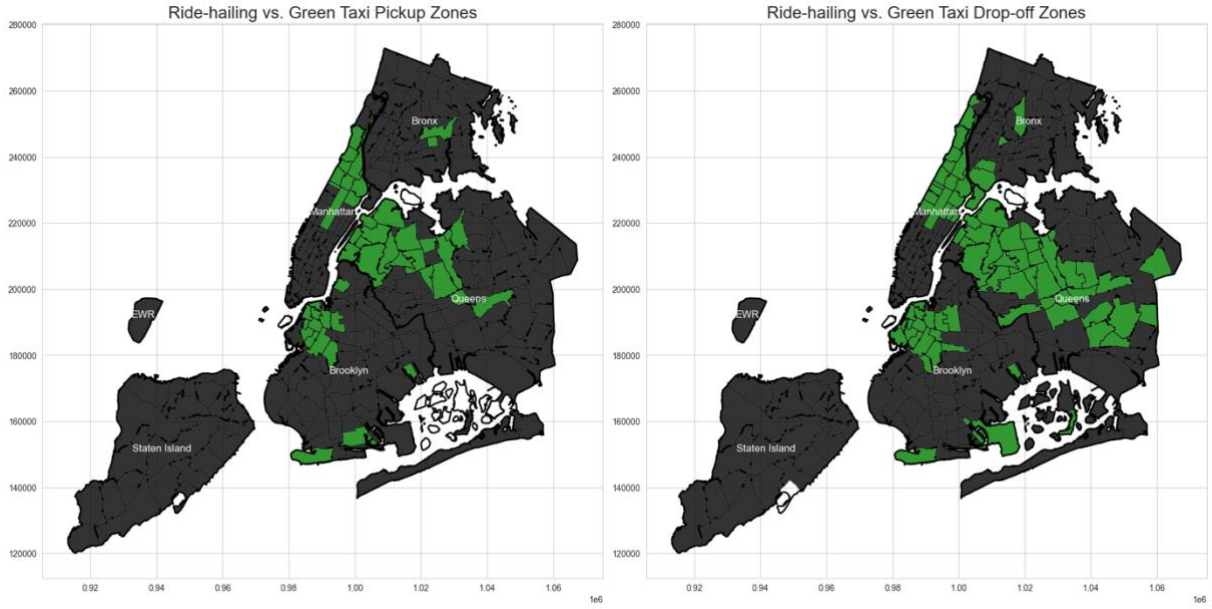

Figure 5. Ride-hailing vs. Taxi based on Percentage of Total Pickups and Total Drop-offs

Ride-hailing is less frequently used for trips to or from busy districts or transportation hubs and rather distributed across NYC, as shown in Figure 31. The map displays an even distribution of shading, indicating a balance in ride-hailing usage between pickups and drop-offs across many areas. Still, there are clusters of zones showing the same shading.

Figure 31 also suggests that Green Taxis are frequently used to reach various destinations after passengers depart from central hubs or locations. This supports the above assumption, that Green Taxis are especially relevant to for people traveling to outer boroughs. The map comparing Green Taxi pickups and drop-offs is dominated by dark green zones, especially in Manhattan and Queens, indicating that taxi drop-offs exceed pickups in these areas.

Despite clear patterns, the geospatial analysis fails to provide substantial evidence for or against the hypothesis that Uber is more likely used for social and leisure activities, while Green Taxis are predominantly used for work-related commutes.

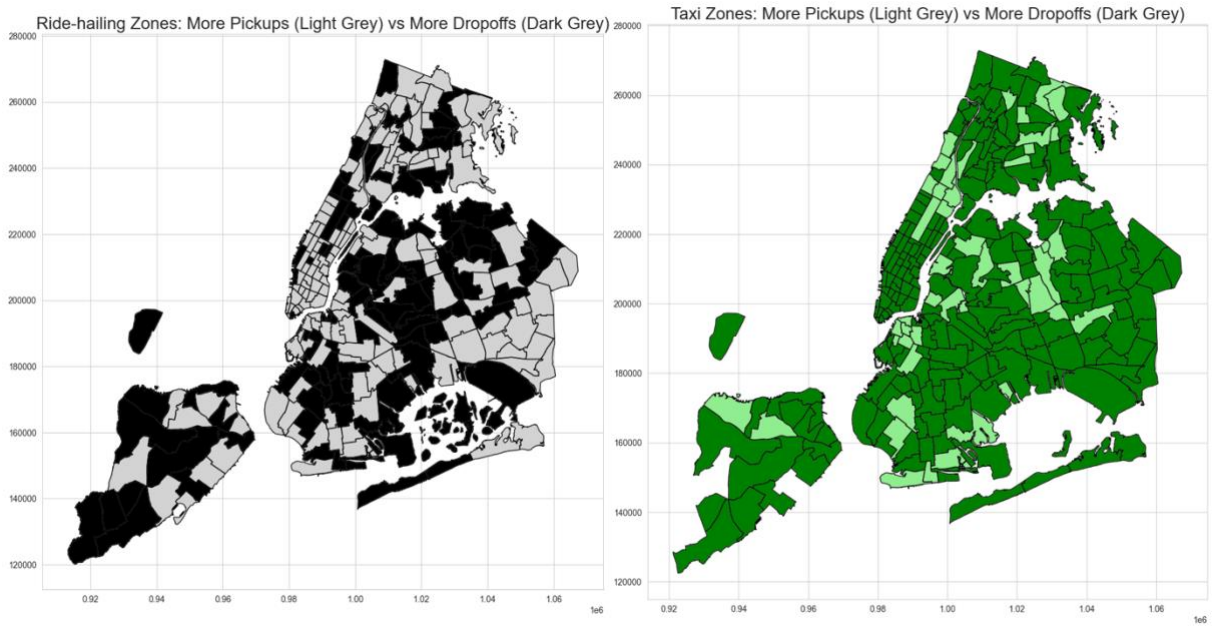

Figure 6. Pickup vs. Drop-off for each service

6. Conclusion

The comparative analysis of ride-hailing and Green Taxi usage reveals distinct patterns that offer partial support for the hypothesis that ride-hailing is predominantly used for social and leisure activities, while Green Taxis are primarily utilized for work-related commutes and errands.

The descriptive statistics on trip timing by day of the week and hour suggest that ride-hailing trips occur more frequently during evenings, late nights, and weekends, aligning with typical leisure and social activity periods. In contrast, Green Taxi trips are concentrated during weekday daytime hours, indicating a possible alignment with routine, structured travel needs, such as commutes or daily errands. These differences in usage timing suggest that each service plays a distinct role in NYC's urban mobility landscape.

The analysis of pickup times further supports this pattern, with ride-hailing showing higher use during non-traditional hours, while Taxis appear more often during standard working hours. Together, these findings imply that ride-hailing services cater more to non-routine, flexible

travel demands, while Taxis are favoured for predictable, regular trips within the weekly work schedule.

Statistical testing through the Welch's t-test and the Mann-Whitney U test show statistically significant differences in trip distances, trip durations, times of pickups, and locations between ride-hailing and Green Taxis. Ride-hailing caters to longer and more expensive trips, whereas Green Taxis are more aligned with shorter trips. These results confirm that the two services serve serve different trip purposes and fulfill distinct roles in urban mobility.

The geospatial analysis presents a more complex picture. Ride-hailing is dominant in most areas, with a strong distribution across NYC, which may suggest that ride-hailing caters to a more diverse range of trip purposes, which is reflected in longer trip distances and durations, as well as broader geographic coverage. Green Taxis show greater activity in the outer boroughs, especially for drop-offs in places like Queens and Brooklyn. This distribution suggests that Green Taxis remain relevant for travellers heading to or from less central areas. However, the spatial patterns do not strongly support or contradict the hypothesis regarding leisure versus work-related travel purposes.

In summary, the findings from trip timing, trip characteristics, and spatial usage partially support the hypothesis, revealing that ride-hailing services and Green Taxis meet distinct user needs and preferences within NYC. Statistical testing confirms the statistical significance of these findings. While the geospatial analysis does not offer substantial evidence in either direction, the temporal and trip attribute data lend support to the hypothesis, underscoring the distinct roles each service plays in urban transportation.

7. Resources

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