

Objective

The STEPS report "Three Revolutions in Urban Transportation," is a scenario analysis of global economic and environmental impacts of market penetration of electrification, automation, and shareduse mobility in replacing single-occupant vehicle trips.

This research examines patterns in taxi trip cost per mile, network attributes, and driving travel times relative to alternative modes to draw high-level conclusions on how an autonomous vehicle rideshare network, as outlined in the "Three Revolutions" scenario of the STEPS report, could impact mode split and affordability of vehicle trips.

Dataset

- 2015 NYC Yellow Cab: 146 million trips (took 12,535 samples for Google Maps API queries)
- 2015 NYC Green Taxi: 19.2 million trips (took 1,683 samples for Google Maps API queries)
- *Chicago 2013 2016 (all cab companies)*: Over 100 million trips
- Variables: trip origins & destinations, passenger count, trip distance, fare, fees, tip, and total costs



Travel Times by Mode

2015 New York City Yellow Cab and Green Taxi trips were sampled and queried through the Google Maps Distance Matrix API to obtain trip travel times of driving, transit, cycling, and walking. Travel times for driving assume a scenario where a taxi or autonomous rideshare vehicle offers point-to-point transportation.

- Driving times are moderately better than transit on average, most commonly by about ten minutes or less
- In roughly half of the taxi trips, cycling would have been faster
- For both cycling and transit, there is a right skew in travel times where driving does substantially better, indicating that for those trips, driving was the optimal approach
- For the portion of trips where alternative modes were faster than driving, either imperfect information or a preference for car travel led to the consumer decision to use a taxi

Heat Map of Time Difference Between Driving and Transit





SUSTAINABLE TRANSPORTATION ENERGY PATHWAYS An Institute of Transportation Studies Program

Travel Time & Cost Savings of a 3 Revolutions Scenario Dominique Meroux

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Taxi Cost per Mile

Savings from Sharing Rides (left two graphics) and Cost per Mile (right two histograms) Cost per mile is dependent on mode, with autonomous rideshare vehicles at ~\$1 per mile. The estimate of \$6/mi for taxis is plausible based on the taxi cost per mile distributions observed for NYC and Chicago. Evidence from taxi datasets suggests that in cases where taxi rides were shared, cost per passenger mile was relatively low at even higher-than-typical per-mile costs. Shared rides in an autonomous rideshare vehicle could thus be a way to increase accessibility to lower-income groups and mitigate the impact of spikes in pricing (e.g. surge pricing during commute hour) for individual passengers.



Histogram of Transit Minus Driving Travel Times



Histogram Cycling Minus Driving Travel Times

Number of Trips by Node, Weekday, and Hour (Right) Trip coordinates were rounded to 3 decimal places to form nodes. By summing trips at each node, we get a sense of the most popular origins and destinations of yellow cab trips, and can separate these by hour and weekday.

PageRank Algorithm (Below)

PageRank was originally designed to rank web pages by the sum of PageRanks of web sites pointing to the given web page, normalized by the total number of outbound links from that web page. This gives both the number of links to a given web page and the quality of each link.

Applied here, we can rank connectivity of trip start and end locations (nodes).





Cycling Minus Driving Travel Times (Minutes)



Total cost per mile is composed of the base fare, tips, and fees.

Network Attributes

Chicago Taxi Trip Location PageRank

Conclusions

- achieve comparable or better fuel economy

Future Work

- average population density, like Sacramento, CA
- driver) when sharing rides with "strangers"









• Better information available to consumers on mode choices and travel times at the trip decision point could shift at least some taxi trips to transit or cycling in cases where driving was not the fastest mode

• Sharing rides mitigates user cost and traffic congestion and expand access to point-to-point transportation to lower-income groups • ~70% of 2015 NYC Yellow Cab trips had one passenger

• Shared zero-emissions taxis are the next step for reducing emissions • ~66% and ~84% of NYC and Chicago taxis, respectively, have hybrid powertrains. Autonomous vehicle rideshare fleets should aim to

• Taxi and rideshare trip-level data is needed for cities with a more

• Data is needed on rideshare trips to understand 1) induced demand for vehicle trips caused by lower-cost and more convenient rideshare services, and 2) the degree to which pooled rides are chosen

• A better understanding is needed of the social dynamic of pooled autonomous vehicle rideshare. It is an ideal concept mathematically, but this service must be viable in absence of an authority figure (the