THE IMPACT OF E-COMMERCE ON LAST-MILE URBAN FREIGHT & HOUSEHOLD SHOPPING TRIPS

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MOBILITY SCENARIOS CONSIDERED

A world of

HIGH SHARING, PARTIAL AUTOMATION (A)

New technology enables people to significantly increase the use of transit, ride-hailing and multi-modal travel. Partial automation is introduced and is primarily used on the highway.

HIGH SHARING, HIGH AUTOMATION (B)

Technology has taken over our lives, enabling high usage of fully automated driverless vehicles, ride-hailing and multi-modal trips, which are convenient and inexpensive. As a result, private ownership has decreased and e-commerce has increased.

LOW SHARING, HIGH AUTOMATION (C)

Fully automated privately owned driverless vehicles dominate the market. The ability to own AVs leads to low ride-sharing and an expansion of urban/sub-urban boundaries, while e-commerce has increased.

3 deliveries per week

5 deliveries per week
BASELINE DESCRIPTIONS
Different Timeframes Considered

**TODAY**
Baseline developed based on large number of diverse data sets representing current
- Population,
- Land use,
- Transportation network,
- Mode availability (e.g. ride-hailing),
- Light duty vehicle fleet distribution and geographical location by ZIP code,
- Freight demand,
- Vehicle technology

**SHORT TERM (A)**
- Increased population (8%),
- New land use
- Moderate vehicle fleet electrification (up to 7% BEV, 5% PHEV and 7% HEV for LDV)
- Increased freight demand (10%)
  - Two improved vehicle technology cases
    - business as usual, or
    - VTO R&D targets achieved

**LONG TERM (B/C)**
- Increased population (20%),
- New land use
- Aggressive vehicle fleet electrification (up to 39% BEV, 11% PHEV and 12% HEV for LDV)
- Increased freight demand (28%)
  - Two improved vehicle technology cases
    - business as usual, or
    - VTO R&D targets achieved

No changes related to connectivity, automation, sharing or e-commerce are considered
RESEARCH QUESTIONS
RESEARCH QUESTION:
NET EFFECT OF E-COMMERCE
RESEARCH QUESTION: COMMODITY FLOW GROWTH

What are the regional impacts?

Source: https://ops.fhwa.dot.gov/freight/freight_analysis/nat_freight_stats/index.htm
RESEARCH QUESTION: VEHICLE TECHNOLOGY IMPACTS
APPROACH
“TOP-DOWN” FREIGHT MODEL

COMMODITY FLOWS
REGIONAL TRUCK TRIPS
PARCEL DELIVERIES

“TOP-DOWN”: INCREASE GRANULARITY

SPATIAL
CMAP, CDOT

TEMPORAL
FHWA

SCENARIOS
COMMODITY FLOWS
E-COMMERCE
MARKET PENETRATION

FREIGHT MOVEMENTS

CMAP: Chicago Metropolitan Agency for Planning
CDOT: Chicago DOT
FHWA: Federal Highway Administration
FAF: Freight Analysis Framework
E-COMMERCE MODULE

*Efficient Delivery Tours

Base year:
Zone-Level: Total Parcel Deliveries
Stop-Level: Random Delivery Locations
--> MDT Delivery Tours

WholeTraveler

Survey Data

E-commerce Behavioral Model

Network Routing

SVTRIP
HOUSEHOLD E-COMMERCE DEMAND BEHAVIORAL MODEL

More e-commerce demand for households with:
• Higher incomes
• More children

Less e-commerce demand for households with:
• More vehicles
• Fewer adults
• Residence is walkable or close to transit

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<td>Constant</td>
<td>-0.103</td>
<td>-1.64</td>
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<tr>
<td># of HH Children</td>
<td>0.104</td>
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<td>HH income less than 25k</td>
<td>-0.459</td>
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<td>HH income between 25k and 50k</td>
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<td>HH income between 50k and 100k</td>
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<td>HH income greater than 200k</td>
<td>0.355</td>
<td>3.32</td>
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<td>Distance to nearest transit stop from home (in 100th of miles)</td>
<td>0.077</td>
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<tr>
<td># of HH Adults</td>
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<td>Walk Score (Range 0 to 10)</td>
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<td># of HH Vehicle</td>
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<td>Theta 5</td>
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<td>Theta 6</td>
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Summary

Number of Observations | 971 |
Final Log-likelihood | -1362.45 |
REGIONAL FREIGHT IMPACTS
In the Chicago Area Today, *MDT and *HDT Make Up 10% VMT and One-Third of Energy

- Household shopping: 6% of VMT
- Regional and long-haul HDT
- MDT-Other: landscaping, mail, and more
- MDT-Retail: major, non-mail parcel carriers

*MDT, HDT: Medium-duty truck, heavy-duty truck
DELIVERY VS. BRICK-AND-MORTAR SHOPPING VARIES BY TYPE OF ITEM*

Prepared meals and grocery: mostly in-person

SAN FRANCISCO

*pre-COVID
TODAY: 1 IN 7 SHOPPING EVENTS HAS BEEN REPLACED BY A DELIVERY TRIP

Deliveries replace both vehicle trips and non-vehicle trips

SAN FRANCISCO

- 0.60 deliveries out of 1.60 (37%) do not substitute for a shopping trip
- Deliveries replace 0.18 out of 2 (9%) of non-vehicle trips
- Deliveries replace 0.8 out of 5 (16%) of vehicle trips
- A given delivery is 1.3 times as likely to replace a household vehicle shopping trip than add on to existing trips
INCREASE IN E-COMMERCE LOWERS OVERALL SYSTEM VMT AND ENERGY

Fewer shopping trips, more deliveries make the difference

SHOPPING TRIP = 7 to 8 miles, one way

DEPARTMENT TRIP

1 ADDED STOP = 0.4 mile
HOME DELIVERIES CAN DECREASE TRANSPORTATION ENERGY USE

Energy savings from e-commerce and vehicle technologies
FREIGHT MOVEMENT WILL BE INCREASINGLY IMPORTANT

Due to increased light duty electrification and freight demand

CHICAGO

33%
CURRENT MD/HD TRANSPORTATION ENERGY

VMT
300M
200M
100M
0M

ENERGY
400
300
200
100
0

MD/HD
LD

281,324,908

22,870,366

150
308

BASE
FREIGHT MOVEMENT WILL BE INCREASINGLY IMPORTANT
Due to increased light duty electrification and freight demand

50% FUTURE MD/HD TRANSPORTATION ENERGY

CHICAGO

VMT

ENERGY

300M

200M

100M

0M

249,985,727

30,204,385

Total GWhr

HIGH SHARING

HIGH AUTOMATION

MD/HD

LD
SUMMARY

- A retail system with e-commerce delivery appears to be more efficient than one based on household shopping trips alone.

- Passenger vehicle technologies are progressing more quickly than those for freight, leading to freight’s increasingly outsized impacts on the system.

- The study reflects pre-COVID trends!
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