Estimation of Demand Responses to Ramp Meters

by

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Problem Statement

Previous research has assumed fixed demand

- How different types of trips respond to ramp meters (work vs. non-work; short vs. long)

- A bill was passed to shut off ramp meters to study effectiveness in the Twin Cities in Spring 2000

- The shut-off experiment provides data not previously available (Oct. 16 ~ Dec. 8, 2000)
Research Objectives

- Develop a methodology to estimate freeway demand shifts from loop detector data.

- Apply the methodology to determine from the empirical data how travelers respond to ramp meters.
Study Locations
Data

- 30-sec flow counts, a measure of the number of vehicles that have passed over a detector, collected during the shut-off period (in 2000) and the corresponding weeks in 1999.

- Freeway geometry

- Hourly precipitation data

- Control for other factors: Seasonal Demand Fluctuation, Weather, Crashes
Methodology

\[ \text{Total Trips} = \sum_{n=1}^{N} Q_n \]

\[ \text{Total VKT} = \sum_{i=1}^{I} \left[ \left( \sum_{n=1}^{N_i} Q_n \right) L_i \right] \]

\[ \text{Average trip length} = \frac{\text{Total VKT}}{\text{Total trips}} \]
Methodology (cont.)

Non-work trips (discretionary trips)

\[ Q_{AM} \]  (morning peak flow)

\[ Q_{PM} \]  (afternoon peak flow)

Eastbound Non-work Trip = \[ Q_{PM} - Q_{AM} \]
Results

Peak Spreading

% Changes of total trips

Early Morning

-20%
-10%
0%
10%
20%

Morning Peak

-3%
-1%
1%
1%
9%
25%
14%
10%

TH 169 NB
TH 169 SB
I-494 WB & NB
I-494 SB & EB
Results (cont.)

Peak Spreading (cont.)

%Changes in total VKT

-3%  3%  8%
-6%  2%  2%
-6%  0%  0%

Peak Total   Weekday Off-peak   Weekends
Results (cont. 2)

Afternoon peak non-work trips

- Afternoon Peak Non-work Trips: 16% increase, 10% decrease, 6% increase
- Afternoon Peak Non-work trip VKT: -5% increase, -15% decrease
- Afternoon Non-work Trip Length: -11% decrease
- Weekday Total Trips: 1% increase, 4% increase

Legend:
- TH 169 NB
- TH 169 SB
- I494 WB&NB
- I494 SB & EB
Results (cont. 3)

Long non-work trips are rescheduled to...

Changes in total VKT

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<tr>
<th>Weekday Off-peaks</th>
<th>Weekends</th>
<th>Weekdays</th>
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<td>I494 WB&amp;NB</td>
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Conclusions

- Evidence of rescheduling trips, switching routes and/or destinations after the shut-off
- Long non-work trips are losers and short non-work trips are winners
- Freeways handle more trips but fewer vehicle kilometers
- If used in combination with an OD prediction technique, the methodology developed herein is capable to estimate the actual freeway supply/demand curve.