HOT Lanes: Their Distributional Impact and Effect on Congestion

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Traffic congestion is a problem we know how to solve

Costs of traffic congestion
- Wastes time
- Wastes fuel
- Creates additional pollution

Solution: Tolls, first proposed by Arthur Pigou in 1920
A barrier to tolling is the belief that it hurts many road users

- **Academics**
  
  “First-best congestion pricing . . . introduces severe disparities in direct welfare impact.”

  Small, Winston, and Yan, 2005

- **Policy makers**
  
  “[Congestion pricing is] unfair in terms of the economic impact.”

  Maryland Gov. Parris Glendening

- **Pundits**
  
  “Exalted [toll] lanes leave the average Joe in the dust.”

  Marc Fisher, The Washington Post

- **Public**
  
  “Turkeys don’t vote for Christmas and motorists won’t vote for more taxes to drive.”

  Voter in Manchester, UK
Only pricing some of the lanes helps improve distributional impacts

Agenda for talk
- Explain theoretical reasons why Express/HOT Lanes have significantly better distributional impacts
  - Key idea: Preserves ability to not pay a toll
  - If tolling can increase throughput, can make everyone better off
  - Value of reliability
- Show that in practice there is (usually) broad support for Express/HOT Lanes
Express Lanes only toll a portion of the lanes
Express Lanes growing quickly in US
Theoretical possibility: A carefully designed toll on a portion of the lanes can help everyone, even before revenue is spent.
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- Time varying
- Collected electronically
- Set to maximize throughput, not profits or social welfare
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- Give up some potential efficiency gains in order to help everyone
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- Source of this new result?
  - Identifying a second externality using insights from traffic engineering literature
An additional driver can impose two externalities

1. Lengthen the line

2. Reduce throughput/reduce speed at which line moves
There are two ways congestion reduces throughput

- Once queue forms throughput at bottleneck drops
  - e.g. throughput on I-805N at 47th St. in San Diego regularly falls by **12%** once a queue forms (Chung et al. 2007)

- Queue behind bottleneck blocks upstream traffic
  - e.g. throughput on I-880N near San Francisco regularly falls by 25% due to queue spillovers from I-238 (Munoz and Daganzo 2002)
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By delaying some departures, everyone can arrive sooner

How tolls can increase throughput

- On a free road:
  Too many cars on road ⇒ queues ⇒ lower throughput

- With time-varying tolls:
  Spread out departures ⇒ no queues ⇒ higher throughput
Queues form because too many drivers depart at once

\[ r(t) \]

\[ r'(t) \]

\[ r''(t) \]

When drivers are the same, pricing helps everyone.
Throughput falls because of queuing

- Departure rate (veh/min)
- Time of day
- Maximum throughput
- Actual throughput

$r(t)$
$r'(t)$

- 7:00
- 8:30
- 7:25
- 9:20

⇒ when drivers are the same, pricing helps everyone
Use tolls to affect rate at which drivers depart.
No queuing means higher throughput and shorter rush hour
No queuing means higher throughput and shorter rush hour

\[
\begin{align*}
    & r(t) \\
    & r'(t) \\
    & \text{Maximum throughput} \\
    & \text{Actual throughput}
\end{align*}
\]

\[\Rightarrow \text{when drivers are the same, pricing helps everyone}\]
When there are rich and poor drivers it is harder to make everyone better off

What happens when we price the entire road?
- Increase speeds and throughput
- Change currency from time to money
When there are rich and poor drivers it is harder to make everyone better off

What happens when we price the entire road?
- Increase speeds and throughput
- Change currency from time to money
By only pricing a portion of the lanes we can still help everyone

Intuition for pricing a portion of the lanes

<table>
<thead>
<tr>
<th>Both lanes free</th>
<th>Lane 1</th>
<th>Lane 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pricing</td>
<td>Free</td>
<td>Free</td>
</tr>
<tr>
<td>Avg. queue length</td>
<td>long</td>
<td>long</td>
</tr>
<tr>
<td>Throughput</td>
<td>low</td>
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<tr>
<td>Travel time</td>
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<td>Share of trips</td>
<td>50%</td>
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### Intuition for pricing a portion of the lanes

<table>
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<tr>
<td>Pricing</td>
<td>Free</td>
<td>Toll</td>
</tr>
<tr>
<td>Avg. queue length</td>
<td>long</td>
<td>0</td>
</tr>
<tr>
<td>Throughput</td>
<td>low</td>
<td>↑</td>
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<tr>
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<td>long</td>
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- ↓: Decrease
- ↑: Increase
Pricing all of the road hurts the inflexible poor

Figure: Change in trip price when pricing all lanes
Pricing 1/2 of lanes helps everyone

Figure: Change in trip price when pricing 1/2 of lanes
The welfare gains from pricing are large

Average annual welfare effects (dollars)

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<td>Social welfare gains</td>
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If willing to relax requirement that pricing hurt no one, then can obtain a larger share of welfare gains.
We can further improve the welfare effects of congestion pricing

Things could add to analysis to help tolling help everyone
- Use of revenue
- Ways to let inflexible poor to pay with time to travel at peak
- Value of reliability
- Use of revenue
- Negative tolls
- Subsidize tolls for low-income drivers
- Cut sales tax
- Expand highway
- Subsidize public transit
We can further improve the welfare effects of congestion pricing

Things could add to analysis to help tolling help everyone

- Use of revenue
  - Negative tolls off peak
  - Subsidize tolls for low-income drivers
  - Cut sales tax
  - Expand highway
  - Subsidize public transit
- Ways to let inflexible poor to pay with time to travel at peak

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  - Subsidize tolls for low-income drivers
  - Cut sales tax
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- Ways to let inflexible poor to pay with time to travel at peak
  - Public transit
  - Carpooling

- Value of reliability
  - Everyone has days they really need to be on time
  - Empirical evidence suggests this accounts for a large share of value of Express Lanes (Bento et al., 2020; Small et al., 2005)
What do low-income drivers think about Express Lanes?

Do low-income drivers use Express Lanes?

Do low-income drivers like Express Lanes?
What do low-income drivers think about Express Lanes?

Do low-income drivers use Express Lanes?
- Yes, on average about 24% of users are low-income, with shares ranging from 4%–61%
  - (Across 11 facilities, using various definitions of low income)
  - Even poor people can have a high value of time

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Do low-income drivers like Express Lanes?
- Generally a majority of low-income drivers support Express Lanes
  - 6 facilities find a majority of low-income drivers support
  - 2 facilities find they do not
- This is based on how actually implemented, with, depending on the facility, discounted fares and subsidized transit
Conclusion

- Traffic congestion is a major problem
- Express Lanes can address concerns over distributional impacts
- Major benefit of Express Lanes is allow drivers to choose to not pay a toll
- Theoretically possible for Express Lanes to help all drivers
- In practice, low-income drivers use and like Express Lanes