Pareto Improvements from Lexus Lanes
The effects of pricing a portion of the lanes on congested highways

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Traffic congestion is a problem we know how to solve

Costs of traffic congestion in USA

- **52 hr/commuter/yr in major urban areas**
  
  (Schrank et al. 2012)

- **2.2% of annual gasoline consumption**
  
  (Schrank et al. 2012; EIA 2012)

- Additional pollution more than **6 times** the amount saved by current fleet of hybrid and electric vehicles
  
  (Samaras and Meisterling 2008; EPA 2011; Schrank et al. 2012; EIA 2013)

- Pollution responsible for **8,600 pre-term births**
  
  (Currie and Walker 2011)

Solution

- **Tolls**

- First proposed by Pigou in **1920**
A barrier to congestion pricing 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

- Public
  “Turkeys don’t vote for Christmas and motorists won’t vote for more taxes to drive.” Voter in Manchester, UK
Key result: 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
- If this allows us to overcome political opposition then we’re trading *potential* efficiency gains for *actual* efficiency gains
- What allows me to get 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)
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- 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)
Queues form because too many drivers depart at once

The graph shows:
- The departure rate (veh/min) as a function of time of day.
- The maximum throughput at different times:
  - 7:00: 48 veh/min
  - 8:30: 32 veh/min
  - 9:20: 8 veh/min

The departure rate function is indicated as $r(t)$.

When agents are homogeneous, pricing is a Pareto improvement.
Throughput falls because of queuing

\[ r(t) \]

\[ r'(t) \]

\[ r''(t) \]

\[ \Rightarrow \text{when agents are homogeneous pricing is a Pareto improvement} \]
Use tolls to affect rate at which drivers depart

Departure rate (veh/min)

\[ r(t) \]
\[ r'(t) \]
\[ \Rightarrow \text{when agents are homogeneous pricing is a Pareto improvement} \]
No queuing means higher throughput and shorter rush hour

Departure rate (veh/min)

\[ r(t) \]

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Actual throughput

Maximum throughput

7:00 7:40 8:30 9:20

Time of day
No queuing means higher throughput and shorter rush hour

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\[ \Rightarrow \text{when agents are homogeneous pricing is a Pareto improvement} \]
When there are rich and poor agents 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 time to money
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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

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<th>Lane 2</th>
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Pareto Improvements from Lexus Lanes 8/14
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

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Pareto Improvements from Lexus Lanes
If willing to relax requirement that pricing hurt no one, then can obtain a larger share of welfare gains.
We can improve the welfare effects of congestion pricing

Things could add to analysis to make it easier to help everyone

▶ Use of revenue

▶ Ways to let inflexible poor to pay with time to travel at peak
We can improve the welfare effects of congestion pricing

Things could add to analysis to make it easier to help everyone

► Use of revenue
  ► 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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  ▸ Expand highway
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▸ Ways to let inflexible poor to pay with time to travel at peak
  ▸ Public transit
  ▸ Carpooling
Conclusion

- Congestion pricing can increase highway throughput
- Theoretically, pricing a portion of the lanes can help all road users, even before we use the revenue
- Empirically, pricing 1/2 of lanes on SR-91 will help all road users, with welfare gains of 3.5% median income