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

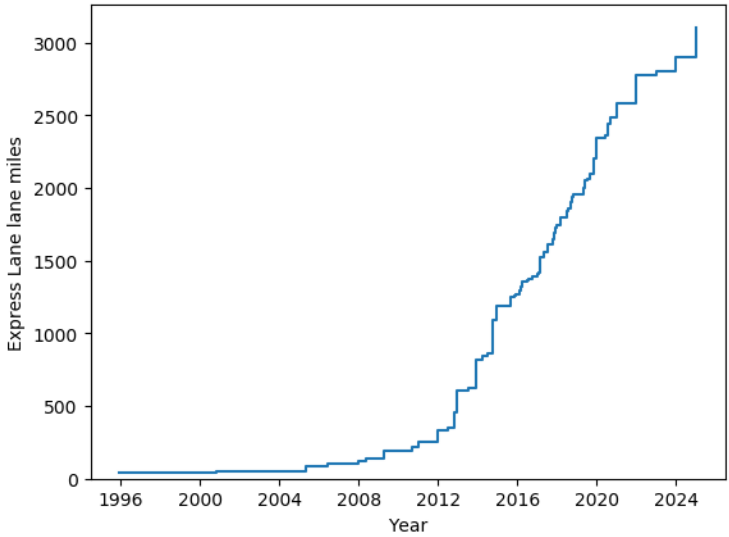
Only pricing some of the lanes helps improve distributional impacts

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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- If this allows us to overcome political opposition then we're trading potential efficiency gains for actual efficiency gains
- 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)
  - cf. Banks (1990), Hall and Agyemang-Duah (1991), Banks (1991), Persaud et al. (1998), Cassidy and Bertini (1999), Bertini and Malik (2004), Zhang and Levinson (2004), Bertini and Leal (2005), Cassidy and Rudjanakanoknad (2005), Rudjanakanoknad (2005), Chung et al. (2007), Guan et al. (2009), Oh and Yeo (2012), Srivastava and Geroliminis (2013)

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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)

By delaying some departures, everyone can arrive sooner

How tolls can increase throughput

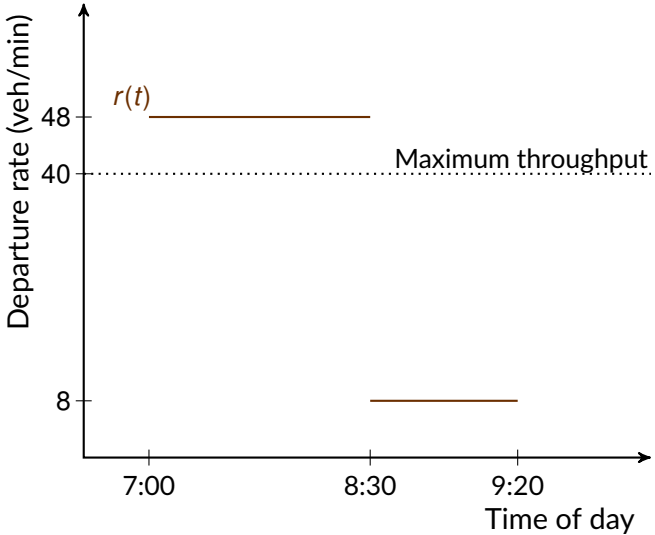
- On a free road:

  Too many cars on road $\Rightarrow$ queues $\Rightarrow$ lower throughput

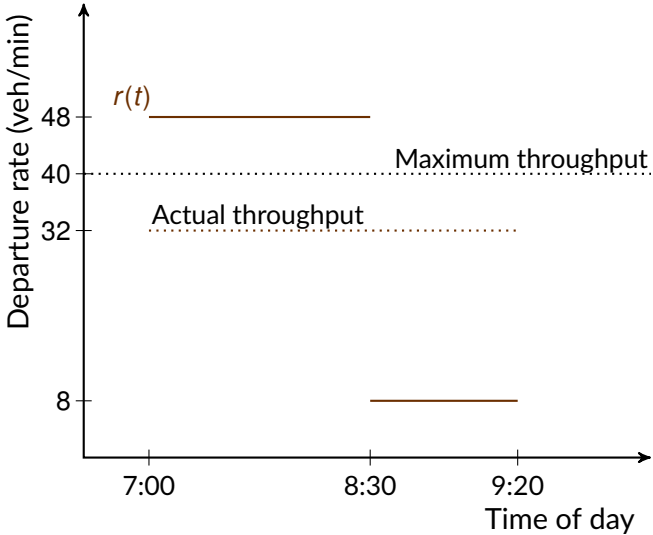
- With time-varying tolls:

  Spread out departures $\Rightarrow$ no queues $\Rightarrow$ higher throughput

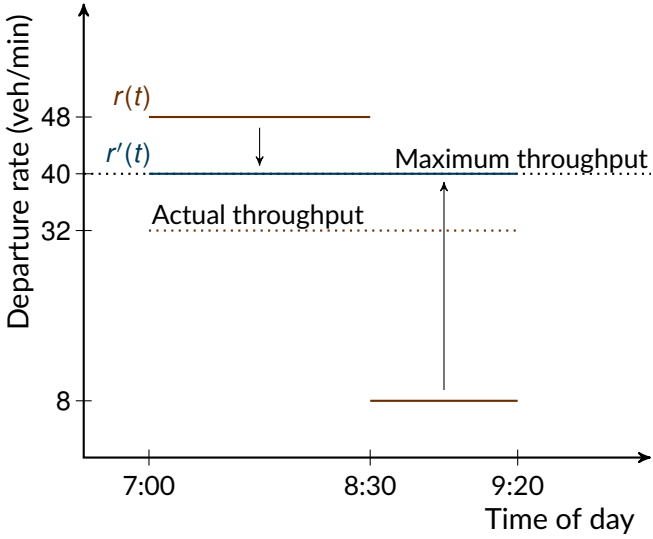
Queues form because too many drivers depart at once



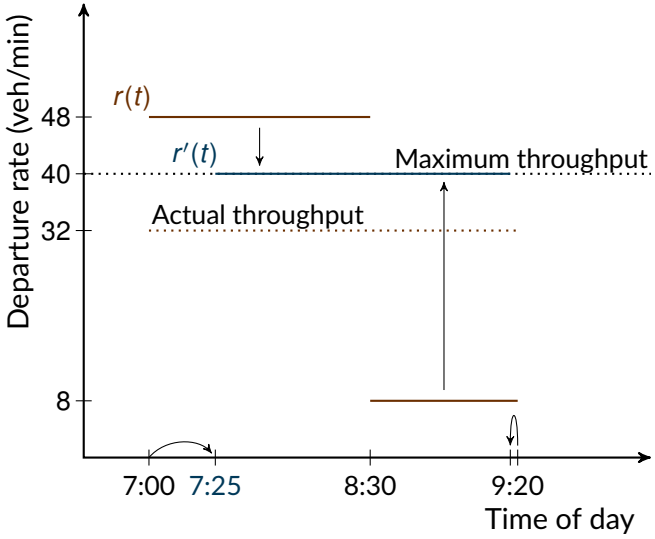
Throughput falls because of queuing



Use tolls to affect rate at which drivers depart



No queuing means higher throughput and shorter rush hour



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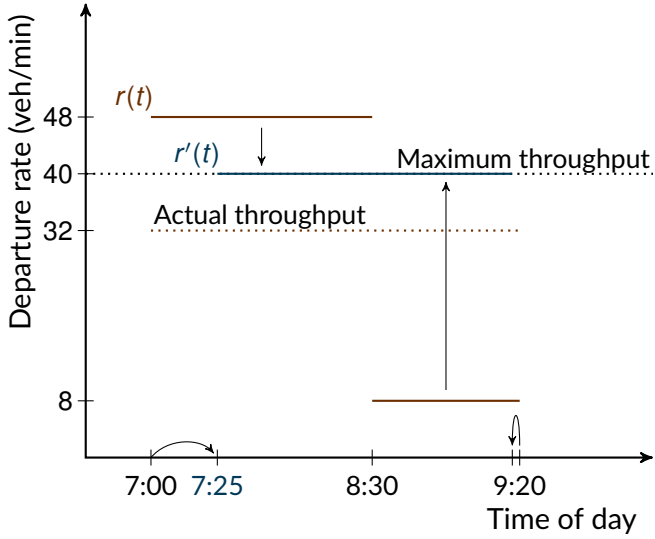

$\Rightarrow$ when drivers are the same, pricing helps everyone

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

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By only pricing a portion of the lanes we can still help everyone

Intuition for pricing a portion of the lanes

	Both lanes free	
	Lane 1	Lane 2
Pricing	Free	Free
Avg. queue length	long	long
Throughput	low	low
Travel time	long	long
Share of trips	50%	50%

By only pricing a portion of the lanes we can still help everyone

Intuition for pricing a portion of the lanes

	Both lanes free		Price one lane	
	Lane 1	Lane 2	Lane 1	Lane 2
Pricing	Free	Free	Toll	Free
Avg. queue length	long	long	0	$\downarrow$
Throughput	low	low	$\uparrow$	$-$
Travel time	long	long	$\downarrow$	$\downarrow$
Share of trips	50%	50%	$\uparrow$	$\downarrow$

Pricing all of the road hurts the inflexible poor

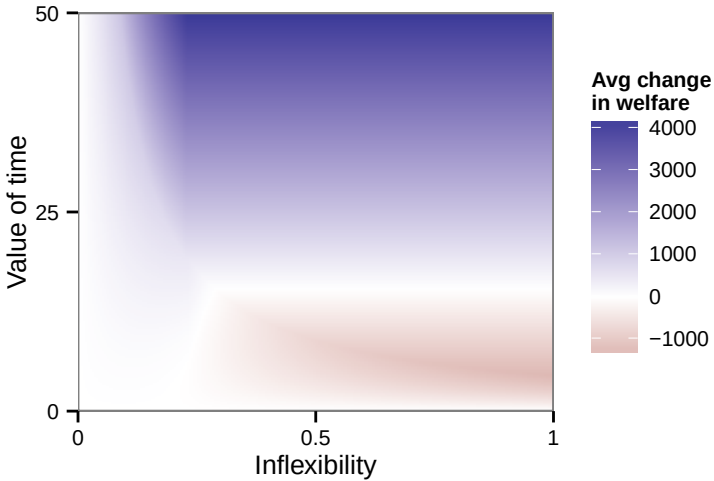

Figure: Change in trip price when pricing all lanes

Pricing 1/2 of lanes helps everyone

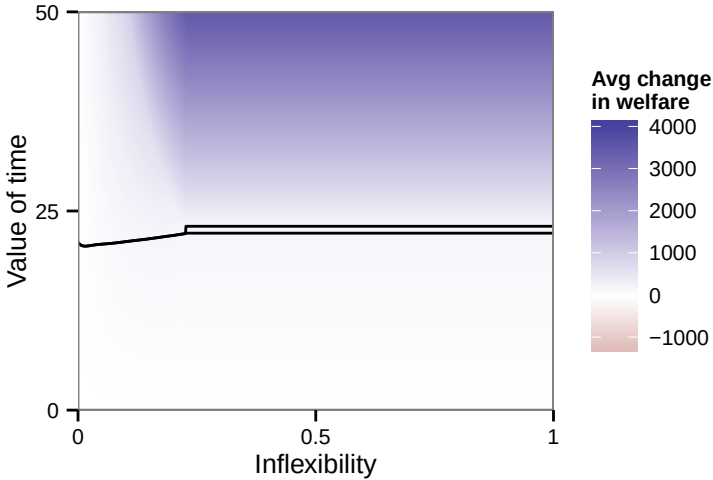

Figure: Change in trip price when pricing 1/2 of lanes

The welfare gains from pricing are large

Average annual welfare effects (dollars)

	Tolled	Pricing 1/2 of lanes
Largest welfare loss	2,390	0
Social welfare gains	2,400	1,740
Private welfare gains	1,080	760

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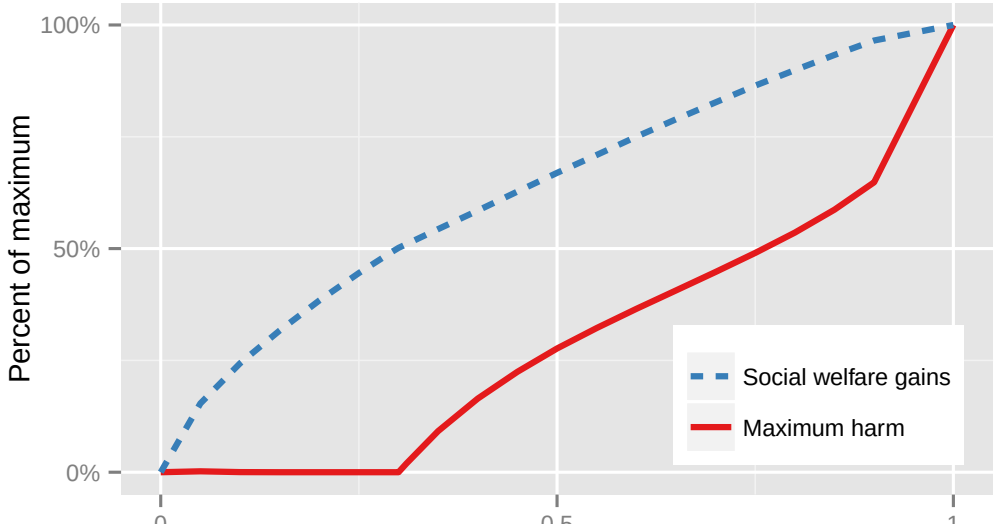
If willing to relax requirement that pricing hurt no one, then can obtain a larger share of welfare gains



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

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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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- 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?

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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