The Value of Urgency:
Evidence from Congestion Pricing Experiments

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Motivation

- There are many instances where individuals exhibit preferences for urgency

- **Value of Urgency** – discrete willingness to pay (WTP) to jump a queue, and avoid a penalty for failing to meet an important schedule constraint.
  Important insight: value of urgency doesn't scale up with time

- Examples:
  - WTP to find a donor of an organ critical for survival
  - WTP for expedited passport processing
  - WTP of an automated trading company to be the first to receive proprietary data from a stock exchange market

Purpose of the Paper

- Take advantage of a program allows solo-drivers access to ExpressLanes upon the payment of a toll, to **recover the first estimates of commuters' value of urgency**

- Demonstrate the **first order** importance of preferences for urgency, relative to other well documented commuters' preference parameters critical for infrastructure project evaluation (*value of time* and the *value of schedule delays)* [take classical theoretical models to the data and test them]

- Because of urgency, the primary welfare effect of the program **overwhelmingly dominates** infrastructure costs and potential interaction effects in related markets

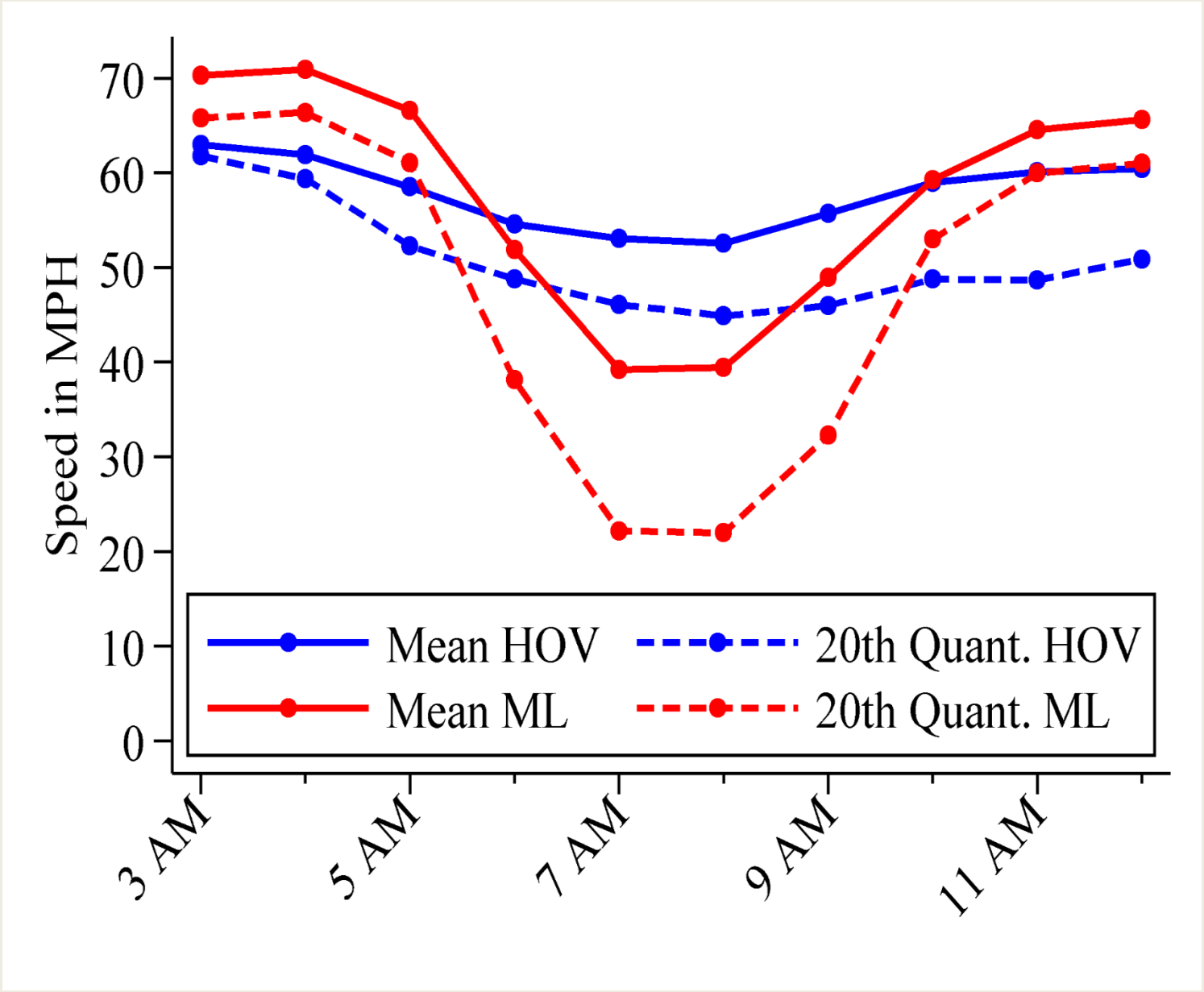
Overview of ExpressLanes Program

- Start date: February 23rd, 2013 on the I-10
- Goal: increase the total throughput and raise funds to cover the operating costs of the corridor
- Transponder: cost is about $40, required in all vehicles
- Pricing: level-of-service that adjusts prices every five minutes to maintain maximum throughput
- Drivers can purchase sub-segments of the Expresslanes: they can enter and exit at 6 locations. Toll rates are posted at these entrances. Once the vehicle enters the lane, the toll rate is locked for the duration of its trip
- Minimum speed: 45 mph to prevent reductions in incentives to carpool; another lane was added December 2013

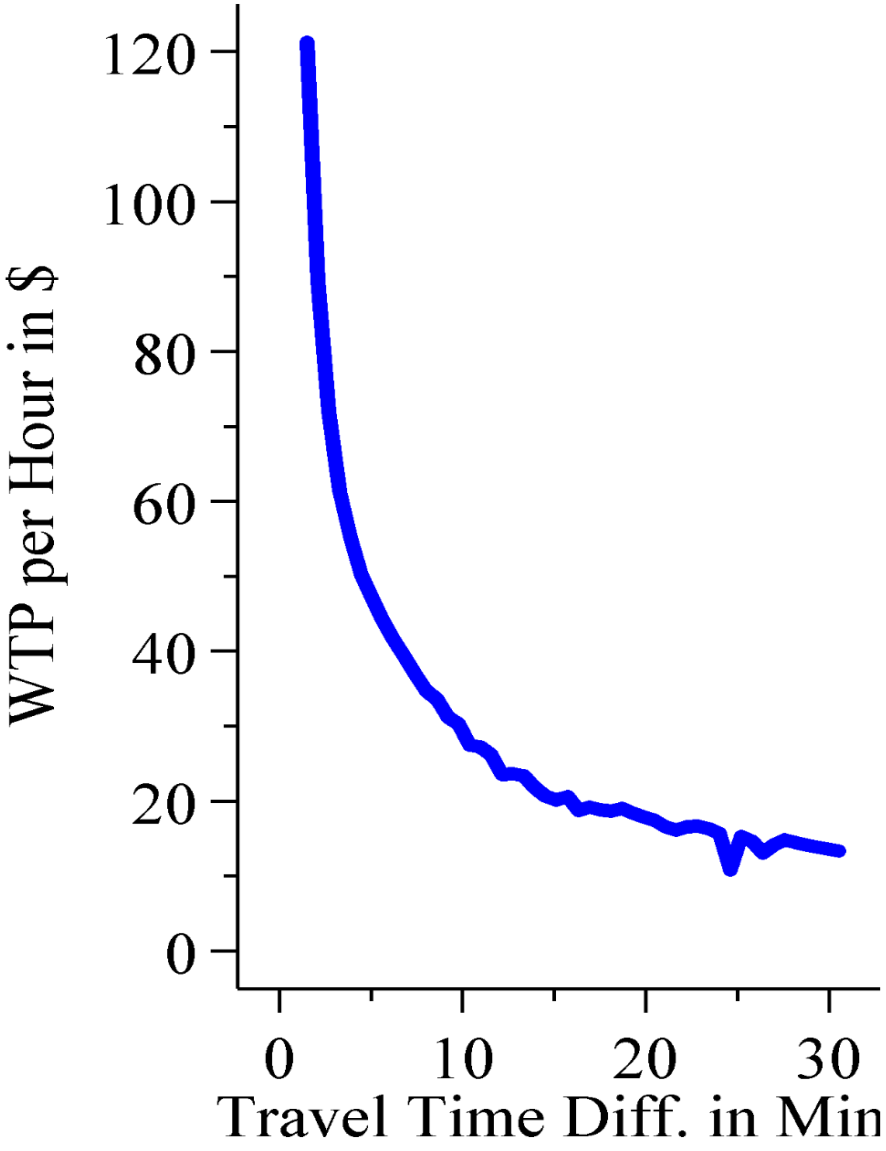
Unusually rich real-time dataset

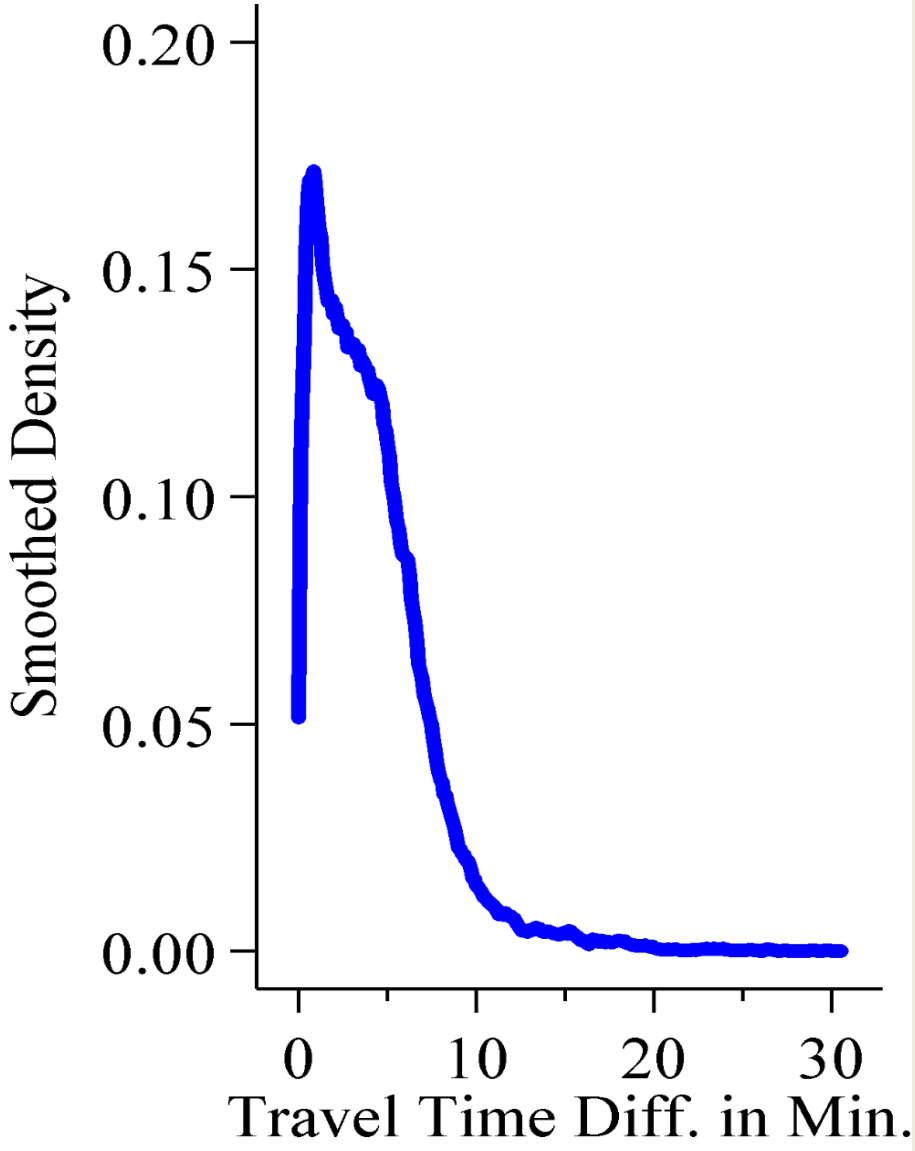
- Freeway Performance Measurement System (PeMS):
  - Measures flow and speed
  - Detectors: 52 detectors tracking the 10.5-mile road segment of the I-10W
  - 75,791 hourly observations for the morning peak (5AM-9AM) covering September 3rd, 2012 to December 30th, 2013
- Los Angeles Metropolitan Transportation Authority (METRO):
  - 1.8 Million trips in I-10W (1.0 Million in the AM peak) covering Deember 1, 2012 to December 30th, 2013.
  - 496,839 private SOVs acconts (466,232 with positive time savings)

Average Travel Times of I-10W (9/12-2/13)



Seen on a per hour basis, WTP appear absurd





Alternative Theoretical Models for Infrastructure Project Evaluation

- Models that quantify the value of travel time savings (Heusher, 2001) and rely on the concept of Value of Time (Becker, 1965). [abstract from any scheduling considerations]
- Models of the journey to work that explicit consider scheduling costs (Small, 1982, Arnott et. al, 1990, 1993, 1994)
  - Focus on schedule delay costs:
    - Costs of early arrivals
    - Costs of late arrivals
  - Schedule delay costs scale up with time (measured on a per hour basis)
  - Ignore the potential of schedule constraint costs – in contrast with schedule delay, these are discrete costs that do not scale up with time

Summary of Theoretical Findings

Model	WTP (per hour)	Frequency	Length of trip in EL	% of agents late
Travel Time Savings	Constant	All the time	Entire	Ignored
Schedule Delay	Constant	Somewhat frequent	longer	20%
Schedule Constraint	Declining	Infrequent	Mostly Short	7%

Data rejects the travel time savings and schedule delay models and support the schedule constraint model

Magnitude of the Value of Urgency

- Fundamental insight of grouping the data into deciles based on time savings: **No traditional theory would have predicted the high WTP per hour recovered for the smaller time savings deciles. But these are the bulk of the trips!**

- Viewing the value of urgency as a 'cost of avoiding late arrival', we can apply hedonic-style methods and regress the total toll paid on time savings to recover the portion of the toll that is due to time savings versus urgency.

- At the same time, one could have potentially gotten the WTP pattern with non-linear scheduling costs. Would that work?

Value of Urgency: A simple 'hedonic' regression

Dependent variable: toll

	I	II	III	IV
Constant	2.94*** (0.50)	2.82*** (0.36)	Implies penalty for being late	Declines with lateness
Time in hours	11.05*** (3.03)	14.49 (9.32)	37.59*** (3.94)	62.27*** (9.12)
Time in hours^2		-15.07 (27.65)		-158.39*** (18.82)
Obs.	466,232	466,232	466,232	466,232
AIC	1,655,287	1,653,423	2,106,127	1,951,494
BIC	1,655,310	1,653,456	2,106,138	1,951,516

Can't distinguish α from γ

OLS Estimates: Weekday, Morning Peak, Private Accounts. * p<0.05, ** p<0.01, *** p<0.001

Relation to Prior Literature

Prior literature that ignores value of urgency: γ ranges from being equal to α to being twice as large as α ; with α=\$10 (50% of hourly wage), γ would range between \$10-\$20

	I	II	III	IV
Constant	3.57***	3.92**		
	(1.10)	(1.25)		
Time in hours	7.24**	5.38*	31.22***	21.68***
	(2.58)	(2.45)	(3.81)	(2.53)
Limit on Trip Differential	> 5 minutes	> 10 minutes	> 5 minutes	> 10 minutes
Obs.	146,365	21,830	146,365	21,830

OLS Estimates: Weekday, Morning Peak, Private Accounts. * p<0.05, ** p<0.01, *** p<0.001

Likely Magnitude of Preference Parameters

- Prior to program: 22343 in Mainline; with program: 1626 solo drivers in EL. This implies that each day, 7% of individuals are late
- The fraction of individuals late is (bottleneck model with urgency):

$$\frac{\beta}{\beta+\gamma} - \frac{\delta/(\beta+\gamma)}{N/s}$$

- Given a rush hour of 4 hours, δ=3, and evidence from prior literature that suggests that γ is 4 times greater than β implies:
  β= \$1.125 and γ=\$4.5 (doesn't depend on α)
- Minimum value of β= \$0.75 and γ=\$3 would imply no more delays
- Earlier literature estimates are \$5 and \$20, likely identified through the flat portion of the WTP per hour curve for 'average' time savings
- If $\alpha+\gamma$=\$11.5, implies α=\$7 (36% of the average hourly wage)
  Maximum estimative of α=\$8 (42% of the hourly wage)

Welfare Effects of ExpressLanes Policy

Primary Welfare Effect (Lower Bound)	
Private SOV Drivers With Urgency	$101,293
Private SOV Drivers Without Urgency	$21,999
All SOV Drivers (including Business accts.)	$154,567
Cost Side Interaction Effect (HOV Market)	$0
System Wide Interaction Effect	
$10 VOT	$37,669
$8 VOT	$30,135
$7 VOT	$26,368

Just for the first month of the program

Getting the Primary Welfare Effect Right: Implications for Project Evaluation

- The ExpressLanes project generated $154,567 (first month) and $1,718,492(first year)
- Infrastructure operating cost is $21,000 per month; Infrastructure cost per SOV in first month $0.65
- With an estimate of VOT of $10 per hour, we would have predicted toll revenue of $35,580 (first month) and $316,747 (year)
- The value of urgency of the 466,232 trips evaluated at $3 would predict $1.4 million
- Urgency accounts for 81% of the revenues while the portion from time savings is less than 19%.
- Future ex-ante state preference surveys for infrastructure project evaluation should aim to **elicit the valuation of urgency and the number of times individuals are likely to be late**, not the valuation of an 'average' trip that saves x versus y minutes.

Conclusions

- Presented convincing evidence that drivers scheduling decisions are largely determined by their value of urgency. They value arrivals on time, not decreases in being late by X versus Y minutes
- Central Estimate for the Value of Urgency is $3 dollars, 15% of wage rate
- Ignoring Urgency, ex-ante these programs barely pass simple cost-benefit analysis, because small time differential trips would be ignored
- Moving forward there is a unique opportunity:
  - to understand how these drivers respond to real-time pricing.
  - Consider tolls that vary by the level of fuel economy of vehicles
  - Consider broadly the role of ExpressLane Revenues to replace revenues of gas tax (which continue to be eroded with fuel economy improvements)