

Pricing Truck Congestion at the San Pedro Bay Ports

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Seiji Steimetz, Otto Chan, Agnes Ng, & Sean Fergus

Department of Economics

California State University at Long Beach





Overview

- The OffPeak Program (PierPass)
 - 24-hour full-service operations for all 12 international container terminals at POLA & POLB (July 2005)
 - Shifts divided into “Peak” & “Off-Peak” operations
 - Peak: Mon-Fri, 3am-6pm
 - Off-Peak: Mon-Thu, 6pm-3am; Sat 8am-6pm
 - “Traffic Mitigation Fee” levied on loaded containers passing through terminal gates during Peak gate hours
 - \$50 per TEU (April 2006)
 - Typically \$100 per container
 - Revenues earmarked to cover Off-Peak operating costs



Overview

□ Congestion Pricing

- The marginal social cost of each trip comprises private costs and “external” costs
- Economic efficiency requires the marginal benefit of the last trip taken to equal its marginal social cost
- Efficiency can be induced by a “congestion toll” equal to the marginal external cost at the optimal traffic level

□ Pricing congestion with the Traffic Mitigation Fee

- Can the TMF be modified to efficiently manage congestion while satisfying cost-recovery requirements?
- Can the burden of congestion management be spread across a wider class of truck trips?



Overview

□ Analytical & Empirical Framework

- Estimating the congestion externalities generated by each port-bound truck trip (loaded or unloaded)
- Prescribing a uniform congestion fee to levy on all truck trips made during peak gate hours
 - Must account for off-peak congestion spillovers
- Examining the scope of congestion management
 - Looking beyond truck congestion at terminal gates
- Comparing fee revenues to off-peak operating costs
- Examining the extent to which the economic-efficiency concerns of policymakers coincide with the cost-recovery concerns of terminal operators

“First-Best” Congestion-Pricing

- Optimal congestion fee levied on each trip equals the marginal external congestion cost

- Objective:

$$\text{Max}_v \int_0^{v'} d(v)dv - v \cdot c(v)$$

- “First-order condition”:

$$c(v) + \tau = c(v) + \frac{\partial c(v)}{\partial v} v$$

- Optimal congestion fee:

$$\tau = \frac{\partial c(v)}{\partial v} v$$

“Second-Best” Congestion-Pricing

- Incorporating constraints
 - Travel can occur during peak or off-peak periods
 - Only peak-period travel can be charged
 - Fees can shift congestion from peak to off-peak periods
- Optimal peak-period congestion fee equals the difference between peak & off-peak externalities
 - Objective:

$$\text{Max}_{v_P, v_O, \tau} \int_0^{v_P + v_O} d(v) dv - v_P \cdot c_P(v_P) - v_O \cdot c_O(v_O) + \lambda_P \cdot [c_P(v_P) + \tau - d(v)] + \lambda_O \cdot [c_O(v_O) - d(v)]$$

- Optimal congestion fee:
$$\tau = \frac{\partial c_P}{\partial v} v_P - \frac{\partial c_O}{\partial v} v_O \cdot \frac{-\partial d / \partial v}{\partial c_O / \partial v - \partial d / \partial v}$$

“Second-Best” Congestion-Pricing

- Assuming a “perfectly inelastic” travel demand
 - E.g. fees will not induce shippers to switch to Oakland
 - Optimal congestion fee:
$$\tau = \frac{\partial c_P}{\partial v} v_P - \frac{\partial c_O}{\partial v} v_O$$
 - Fee equals the difference between peak and off-peak congestion externalities
- Empirical Requirements
 - Estimates of peak and off-peak congestion costs at terminal gates and on surrounding highways
 - Must average costs across highways and travel periods to obtain a uniform fee

Empirical Framework

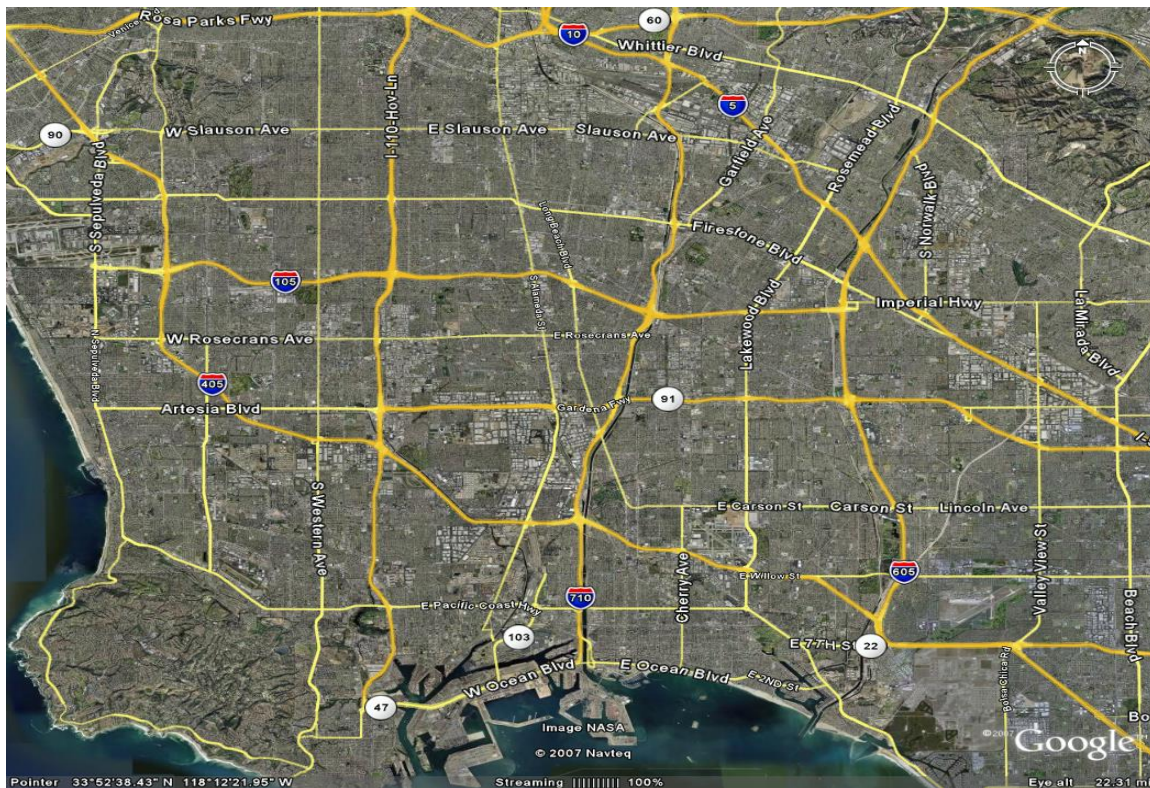
□ Bottleneck Model of Travel Delays

- Average travel time:
$$T(v) = T_f + \frac{w}{2} \cdot \left[\frac{v}{v_k} - 1 \right]$$
- External congestion cost:
$$EC = (\gamma_C \cdot \alpha_C + \gamma_T \cdot \alpha_T) \cdot v \cdot \frac{w}{2} \cdot \left[\frac{1}{v_k} \right]$$
- Must estimate highway or pedestal processing capacities and bottleneck durations
- Combine with existing estimates on passenger and commercial “value of time” (\$27, \$49)
- Must use “passenger car equivalents” for truck trips (2.7)

Empirical Framework

□ Traffic Data

- Highways: PeMS Traffic Database
- Terminal Gates: Ioannu et al. (2006) (METRANS)

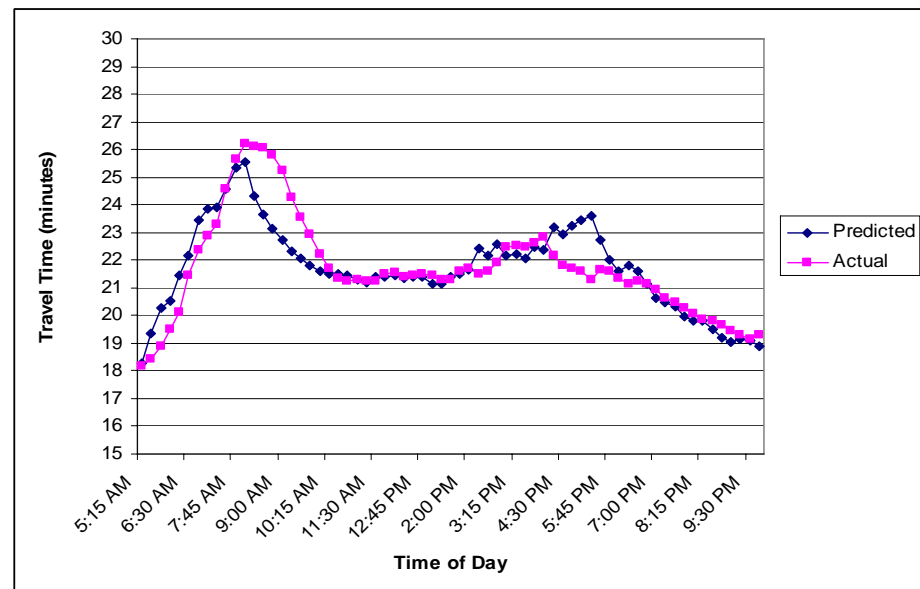


Empirical Framework

- Sample output: peak-period northbound travel on I-110 from Port of Los Angeles to Downtown

- Model estimated:
$$T(v) = 18.5 + \frac{w}{2} \cdot \left[\frac{v}{v_k} - 1 \right]$$

Parameter	Estimate	t-stat
Free-Flow Capacity	1479.92	29.46
Bottleneck Duration	4.92	9.78
	Adj. R^2	0.9981





External Cost Estimates

- Highway-specific congestion costs
 - For a northbound I-110 truck trip: \$5.90
 - Represents an average external cost across the peak period, weighted by estimated shares of truck trips taken during travel-time intervals within the peak period
 - Calculations repeated for all relevant highways in each direction and for both peak and off-peak travel
- Roundtrip costs for several proposed routes
 - E.g. peak-period trip on 91 West to 710 South: \$10.97
 - Outbound trip (assuming same reverse route): \$8.79
 - Roundtrip external cost: \$19.75



External Cost Estimates

- Weighted-average highway costs across routes
 - Shares of port-bound truck trips on each route drawn from previous studies serve as weights
 - Average peak-period highway externality: \$19.75
 - Average off-peak highway externality: \$3.63
- Terminal-gate delay costs
 - Bottleneck modeling applied to truck flows and delays
 - Average peak-period gate delay externality: \$2.13
 - Average off-peak gate delays are assumed negligible

Peak-Period Congestion Fees

	Peak Gate Hours	Off-Peak Gate Hours
Avg. Highway External Cost	\$19.75	\$3.63
Avg. Terminal-Gate External Cost	\$2.13	-
Sum of External Costs	\$21.88	\$3.63

- Optimal peak-period congestion fee: \$18.25
 - Levied on each port-bound truck trip (loaded or not)
 - Balances truck trips across peak and off-peak periods
 - Reduces peak-period truck congestion to an economically-efficient level



Discussion Points

- Levying fees on all truck trips
 - Fee of \$18.25 is small compared to current TMF of \$50 per TEU (typically \$100 per trip)
 - Fee applies to all truck trips because all truck trips generate external congestion costs
 - Warrants discussion on why the burden of congestion management falls on only a limited class of gate moves
- Scope of congestion management
 - Gate delays account for only 10% of the peak-period congestion costs generated by truck trips
 - Warrants discussion beyond terminal gates, I710, & I110



Discussion Points

- Revenue requirements
 - Off-peak terminal operating costs are currently about \$13M per month (PierPass)
 - Assuming 38,000 peak-period truck trips per month, an \$18.25 fee can generate monthly revenues of \$13.9M
 - It may be possible to efficiently manage truck congestion while satisfying terminal cost-recovery requirements
- Caveats
 - Estimates are sensitive to underlying modeling assumptions, parameter values, and estimation methods
 - This research only lays the groundwork for continued investigation and discussion