Traffic Choices Study

Findings from a Road Pricing Experiment

Symposium on Mileage-Based User Fees
April 14, 2009
Project Background
Lessons From A Road Charging Experiment

Road Finance: The Past…

• **Early Finance**
  – Most roads built by “private” companies and financed through tolls
  – Public contributions financed through general taxes
  – In 1901 New York City imposes a vehicle registration fee
  – By 1914 all states collect vehicle registration fees

• **Federal Aid Road Act of 1916**
  – Federal grants to States to improve public roads system
  – Led to the formalization of State Road Authorities
  – Prohibited tolls on Federal Aid facilities

• **A Tax on Fuels**
  – Oregon is the first; 1919
  – By 1929 all 48 states impose a tax on fuels
  – Federal fuel taxes imposed in 1932
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**Road Finance:** …the Present…

Current finance approaches are familiar and relatively easy and efficient to administer, but...

- **Road Finance System is financially weak:** poor fiscal elasticity of gas tax while costs are rising
- **System performance is declining:** congestion; deteriorating roads; land use and transit not obviating the problems
- **Gas tax (and other tax-based) finance perceived as unfair:** benefits are targeted while the taxes are broadly applied
- **Conventional road finance is a vicious circle:** low charge per mile fails to address peak loads which prompts road building without fiscal resources
- **Demand pricing can break the circle:** charges are levied selectively which controls excessive congestion and yields revenues for new capacity as it is really needed
Road Finance:...and, the Future?

Long-run viability of existing transportation finance approaches in question...

- TRB Special Report 285: The Fuel Tax and Alternatives for Transportation Funding
  - should undertake serious exploration of the potential of road use metering and mileage charging
- Surface Transportation Policy and Revenue Study Commission
  - recommends the next surface transportation authorization act require a major national study to develop the specific mechanisms and strategies for transitioning to an alternative to the fuel tax to fund surface transportation programs
- Surface Transportation Infrastructure Finance Commission
  - a federal funding system based on more direct forms of “user pay” charges, in the form of a charge for each mile driven, has emerged as the consensus choice for the future.
Traffic Choices Study

- Detailed analysis of road user choice and behavior under a broad and sustained tolling experiment
  - Tolling on all major roads
  - Tolls based on time of day and type of road
  - True price incentive with hold harmless design

- Development and proofing of tolling technical applications and systems design
  - In-vehicle GPS-based tolling
  - Cellular communicating to central system
  - Large-scale operational test showing the feasibility of network-wide tolling

- A pilot for understanding key policy variables and requirements
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Participant-Centered Project

- 275+ households; 400+ vehicles
- Randomly selected from an enriched pool of potential participant households
- Each household was provided a unique travel endowment account, based on their baseline travel behavior
- Tolls were levied against this endowment account
- At the end of the tolling period participants were given any remaining account balance
Technology

Lessons From A Road Charging Experiment
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Project Operations

- 450 OBU installations and removals
- System fully operational for over 18 months
- Over 270 participating households
  - Up to 18 months of trip records per household
- Hundreds of customer service calls
- Over 4,000 invoices distributed
- Over 100,000 device to central system transactions
- Over 750,000 individual trip records
- Household surveys and focus groups
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Behavioral Analysis
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Measured Dimensions of Demand Elasticity

- **Demand Dimensions**
  - Tours Per Week
  - Tour Distance (Miles Per Week)
  - Drive Time (Minutes Per Week)
  - Tour Segments (Segments Per Week)
  - Tolled Tour Distance (Tolled Miles Per Week)
  - Tour Start Time
  - Tolls Paid

- **Across tour (trip) purposes**
  - Home-to-Work
  - Work-to-Home
  - Home-to-Home
  - Work-to-Work
  - All Trips

- **Primary explanatory factors**
  - Toll Costs
  - HH Income
  - Drivers per HH
  - Transit Access
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Drivers Responded to Tolling by Altering Their Driving Behavior

Motorists made small-scale adjustments in travel that, in aggregate, could have a major effect on transportation system performance.

Household Sensitivity to Toll Costs (percent change in measures of demand)

- Elasticities measure percent change in driving behavior in response to 100% increase in trip costs.
Value of Time Observations: Home-to-Work Tours

Observed Home-to-Work Tour Values of Time (As a Function of Route Choice)

- Values of Time as a Percent of Wage Rate (right axis)
- Values of Time by Income (left axis)
Departure Time Response

Home-to-Work Tour Probability of Moving to Lower Toll

- Probability of Moving to Lower Cost Toll Period
- Minutes to Lower Toll Period
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Implications for Road Management
High Level Architecture for Network Road Pricing

- **GNSS Satellite System**

- **Central System**
  - Central Servers
  - Point of Sale

- **Electronic Tolling**
  - OBU
  - GSM

- **Enforcement**
  - Stationary Enforcement
  - Mobile Enforcement

- **Back Office**
  - General

- **WAN**
  - General

- **GSM**
  - General
## Network Road Tolling Cost Estimate

**Central Puget Sound Region**

<table>
<thead>
<tr>
<th>System Elements</th>
<th>Capital 2008 Dollars</th>
<th>Annual 2008 Dollars</th>
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</thead>
<tbody>
<tr>
<td>OBU and installation</td>
<td>$665,000,000</td>
<td>–</td>
</tr>
<tr>
<td>OBU / Installation – New Vehicles</td>
<td>–</td>
<td>$31,500,000</td>
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<tr>
<td>OBU – Repair / Replacement</td>
<td>–</td>
<td>$25,200,000</td>
</tr>
<tr>
<td>Training / Certification – Installers</td>
<td>$500,000</td>
<td>$50,000</td>
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<tr>
<td>Spare OBUs</td>
<td>$1,750,000</td>
<td>$20,000</td>
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<tr>
<td><strong>OBU Subtotal</strong></td>
<td><strong>$667,250,000</strong></td>
<td><strong>$56,770,000</strong></td>
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<tr>
<td>Stationary Stations</td>
<td>$20,000,000</td>
<td>$1,060,000</td>
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<tr>
<td>Transportable Stations</td>
<td>$1,875,000</td>
<td>$187,500</td>
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<tr>
<td>Mobile Stations / Vehicles</td>
<td>$1,200,000</td>
<td>$1,400,000</td>
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<tr>
<td>Enforcement Back Office</td>
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<td>$2,750,000</td>
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<td><strong>Enforcement Subtotal</strong></td>
<td><strong>$28,075,000</strong></td>
<td><strong>$5,397,500</strong></td>
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<td>Central System</td>
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<tr>
<td>Staff / Operations Training</td>
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<td>$100,000</td>
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<tr>
<td>Space for Central System / Back Office / Call Center</td>
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<td>$200,000</td>
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<td><strong>Central System Subtotal</strong></td>
<td><strong>$25,500,000</strong></td>
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<td>Data Communications Subtotal</td>
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<td>$201,758,800</td>
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<td><strong>Other Subtotal</strong></td>
<td><strong>$27,715,000</strong></td>
<td><strong>$3,500,000</strong></td>
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<tr>
<td><strong>Grand Total</strong></td>
<td><strong>$748,540,000</strong></td>
<td><strong>$287,726,300</strong></td>
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</table>
Modeling: Afternoon Peak Travel Times

Drive alone work trips Across all paths

Base Case vs. Tolling Scenario

- Total VMT down 7%
- Total VHT down 5%
## Benefits and Costs of Network Road Tolling

<table>
<thead>
<tr>
<th>Present Value Benefits/Costs</th>
<th>Millions of 2008 Dollars</th>
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<tbody>
<tr>
<td><strong>Benefits</strong></td>
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<tr>
<td>Time Savings</td>
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<td>Reliability Benefits</td>
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<td>Operating Cost Savings</td>
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<td>Toll Effects on Consumer Surplus</td>
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<td>System Operator Benefits (Tolls)</td>
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<td><strong>Present Value of Benefits</strong></td>
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<table>
<thead>
<tr>
<th><strong>Costs</strong></th>
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<td>OBU Costs</td>
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<tr>
<td>Enforcement</td>
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<td>Central System</td>
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<tr>
<td>Data Communication</td>
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<tr>
<td>Other</td>
<td>$100</td>
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<tr>
<td><strong>Present Value of Costs</strong></td>
<td>$5,500</td>
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</table>

**Present Value of Benefits less Costs** | $28,200

**Benefit-to-Cost Ratio** | 6.1
Estimating Revenue Potential

Gross proceeds from variable network tolls (not necessarily optimal toll rates):
$2.8 - $3.2 billion per year

Region’s share of State fuel tax proceeds:
$500 million per year

Costs for a fuel tax collection system
- Initialization Costs = NA
- Operations = 1% of proceeds

Costs for a network tolling system, (based on cost model)
- Initialization Costs = $750 million
- Operations = 5-8% of proceeds
Variable Tolls and Mileage Charge Compared to a Base Case (no new charges) in 2040

With similar revenue yields the user benefits (largely travel time savings) are over 2.5 times larger for variable tolls than for a uniform charge.
Lessons From A Road Charging Experiment

Toll Revenues On the Road Network

• 5% of centerline miles produced 50% of toll revenues

• Next 50% of revenues spread broadly across the core urban network

• 25% of the centerline miles produced less than 1% of total revenues
Participant Opinions on Funding

What Percent of Funding from Use Charges

- Before Tolling Survey
- After Tolling Survey

<table>
<thead>
<tr>
<th></th>
<th>Average</th>
<th>St. Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before Tolling Survey</td>
<td>38.9</td>
<td>28.4</td>
</tr>
<tr>
<td>After Tolling Survey</td>
<td>51.7</td>
<td>30.7</td>
</tr>
</tbody>
</table>
Participant Opinions About Privacy

Before Tolling Survey
After Tolling Survey

How Concerned Are You With Privacy? (1 = Low, 7 = High)

1 2 3 4 5 6 7
Conclusions

1. Observed response of drivers to tolls suggests there is a dramatic opportunity to significantly reduce traffic congestion and raise revenues for investment.

2. Not all aspects of a road network tolling system have been fully demonstrated yet. But the core technology for satellite-based (and whole road network) toll systems is mature and reliable.

3. A large-scale U.S. deployment of a GPS-based road tolling program will depend on proven systems, a viable business model, and public acceptance of underlying concepts.
Lessons From A Road Charging Experiment

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