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Traffic Choices Study – *In Summary*

Metropolitan regions throughout the nation face increasing problems with urban congestion. Their citizens want better (or, at least, not deteriorating) mobility. Yet, in most cases new road and transit capacity is a small portion of the total system, is increasingly expensive, and is often quickly congested with new trips. Not only is new capacity less effective and more expensive than it used to be, but funding to build that capacity has grown slower than the growth in traffic.

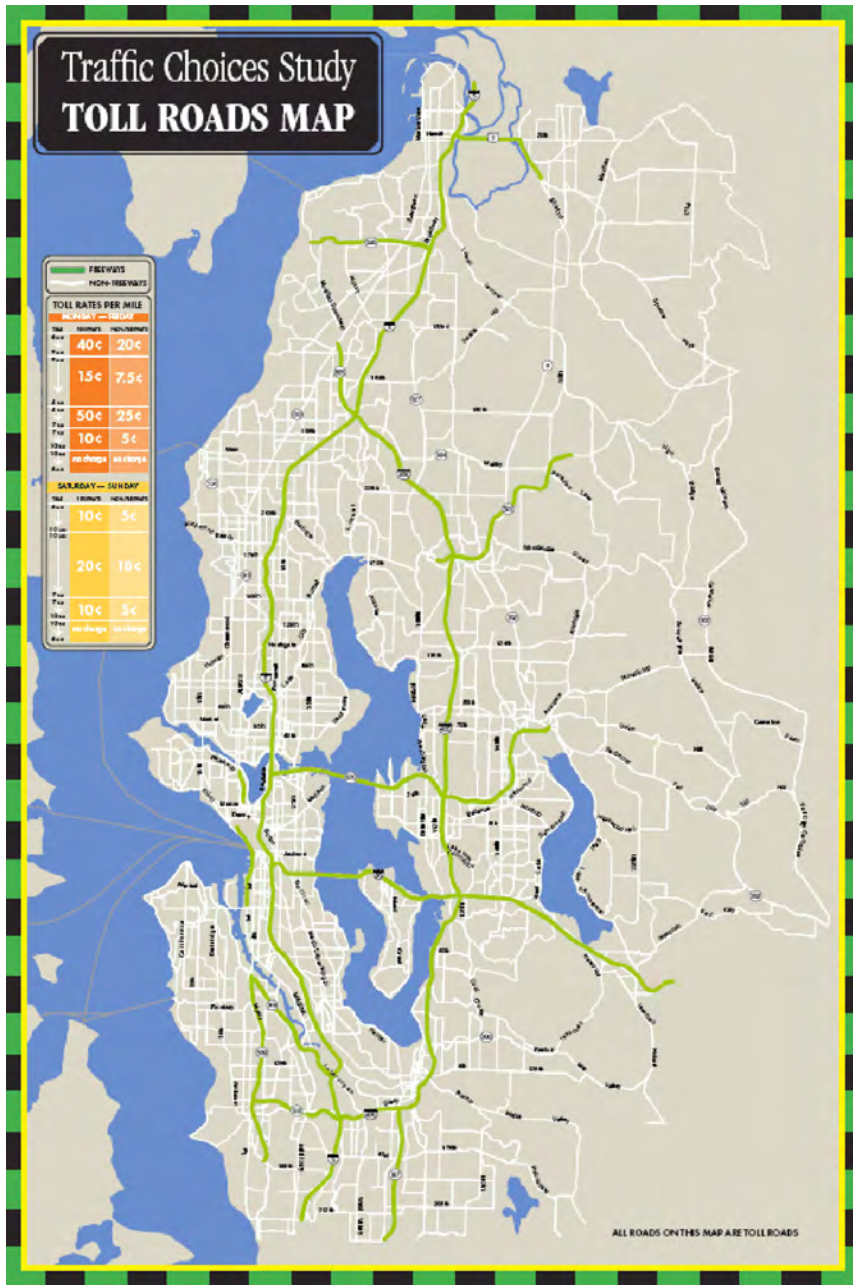
These problems have encouraged transportation professionals and regional policy makers to consider more seriously the role that time-of-day variable road tolling can play in bringing more balance to transportation supply and demand.

Congestion occurs when too many people want to use the same route at the same time. Thus, road tolling, based on charges that vary by time of day or amount of congestion, lets people know that they are imposing uncompensated costs on others, and that they are contributing to the poor performance of existing road capacity. It is appropriate that these users contribute the greater portion of the funding required to improve the supply. By failing to price road use under congested conditions, current policy prematurely justifies new capacity and, simultaneously, limits the fiscal capability to respond. The absence of congestion tolls leads to time wasted stuck in traffic, an overstatement of investment needs, and fiscal disarray. Congestion-based tolling can not only turn stop-and-go congestion into flowing traffic; it can also generate revenue and give signals to road operators about where travelers think trips are important enough that they are willing to pay for road improvements.

In 2002, the Puget Sound Regional Council (PSRC) received a grant from the Federal Highway Administration to conduct a pilot project to see how travelers change their travel behavior (number, mode, route, and time of vehicle trips) in response to variable charges for road use (variable or congestion-based tolling). The project, called the Traffic Choices Study, placed Global Positioning System (GPS) tolling meters in the vehicles of about 275 volunteer households. The project observed driving patterns before and after experimental tolls were charged for the use of all the major freeways and arterials in the Seattle metropolitan area.

Participants did not lose money. They were given a travel budget (or endowment account) from which tolls were deducted. If their driving patterns remained unchanged over the experiment, they would “spend” their account balance by the time the experiment concluded. If they changed their driving patterns to reduce the amount of driving on toll roads, they would keep the difference. This method held participants financially harmless, yet offered them the incentive of keeping their leftover budget if they changed their driving patterns. In this way, the study introduced real price incentives of a toll system, and measured whether and how much participants responded to those incentives.

Figure 1. Traffic Choices Toll Roads Map



Recent interest in less infrastructure-intensive toll systems, and rapid advances in mobile computing and satellite-based positioning technologies, has created an emerging industry for charging systems based on vehicle positioning capabilities. The Traffic Choices Study was able to install a single on-board device, or meter, in participating vehicles and avoid any roadside infrastructure costs. The meter used Global Positioning System (GPS) technology to provide a highly detailed record of travel behavior for each vehicle.

The GPS receiver in a vehicle’s meter used radio signals sent from satellites to determine the vehicle’s position, and matched that position to an embedded map of the toll-road network. The meter’s display showed toll rates and a road description. The meter stored location and toll information, and periodically communicated them to a central computer using cellular wireless communications. Through this approach, the Traffic Choices Study could toll an entire road network (**Figure 1**) with a toll system without incurring extensive roadside infrastructure costs.

On July 1, 2005 the Traffic Choices Study tolling system became operational. As study participants drove their vehicles on tolled roads the appropriate charges were deducted from their

account balance. The on-board tolling meters, or OBUs, which had previously been displaying only the name of roads driven, were now displaying the name of the road and the toll rate per mile. The OBUs also displayed the cumulative toll incurred during the current trip, allowing the participants to understand the cost of their travel decisions.

The Traffic Choices Study is the most comprehensive study of demand response to network tolling in existence. The study monitored driving behavior of participants for an average of approximately 18 months per household. While there is no single answer to the question of how participants changed

their travel in order to save money by paying fewer tolls (each household is unique, with specific flexibilities and constraints), findings from the Traffic Choices Study illustrate the magnitude of the short-run response to tolls across a broad range of behavioral dimensions. **Figure 2** depicts short-run response to tolls for all participants' vehicle travel. These are estimates of the near-term changes in behavior for the sample of households included in the study.

When measured across all types of travel purposes, and all study participant households, the tolls used in the study resulted in a number of important changes in travel demand. These included:

- 7 percent reduction in all tours of vehicle trips (tours per week)
- 12 percent reduction in vehicle miles traveled (miles per week)
- 8 percent reduction in tour drive time (minutes of driving per week)
- 6 percent reduction in tour segments (segments of tours per week)
- 13 percent reduction in miles driven on tolled roads (tolled miles per week)

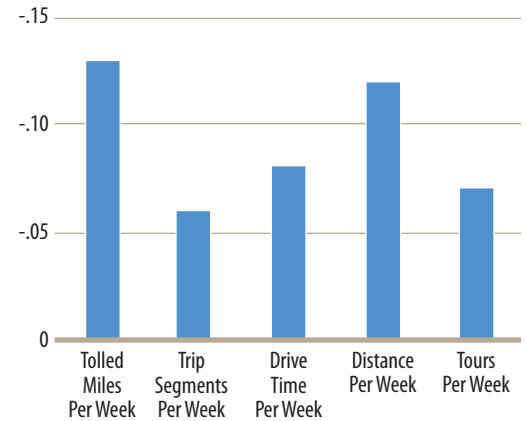
Analysis of the data revealed important changes in household driving patterns that could significantly reduce congestion if variable tolling were implemented within a regional road network. Many households made notable changes in their travel practices. Households that modified their travel did so in many different ways: taking fewer and shorter vehicle trips, choosing alternate routes and times of travel, or by linking trips together to reduce vehicle use altogether. Some households altered their routine travel practices (such as how they moved between home and work); other households made changes when they could, in more irregular ways over the course of daily events. Some participants report that these changes have persisted beyond the end of the study. Other households appear to have had very limited opportunities, in the short-run, to avoid using high demand roads during peak travel times.

The primary aims of the Traffic Choices Study were to (1) accurately describe the behavioral response to the variable tolling of roadways, (2) better understand issues of policy related to the implementation of road network tolling, and (3) test an integrated system of technical solutions to the problem of tolling a large network of roads without installing substantial physical hardware on the roadside. The study has met these goals and some of the primary conclusions from the study include:

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

- Motorists made small-scale adjustments in travel that, in aggregate, would have a major effect on transportation system performance.
- The scale of the revenues confirms the theoretical expectation that “optimal” tolls would support expanding transportation supply when and where it is needed most.
- While most revenues were generated on a small portion of the toll roads, the secondary road network (arterials) should not be ignored, as diversion causes real problems with revenue loss and displaced traffic.
- Done right, network-wide variable tolling could provide broad benefit, including lower vehicle emissions, fewer accidents, travel time savings, improved roadway performance reliability, and lower operating costs.
- A conservative analysis of the benefits of network tolling in the Puget Sound region indicates that the present value of net benefits could exceed \$28 billion over a 30-year period.

Figure 2. Household Sensitivity to Toll Costs
(percent change in measures of demand)



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.
 - The tolling system performed as expected, and met basic system operating requirements. Further work on system refinement and design of enforcement and billing systems would be required prior to any full system deployment.
 - The costs for GPS-based tolling systems are dominated by the initial investment in in-vehicle tolling equipment, and the communication of data during operations. Over the last few years, costs have declined dramatically and are expected to continue to come down.
 - Enforcement would require other facility use verification approaches (microwave, video capture, mobile enforcement) in addition to the GPS-tolling technology.
 - Installing in-vehicle tolling devices is a costly logistical challenge, but relying on equipment to come standard with new automobiles won't be practical if it doesn't represent a trusted platform for road tolling.
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.
 - The public sector business case is based on the sizable social benefits of road tolling. There are ways to generate revenues that are less administratively burdensome, but these displace economic activity, and fail to address traffic congestion.
 - Variable road tolling will be seen as unfair unless people understand that directly charging users addresses existing inequalities across users of the transportation system, and improves overall economic efficiency, leaving society with greater resources available to address remaining issues of fairness.
 - Concerns over user privacy depend on what data leaves the vehicle, and what safeguards are in place to limit its availability and use. A road tolling system can be developed such that user privacy is maintained. But like so many things, this would come at a price.
 - Some experience and familiarity with road tolling makes people more open to the concept, but all programs are unique and will succeed or fail on their own merits. Road users are particularly interested in the question of how revenues will be used.

The idea that the variable tolling of roads can result in substantial improvements in traffic conditions is unfamiliar to most motorists. There is a natural skepticism about how this might work, and how individuals might be affected by such an approach to road financing. If motorists do not believe that the traffic reduction benefits of road tolling will materialize, they will see the policy as a veiled attempt to simply raise revenues for government. The Traffic Choices Study has demonstrated that households and motorists faced with variable tolls do make the modest adjustments in their travel that will translate into large-scale reductions in roadway congestion. Many study participants even characterized their travel changes as minor, but the sum total of all their individual decisions can be shown to result in important shifts in the time, amount, and mode of travel so as to minimize the amount of time the region's residents would be stuck in traffic. The implications of these findings are explored in more detail in the rest of the study's reports.

In addition to this folio there is a **summary** of the study. It is intended for a broad audience of decision makers, policy analysts, and interested citizens. Those wanting more detail can find it in a longer technical report (*A GPS-Based Pricing Pilot Project: Evaluating Traveler Response to Variable Road Tolling Through a Sample of Volunteer Participants; Volume 1: Project Report*; April 2008) and in yet more detailed technical appendices to that report. All project materials will be made available online at www.psrc.org.