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**To:** Regional Pricing Coordination Team

**From:** Maren Outwater and Matthew Kitchen, PSRC

**Subject:** Value of Time for Travel Forecasting and Benefits Analysis

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## Overview

In 2005, the Puget Sound Regional Council (PSRC) began collecting Global Positional System (GPS) data for 275 households to study the travel behavior in response to variable road charges as part of the Traffic Choices Study<sup>1</sup>. These data have been analyzed to identify the value of time for different auto market segments represented in the PSRC regional travel demand forecasting model. The derivation of these values of time estimates and the implementation in the PSRC travel demand forecasting model are described in this memorandum. In addition, the specification of truck values of time is described based on a literature review of national sources. These values of time are also used in the benefits analysis to quantify the value of time savings in the region.

## Auto Value of Time Observations

In 1992 Kenneth Small observed that there appeared to be sufficient consistency in the evidence to suggest that the value of time spent traveling to work could be approximated by 50 percent of the gross wage rate<sup>2</sup>. Small observed that this was a reasonable average that would vary considerably (between 20 percent and 100 percent) across regions and possibly even more among subgroups of a population. Recently Small and David Brownstone estimated values of time savings and improvements in travel time reliability for two California road pricing projects, the I-15 HOT Lanes in San Diego and the State Route 91 (SR91) facility in Orange County<sup>3</sup>. Their empirical results confirm original estimates and reveal values of time of \$20-\$40 per hour (50 percent-90 percent of area average wage rates) during the morning commute.

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<sup>1</sup> Puget Sound Regional Council, *Traffic Choices Study: Summary Report*, A Global Positioning System Based Pricing Pilot Project: Evaluating Traveler Response to Variable Road Tolling Through a Sample of Volunteer Participants, March 2008.

<sup>2</sup> Small, Kenneth, *Urban Transportation Economics*, Vol. 51 of *Fundamental of Pure and Applied Economics*, Char, Switzerland, Harwood Academic Publishers, 1992.

<sup>3</sup> Brownstone, David and Small, Kenneth, *Valuing Time and Reliability: Assessing the Evidence from Road Pricing Demonstrations*, *Transportation Research A*, 39, 279-293, 2005.

Common assumptions about values of time often focus upon the 50 percent of gross wage rate estimate, even through Small's original conclusion emphasizes the heterogeneity of value of time both across and within a given population. Often this simplifying assumption is a result of the lack of available local data about people's revealed behavior in the face of time-money tradeoff opportunities. As an example, the PSRC regional travel demand model has historically employed value of time assumptions that are approximately 50 percent of average regional wage rates for each of four household income quartiles. With no tolling projects or demonstrations in operation, the region has had to adopt more global estimates, and has only recently conducted stated preference experiments in an attempt to refine such estimates.

The Traffic Choices Study provides the opportunity to observe value of time directly as a function of actual route choices made over the course of the experiment. Participants faced a financial incentive to avoid routes with high toll values. In many cases participants chose longer, more time consuming routes that resulted in lower toll costs. These explicit decisions allowed the study team to estimate value of time across the study sample, and over an extended period of observation.

The value of time was computed for each household, vehicle, or worker unit of observation. It is implicit in the observed rate at which participants demonstrated willingness to trade a change to a path with longer drive time against reduction in tolls (relative to the control toll.) An example illustrates the basic value of time measurement procedure:

- Say, for simplicity, that the control period path involved 30 minutes of drive time, but possible exposure to a 140 cent toll, and the actual, experimental path involved 40 minutes of drive time, and a 40 cent toll.
- The implication is that the traveler was willing to incur 10 minutes of additional drive time to spare a 100 cent toll cost. In this hypothetical case, the revealed value of drive time is thus 10 cents per minute of drive time, or six dollars per hour of drive time.

$$VoT = \text{value of time in dollars per hour} = \frac{60}{100} (-\Delta P / \Delta T)$$

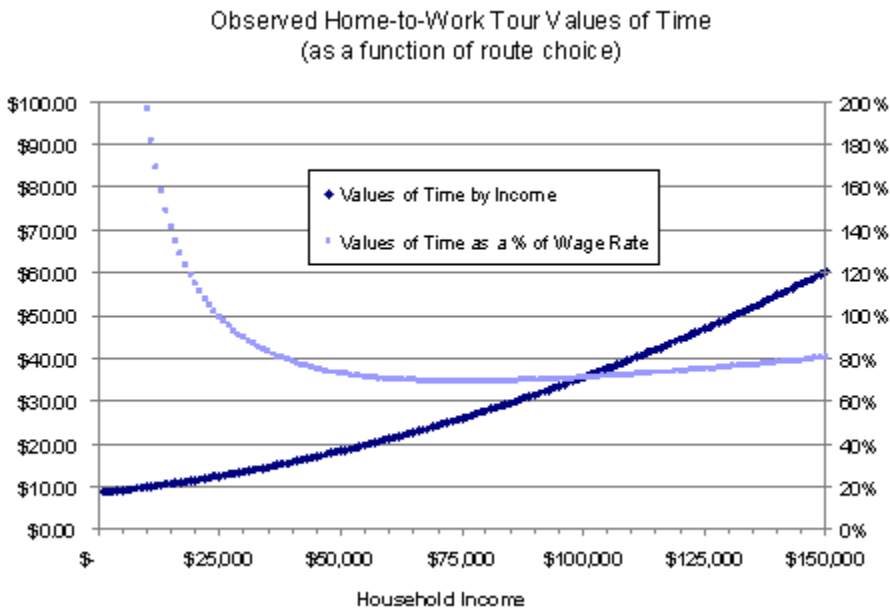
where :

$$\Delta P = P_e - P_c = \text{experimental vs. control toll, in cents}$$

$$\Delta T = T_e - T_c = \text{experimental vs. control drive time, in minutes}$$

The computation above was performed for individual units of observation (households, vehicles, and work trips). The principle finding is that the value of commute (home-to-work tours) travel time appears to be closer to 75 percent of the wage rate for the greater Seattle metropolitan area. This is generally consistent with the range of findings of Small and Brownstone mentioned above. Figure 1 plots home-to-work values of time against household income and also displays the fraction of wage rates that these values represent. Value of time is displayed as a line fit to the observations across households. Since the line is fit to observations caution should be used when relying upon value of time estimates at the very low and high end of the income distribution as there are fewer experimental observations in these regions. It is notable that value of time as a function of income initially drops steeply as income rises and then appears to gradually rise again for upper incomes.

**Figure 1: Observed Home-Work Tour Values of Time**



Values of time were also observed for other tour types. Below in Figure 2 values of time are displayed for the work-to-work tour. Within the project tour dataset there are considerably fewer observations of work-to-work tours, and in truth these tours probably represent a non-homogenous set of activities that both start and end on the work location, with no home stop in between. These tours, however, exhibit an interesting value of time distribution when plotted against household income. Work-to-work tour values of time initially rise with income and then fall again. At first, this appears non-intuitive, but is a plausible result of a greater likelihood of higher income work-to-work tours being “on-the-clock” tours, or at least of importance to workplace productivity. It is even conceivable for compensated work related travel to exhibit a negative value of time as a function of route choice.

**Figure 2: Work-to-Work Tour Values of Time**



## Truck Values of Time

PSRC does not have an observed dataset to estimate truck values of time, so a national literature search of observed or estimated truck values of time was conducted to identify a reasonable estimate for values of time for trucks. This literature search identified a range of \$28 per hour<sup>4</sup> up to \$73 per hour<sup>5</sup> for trucks, with one additional source identifying the range as \$25 per hour to \$200 per hour<sup>6</sup>. This literature review, along with the knowledge that the observed auto values of time were 50 percent higher than previously expected, led us to increase the truck values of time to a range of \$40 per hour to \$50 per hour for light, medium and heavy trucks. These ranges for truck values of time were also discussed with the Washington State Freight Data System Working Group and there was a general consensus that the \$50 per hour values of time for heavy trucks was reasonable.

## Values of Time by Market Segment

Values of time derived from the above sources were established for input to the PSRC regional travel forecasting model (Version 1.0a) and will also be used in the Benefit-Cost Analysis (BCA) employed by the PSRC to evaluate transportation investment alternatives. These values are

<sup>4</sup> Kawamura, K. *Perceived Value of Time for Truck Operators*, Transportation Research Record 1725, Transportation Research Board, Washington, D.C., 2000

<sup>5</sup> *Freight Management and Operations: Measuring Travel Time in Freight-Significant Corridors*, accessed June 2005, <http://ops.fhwa.dot.gov/freight/time.htm>.

<sup>6</sup> U.S. Department of Transportation, Federal Highway Administration, *Freight Performance Measurement: Travel time in Freight-Significant Corridors*, December 2006.

presented in Table 1. The Traffic Choices observed data indicated that values of time were 50 percent higher than previously assumed in the PSRC regional travel demand forecasting model (Version 1.0) for all trip types. The Traffic Choices study was unable to identify any different values of time by vehicle occupancy (SOV and HOV) because these data were not collected as part of that study. Instead, we analyzed the 2006 PSRC household travel survey to identify the mix of trips by purpose (work and non-work) and time of day (am peak, midday, pm peak, evening and night) for carpool and vanpool trips to generate weighted values of time for these trips. These take into account vehicle occupancy and so represent the cumulative value of time of all persons in the vehicle. For this purpose, a factor of 1.5, 2.0, and 6.0 was used to represent the conversion of vehicle values of time to person values of time for HOV2, HOV3+ and vanpools, respectively. The household survey was also used to identify the portion of non-work tours that are made for work and non-work purposes, by income group, to derive weighted average values of time for the non-work trips that comprise these tours. This accounts for the different definition of tours in the Traffic Choices Study and trips in the regional travel demand forecasting model. Truck values of time were specified from a review of national literature sources and discussed with the Washington State Freight Data System Working Group.

**Table 1a: Values of Time by Market Segment used in the PSRC Regional Travel Forecasting Model (Version 1.0b)**

<b>Market Segment</b>	
<b>Home-based Work Single Occupant Vehicles</b>	
Low Income	\$9.52
Low-Medium Income	\$17.65
Medium-High Income	\$26.09
High Income	\$33.33
<b>Non-Work Single Occupant Vehicles</b>	
All Income Groups	\$15.68
<b>Carpool and Vanpool</b>	
All Income Groups	See Table 1b
<b>Trucks</b>	
Light Trucks	\$40.00
Medium Trucks	\$45.00
Heavy Trucks	\$50.00

**Table 1b: Values of Time for High Occupancy Vehicles by Time of Day**

	<b>HOV2</b>	<b>HOV3+</b>	<b>Vanpool</b>
<b>AM Peak</b>	\$30.33	\$38.34	\$102.49
<b>Midday</b>	\$19.34	\$21.35	\$37.38
<b>PM Peak</b>	\$23.00	\$27.01	\$59.08
<b>Evening</b>	\$20.56	\$21.35	\$37.38
<b>Night</b>	\$26.66	\$34.57	\$88.02

For additional information on the development of values of time, contact Maren Outwater at (206) 971-3274 or [moutwater@psrc.org](mailto:moutwater@psrc.org) or Matthew Kitchen at [mkitchen@psrc.org](mailto:mkitchen@psrc.org).