Difference in Probability Weighting: A Managed Lane Choice Application #15-1553

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Abstract

Using stated preference survey data pegged to data on a traveler's most recent actual trip, this study predicts route choices. The model incorporates a probability weighting for risky travel times on a Houston, Texas freeway. The results indicate significant improvement in predicative power and confirm non-linearity in the probability weighting function.

The maximum willingness to pay (WTP) measures calculated in this study are lower than estimated in many previous route choice studies. This highlights the importance of incorporating individual weights for travel risk. Travelers' underweighting of travel time risks helps explain the lower WTPs found in our study because respondents consider route choice decision-making as a gamble, but assign their own probabilities of occurrence to arriving late, on time, or early.

We find that traveler groups are heterogeneous and the different weights developed for different groups of travelers can be used to better understand their objective probabilities. Segmentation analysis indicates that *Age* may serve to proxy the effects of more experience over time, or changing driving abilities, or changes in one's sense of optimism or pessimism at different ages. *Gender* and *Income* also play a role in how the objective probabilities were translated into subjective probabilities.

Acronyms

DA=Drive Alone, ML=Managed Lanes
CP=Carpool, GPL=General Purpose Lanes
TT=Travel Time, TTV=Travel Time Variability
p=probability, ω=weighting function
ASC=Alternative Specific Coefficient

Data Collection, Discrete Choice Models & Results

PT-Probability Weighting Functions Model

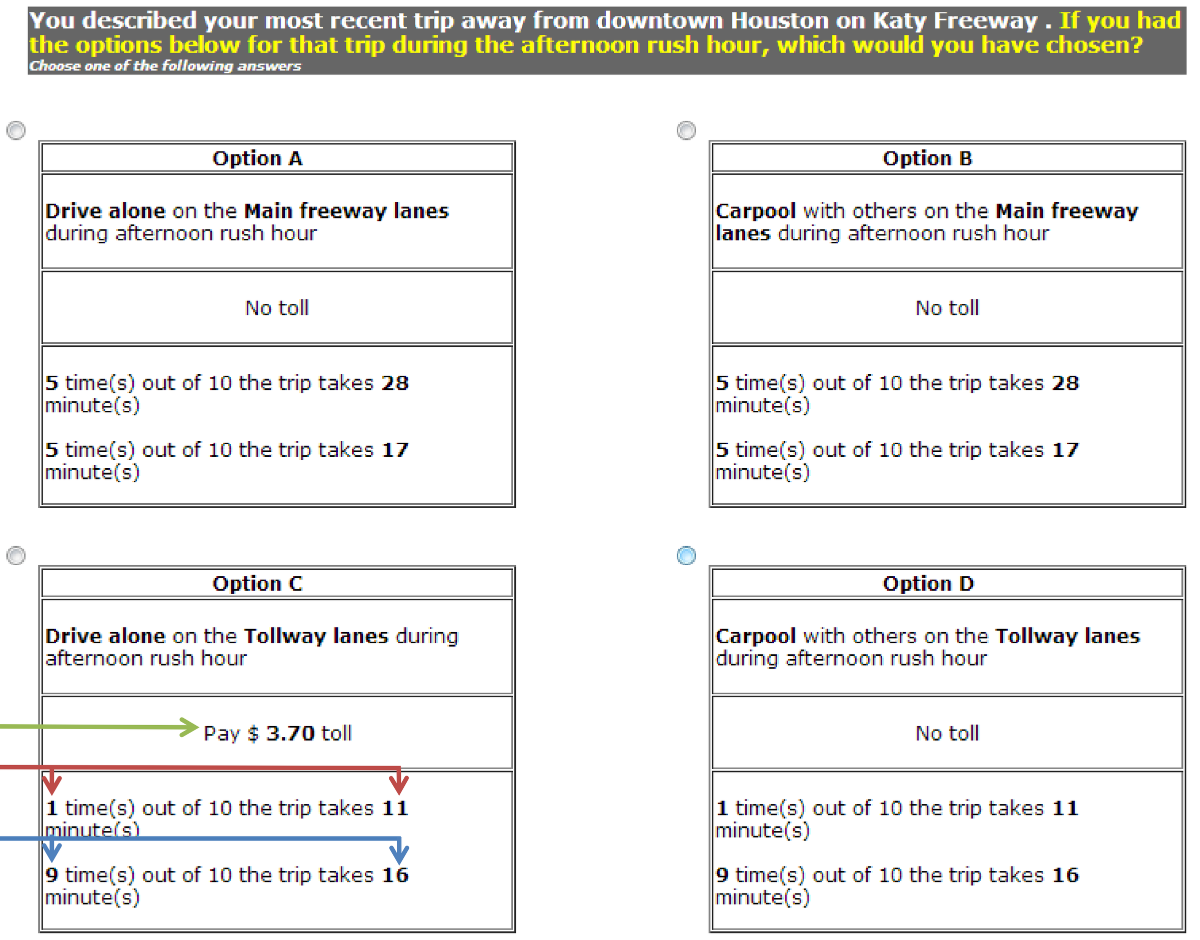
$$U_{\text{DA-GPL}} = \beta_{TT} \times \{\omega_1(p_1)\times \text{TT}_1 + \omega_2(p_2)\times \text{TT}_2\}$$

$$U_{\text{CP-GPL}} = ASC_{CP-GPL} + \beta_{TT} \times \{\omega_1(p_1)\times \text{TT}_1 + \omega_2(p_2)\times \text{TT}_2\}$$

$$U_{\text{DA-ML}} = ASC_{DA-ML} + \beta_{TT} \times \{\omega_1(p_1)\times \text{TT}_1 + \omega_2(p_2)\times \text{TT}_2\} + \beta_{toll} \times Toll$$

$$U_{\text{CP-ML}} = ASC_{CP-ML} + \beta_{TT} \times \{\omega_1(p_1)\times \text{TT}_1 + \omega_2(p_2)\times \text{TT}_2\}$$

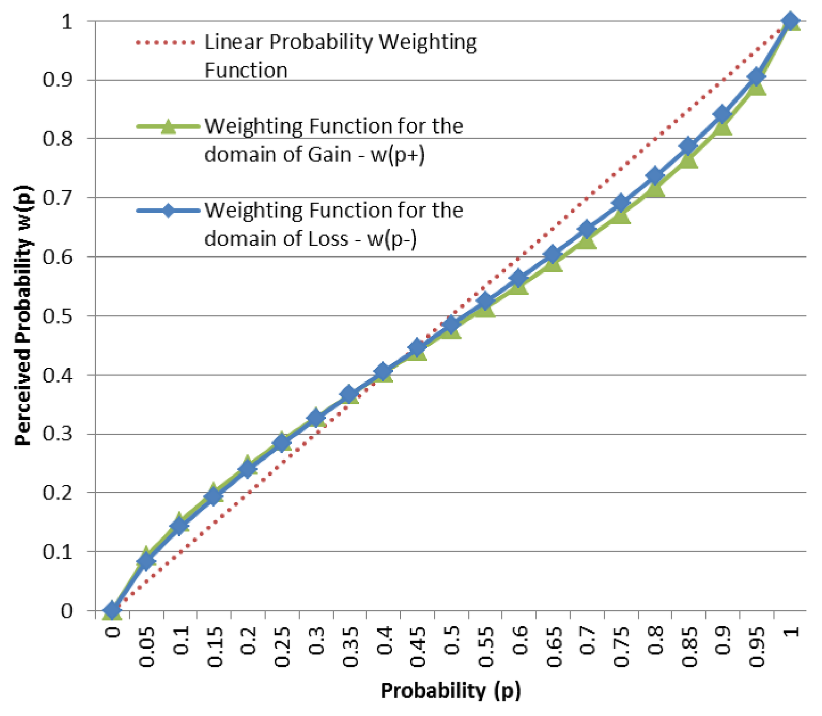
$$\omega_1(p_1) = \frac{p_1^{\delta}}{((p_1^{\delta} + (1-p_1)^{\delta})^{\frac{1}{\delta}}} \qquad \omega_2(p_2) = \frac{p_2^{\gamma}}{((p_2^{\gamma} + (1-p_2)^{\gamma})^{\frac{1}{\gamma}}}$$



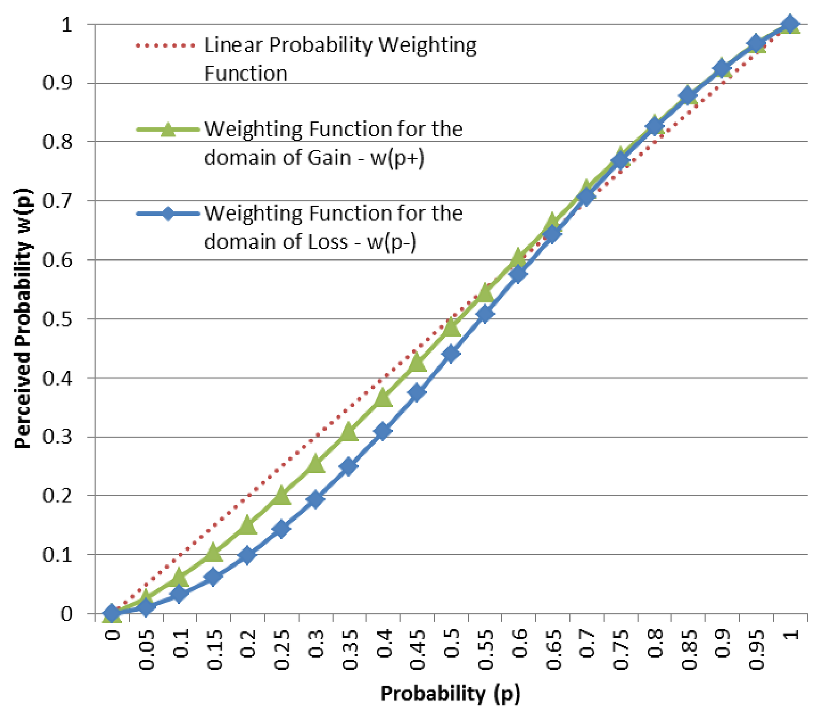
Characteristics		% of Travelers	Parameter	Parameter
Age	18 to 24	4	δ	N/A
			γ	N/A
	25 to 34	24	δ	1.53***
			γ	1.23***
	35 to 44	25	δ	0.60***
			γ	0.76***
	45 to 54	21	δ	1.72
			γ	0.90***
	55 to 64	16	δ	0.64***
			γ	0.56***
	65 or older	5	δ	1.19
			γ	0.59
Gender	Male	56	δ	0.81***
			γ	0.65***
	Female	41	δ	0.70***
			γ	0.70***
Income	$50,000<	9	δ	0.72
			γ	0.58
	$50,000 -$10,0000	28	δ	0.67***
			γ	0.47***
	> $10,0000	52	δ	2.67***
			γ	0.91***

***, **, * ==> Significance at 1%, 5%, 10% level; Percent doesn't sum up 100% due to refused answer.

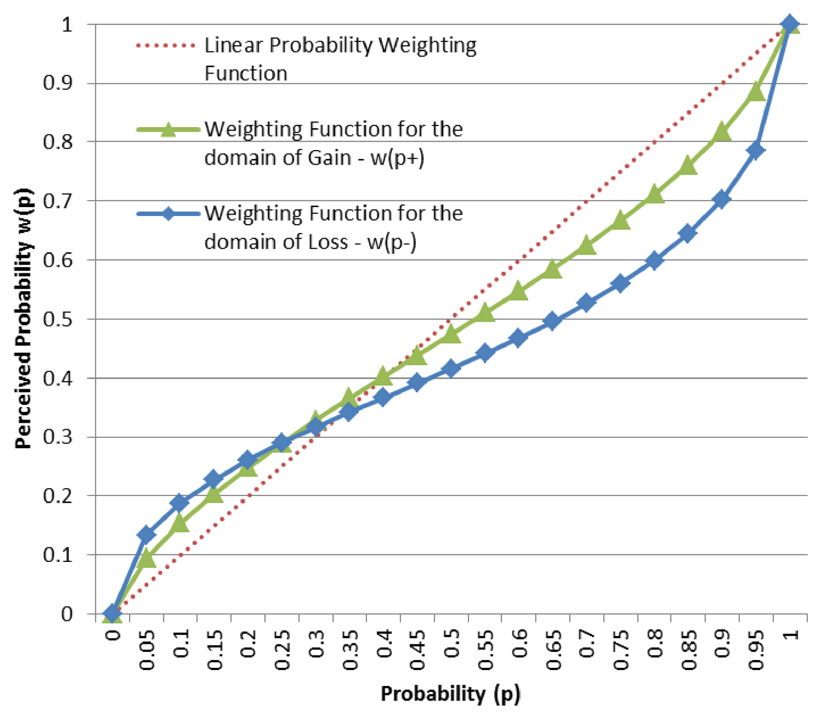
Conclusions



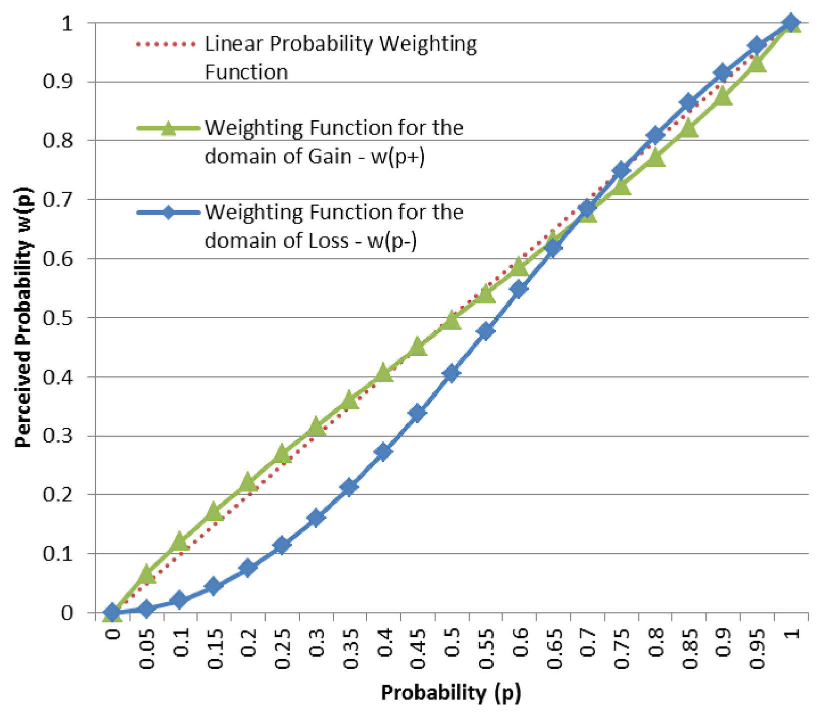
γ = 0.77, δ = 0.81
All Inclusive



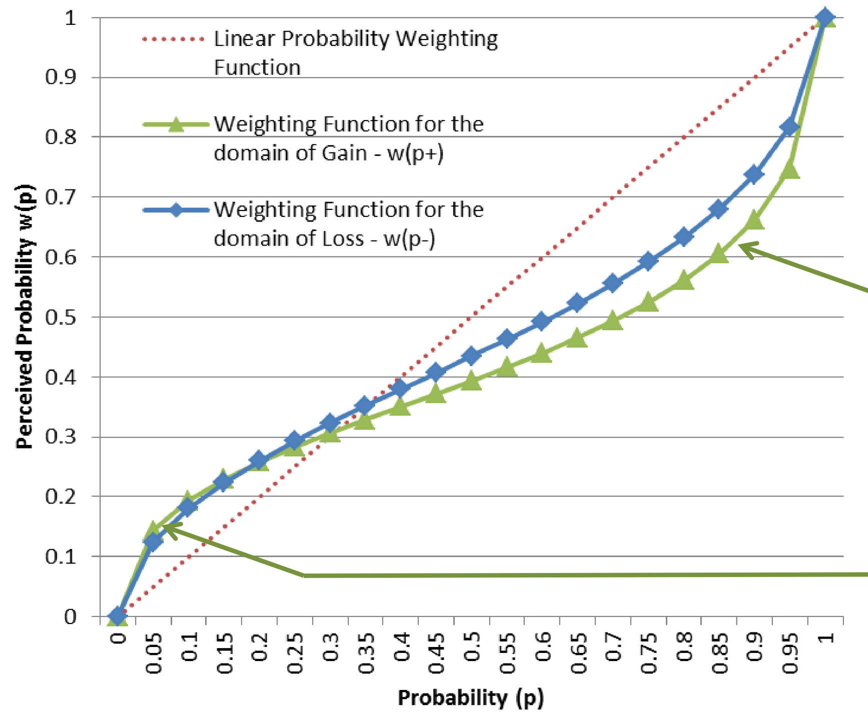
γ = 1.53, δ = 1.23
Age: 25 to 34



γ = 0.60, δ = 0.76
Age: 35 to 44



γ = 1.72, δ = 0.90
Age: 45 to 54



γ = 0.64, δ = 0.56
Age: 55 to 64

γ - Probability Weighting for Gain
δ - Probability Weighting for Loss

Underestimating the likelihood of a highly probable gain (or loss) in travel time.

Overestimating the likelihood of a very unlikely gain (or loss) in travel time.

The parameter estimates indicate that the four age groups used four somewhat different weights to translate the objective occurrence of probability of faster or shorter travel times into perceived probability. This comparison suggests that respondents use different weights in probability weighting as they age. Significant estimates of γ and δ in the probability weighting functions suggest an inverted S-shape which implies that when the function is concave low probabilities are over-weighted and when the function is convex high probabilities are under-weighted. The change of parameter estimates of γ and δ as people ages may imply a gradual adjustment of travelers' attitude towards risk and objective probability. Respondents who are between 25 and 34 years old overestimate high probabilities and underweight low probabilities while older respondents generally underestimate high probabilities and overestimate low probabilities. Age may serve to proxy the effects of more experience over time, or changing driving abilities, or changes in one's sense of optimism or pessimism, or some difference in an innate sense of patience at different ages.