Appendix C: Estimating Average Marginal Effects and Elasticities

We use the prediction functions from the Apollo package in R to estimate both the average marginal effects (AME) and elasticities for the extensive margin model (Hess and Palma, 2019a, 2019b). The procedures for estimating AMEs and elasticities from a random parameters logit are nearly identical, but we indicate two places where these procedures differ. We use Monte Carlo simulation to consistently estimate these marginal effects and elasticities of the random parameters in our model.

Let X represent a variable whose AME and elasticity we are estimating. For each choice occasion faced by individual i, we first drew 1,000 β_i values and then calculated the corresponding baseline choice probabilities using the original, unaltered data for all variables aside from X. For X, we use the original unaltered data for continuous variables, and set $X = 0$ across all trip alternatives for discrete variables.

We then perturb X in trip alternative one for each choice occasion n and re-estimate the choice probabilities across the same individual and choice-occasion specific 1,000 β_i draws as used for the baseline choice probabilities. When estimating the AME of a continuous variable, we perturb variable X by adding Δ_c for continuous variables or $\Delta_d = 1$ for discrete variables to each X_n. Δ_c is defined as .001 of the standard deviation of a continuous variable.[1,2]

We estimate both *own* marginal effects and elasticities of alternative-specific attributes (e.g., price, congestion) and *cross* effects on the probability of opting-out (i.e., of choosing the outside option). For demographic variables that only enter the regression through interactions with "optout", we estimate *own* marginal effects and elasticities with the choice to not take a trip, as well as *cross* effects with alternative 1.

In order to estimate the average marginal effects of each observation for each of the 1000 draws for a given alternative, we perform the following calculation for each of the 1000 draws j

$$AME_j = \sum_{n=1}^{2148} \frac{Pr_{nj}^{new} - Pr_{nj}^{baseline}}{\Delta} \qquad [A1]$$

[1] We perturb only the X_n of alternative 1, not that of alternative 2. As a robustness check, we also tried perturbing only alternative 2 attributes, and found only trivial differences in our results, as expected in an unlabelled choice experiment.
[2] When estimating elasticities for a continuous variable, $\Delta_c = 0.01X_{old}$.

where 2148 is the total number of choice occasions in the sample, *n* is the choice occasion, *j* is the draw, and Δ is the amount by which the variable was perturbed.[3] This transformation leaves us with a matrix of AMEs or elasticities by alternative for each of the 1,000 sets of draws. When discussing average marginal effects and elasticities, we describe the distribution of effects across all draws of unobserved heterogeneity.

References

Hess, S., and D. Palma. 2019a. "Apollo: A Flexible, Powerful and Customisable Freeware Package for Choice Model Estimation and Application." *Journal of Choice Modelling* 32: 100170.

Hess, S., and D. Palma. 2019b. "Apollo Version 0.2.4, User Manual." Available at www.ApolloChoiceModelling.com.

[3] When estimating elasticities, Δ is replaced with $0.01 \times Pr_{nj}^{baseline}$.