Appendix D: Trip-Taking and Aggregate Retention: Policy Simulations

We investigate trip-taking and retention behavior across a grid of trip prices and per-fish retention fees. The trip prices over which we run simulations range from $0 to $250 in $5 increments, while the fees range from $0 to $150 in $5 increments. In order to maintain consistency across estimates, we fix trip-attributes to common values for both trip alternatives across all observations. Congestion is always set to "spacious" and the expected catch of fish other than red snapper to eight (the median number of fish other than red snapper actually caught by headboat passengers from 2012-2013).

Extensive Margin: Trip-Taking

Simulating the Extensive Margin

We use the prediction tools built into the Apollo package in R to generate a matrix of predicted trip probabilities for each price-fee combination (Hess and Palma 2019a; 2019b). Our extensive margin predictions are drawn from a random parameters logit, so we draw 1,000 predicted probabilities per observation (i.e. choice occasions) and price-fee combination. Some adjustments to the simulation are needed to accommodate for the fact that each simulation concerns a single set of trip attributes vs. the opt-out option, whereas the underlying choice experiments utilize two trip alternatives plus the opt-out. To maintain congruity with our estimation model, we simulate by setting the attributes for alternatives one and two to be always identical. However, this will overstate the probability of the trip alternative and understate the probability of the opt-out without an algebraic adjustment. The necessary adjustment directly follows from the Independence of Irrelevant Alternatives (IIA) assumption, which holds for a given draw of the random preference parameters.

To implement the correction, we extract a matrix of predicted probabilities of opting-out (P_3) for each draw of the random coefficients and price-fee combination, then calculate the true probability of opting-out (P_o) using equation A2 below.

$$P_o = \frac{2P_3}{1+P_3} \qquad \text{[A2]}$$

The probability of the trip option is then $1 - P_o$. We then store the mean probability of taking the trip over 1,000 random coefficient draws for each individual and price-fee combination in an (N×F×P)×1 "prediction vector," where *N* is the number of observations, and *F* and *P* are the number of fees and prices simulated over.

Scaling the Extensive Margin

We use logbook data from GHC vessels in the two years prior to the GHC experiment (2012 and 2013) to create a representative "status-quo" scenario with which to scale each respondent's predicted probability of taking a trip up to total predicted trips aboard GHC vessels. Of all 2012-2013 headboat trips taken aboard these vessels, we used data from only those 1,850 that occurred within the federal red snapper season (i.e., when red snapper could be retained) and for which we had data on trip price for fishing passengers. We omitted trips for which payment type was "per group" or "no charge," leaving 1,756 trips for which payment type was either "per person" or unspecified. After dropping multi-day and specialty trips (identified through a combination of high trip prices and captain comments), we were left with 1,716 partial or full-day trips.

The trip price for a fishing passenger on those 2012-2013 trips ranged from $40-$145, with a mean price of $83 per head. The mean number of fish other than red snapper caught per angler day is 13, while the median is 8. The long right tail on this distribution has a clear and significant impact on the mean, so we assume 8 fish other than red snapper caught per angler day is more representative of a typical headboat trip. Average red snapper catch per angler trip on this subset of trips is distributed normally with a mean of 2.14 fish per angler day. In 2012-2013, the daily bag limit was two red snapper per angler, which implies an average discard of 0.14 red snapper per angler day. The average number of trips (i.e., total angler counts) taken per year between those two years was 39,265.[1]

We plug these status-quo trip attributes into each trip alternative from the bag limit choice experiment scenarios and use the mixed logit model in which price is a random parameter (Table 3, column 3) to estimate predicted probabilities of trip-taking under representative 2012-

[1] We scale to "trips" rather than to angler-days because the units match our extensive margin model, which pools full- and part-day trips and is thus agnostic about trip-length.

2013 conditions. We then calculate *scale* such that the weighted mean (weighted with the extensive margin weights from appendix section 1) of those predicted probabilities times *scale* equals the actual average annual trips taken during the 2012-2013 red snapper seasons (39,265). We multiply *scale* by the (weighted) mean predicted trip probabilities for each fee version simulation to visualize aggregate trip demand for the GHC vessels.

Intensive Margin: Retention Per Trip

We estimate the top-censored Poisson model of retention using the post-estimation command *margins* from the *rcpoisson* package in Stata (Raciborski 2011). So that our retention predictions can be consistently multiplied by our extensive margin trip predictions to generate aggregate harvest and revenue predictions, we integrate them over a representative distribution of catch rates from 2012 and 2013 GHC vessel logbook data. For each trip taken, we know the total number of red snapper caught, the number of anglers on board, and trip length. We assign each passenger a catch rate equal to the average number of red snapper caught on their trip, using only trips on which at least one red snapper was caught. For instance, if 12 red snapper were caught on a single trip for which there were six anglers, the data frame from which we sample catch rates represents this trip as six observations for which two red snapper were caught. We then take $N \times j$ (where $N=736$ equals the number of observations in our intensive margin estimation and $j=100$ is the number of draws per observation) draws of catch rate from the full angler population and save those draws in a catch rate matrix.

By integrating over draws of average catch per trip, we assume that catch in excess of the bag limit for high-catch anglers is given to anglers with catch rates below the bag limit, as opposed to discarded. In other words, we implicitly assume that bag limits are enforced at the vessel level, rather than at the individual level. This is consistent with our interviews with headboat captains. We also considered a model of individual accountability under bag limits by fitting an intercept-only negative binomial model to trip-level catch data with number of anglers per-trip included as an exposure variable. We then applied bag limits to angler-specific draws from the catch distribution. However, the unrealistic level of regulatory discards (relative to the headboat survey data) combined with our prior interviews lead us to reject this individual bag limit model.

We generate retention predictions over a price-fee grid as in our extensive margin simulations, integrating over 100 draws of catch per observation for each unique combination of price-fee. We then average over these averages for each observation, weighted by the intensive margin weights from appendix section 3, to provide an expected retention prediction for each pricing bundle. Population-level harvest is the product of predicted trips (scaled to the population as described above) and predicted retention-per-trip at any given price-fee bundle. Expected fee revenues are calculated for each price-fee combination as the number of predicted trips times the predicted per-trip harvest times the per-fish retention fee (fee revenues).

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.

Raciborski, R. 2011. "Right-Censored Poisson Regression Model." *Stata Journal* 11 (1): 95–105. Available at www.stata-journal.com/article.html?article=st0219.