Appendix B: Expected travel cost calculations (Reproduced from Lloyd-Smith et al. (2019))

In this appendix, we describe the approach to calculating the travel costs of a headboat fishing trip in the GOM. The cost of traveling to each port is calculated using both non-monetary opportunity costs of time represented as μ/λ in the conceptual model and monetary cost information represented as c_t. The approach to calculating VOT using the income-based and individual-specific approaches are explained in the text and here we outline the approach to calculating the monetary costs of traveling to each port and the fees to take a headboat fishing trip.

The monetary travel costs are calculated generally following the approach described in the Deep Water Horizon Recreation Assessment Study's (DHW study) technical memoranda documents (Industrial Economics, 2015; Leggett, 2015). We consider that individuals can either fly or drive to each port and travel costs are calculated as a weighted average of these costs where the weights are the probabilities of choosing each mode of travel. Formally, the cost C^{TC}_{iojt} to individual i incurred from traveling from origin o to port j in time period t is represented as

$$C^{TC}_{iojt} = \pi_{ioj} C^{Fly}_{iojt} + (1 - \pi_{ioj}) C^{Drive}_{iojt}$$

where π_{ioj} represents the probability that individual i will choose to fly when traveling from origin o to port j. Origin locations are assigned by geocoding the zip code provided by respondents in the survey. Time period t refers to one of the four seasonal time periods in each of the two years.

The Costs of Driving

Driving costs are calculated using information on both monetary and non-monetary expenses. Data on average per-mile fuel costs (f_t) and average per-mile non-fuel vehicle operation costs (nf_t) including tires, maintenance and depreciation is collected from the AAA (American Automobile Association, 2015, 2016).[1] One-way driving distances (in miles) and time (in

[1] Costs are obtained for an average sedan and depreciation costs are calculated using 5,000 mile deviations (higher and lower) from the 15,000-mile annual depreciation scenario reported by the AAA following the DWH approach. Specifically, the AAA estimates that in 2014 depreciation costs for the average sedan are \$252 less if the car is driven 5,000 miles less than the 15,000-mile scenario and \$204 more if the car is driven an

hours) between any given points a and b are estimated from Google Maps using the R package ggmaps (Kahle and Wickham, 2013). The average cost of a night at a hotel (h_t) is obtained from the American Hotel and Lodging Association (American Hotel & Lodging Association, 2015). The number of nights is derived by dividing total driving time by 12 and rounding down to the nearest integer. These monetary costs of driving are divided by the fishing party size reported by each individual (ρ_i) in the survey. If the reported party size is greater than 5, then the costs are divided by 5 to reflect the capacity of a typical sedan.[2] Thus, the one-way driving costs is calculated as,

$$C_{it}(a,b) = \left[(f_t + nf_t) * distance(a,b) + h_t * nights(a,b)\right]/\rho_i + VOT_{it} * time(a,b),$$

where VOT_{it} is the value of leisure time for individual i in time period t. These one-way costs are multiplied by two to derive the round-trip cost to each individual.

$$C^{Drive}_{iojt} = 2 * C_{it}(origin_{io}, port_j)$$

The Costs of Flying

To calculate the costs of flying, we first identify several possible flying routes for each individual and then choose the flying route with the least cost. Specifically, the four closest origin airports m to each individuals' residences are identified along with the four closest destination airports n to each visited port, for a total of 16 potential flying routes for each individual to each port.[3] The costs of flying is then estimated to be the minimum cost route amongst these possible pairs:

$$C^{Fly}_{iojt} = min_{m,n}\left\{C^{Fly}_{iojtmn}\right\}$$

The costs of flying can be divided into five parts: the costs of driving from the origin location o to the origin airport m, the costs of parking at the origin airport, the flight costs from the origin airport to destination airport n near the port j, the cost of renting a car, and the cost of driving from destination airport to the port (Leggett, 2015). These different components

additional 5,000 miles. The average per-mile depreciation costs is \$0.0511 ((\$252/5,000) + (\$204/5,000))/2).

[2]If the party size information was missing, then the median party size of 3 is used in its place.

[3]We only consider airports that have annual enplanements of over 100,000 (Industrial Economics, 2015). Enplanement data is obtained from the Federal Aviation Administration (FAA) Calendar Year 2014 Passenger Boarding and All-Cargo Data lists.

are represented using the following expression:

$$C_{iojtmn}^{Fly} = 2 * C_{it}(origin_{io}, airport_{iom}) + C_{mt}^{Parking} + C_{itmn}^{Flight} + C_{t}^{Rental} + 2 * C_{it}(airport_{jn}, port_j)$$

Both driving portions of the costs are calculated using the same methodology as the cost of driving directly to the port as described previously. Average parking costs for large/medium and small airports are based on data used in the DHW study. The number of parking days is calculated using the number of total nights away reported by respondents and all parking costs are weighted by the reported party sizes. Average rental car costs are based on data reported by the American Hotel and Lodging Association (American Hotel & Lodging Association, 2015).

Total round-trip flying costs from origin airport n to destination airport m is calculated as

$$C_{itmn}^{Flight} = VOT_{it}(time^{airport} + time_{tmn}^{flight} + time_{tmn}^{layover}) + price_{tmn}^{ticket}$$

where VOT_{it} is the value of time, $time^{airport}$ is the time spent at the origin and destination airports before and after the flights and is assumed to be 4 hours for each round-trip, $time_{tmn}^{flight}$ is the flight time between airports, $time_{tmn}^{layover}$ is the time spent during any layovers, if any, and $price_{tmn}^{ticket}$ is the round-trip ticket price.

The flight time between airports is calculated using the 'On-Time Performance' database collected by the Office of Airline Information of the Bureau of Transportation Statistics (BTS). For each origin-destination airport pair, the average flight time is calculated for each quarter of 2014 and 2015. The last two terms are based on data from the Airline Origin and Destination Survey (DB1B) conducted by the Office of Airline Information of the BTS. The DB1B dataset represents a 10% sample of airline tickets from reporting carriers in the United States every year. The DB1B consists of three different data tables (*ticket*, *market*, and *coupon*) that can be joined by an "Itinerary ID" variable. The *ticket* data table is the most aggregated and includes information on ticket fare costs and the origin of the flight but does not include destination. It represents each purchased ticket by one observation (either one-way or round-trip). The destination information is found in the *market* data table which includes one observation per direction of travel (i.e. one observation for a one-way ticket and two observations for a round-trip ticket). The *coupon* data table includes one observation per flight of the journey and has information on the number of layovers. We use the quarterly average number of layovers per origin-destination pair. We obtain data for each quarter of 2014 and 2015. Some flight routes had missing time data for certain time periods. In these cases, a regression model is estimated using distance (in miles) and number of layovers as explanatory variables to predict the expected flight times for a small subset of routes. For each layover, 60 additional minutes are added to the total flight time based on data from Sabre Airline Solutions (Industrial Economics, 2015). The ticket fares are taken from the *ticket* data table and the 30th percentile fare is used as the expected flight costs (Industrial Economics, 2015). Finally, the average flight times and costs for each quarter are converted to our four seasons.

Probability of Flying

The probability of flying is modeled as a function of distance using data on actual mode choices from the 2009 National Household Travel Survey (NHTS). The NHTS survey collects information on mode of transportation and distance for a nationally representative sample of travel behavior. After excluding trips that are less than 250 miles, we are left with 2,393 trip decisions that are used in a logit model of the decision to fly or drive based on miles and miles squared. The estimated intercept and distance parameters are used to predict the probability of flying for respondents in our data. Following DHW study, we assign a zero probability of flying to all respondents who reside less than 250 miles away from the port and to respondents who live less than 500 miles away and have income less than $70,000 per year or more than 2 household members. Figure B1 shows the predicted probability of flying for respondents in our data based on their distance to the port.

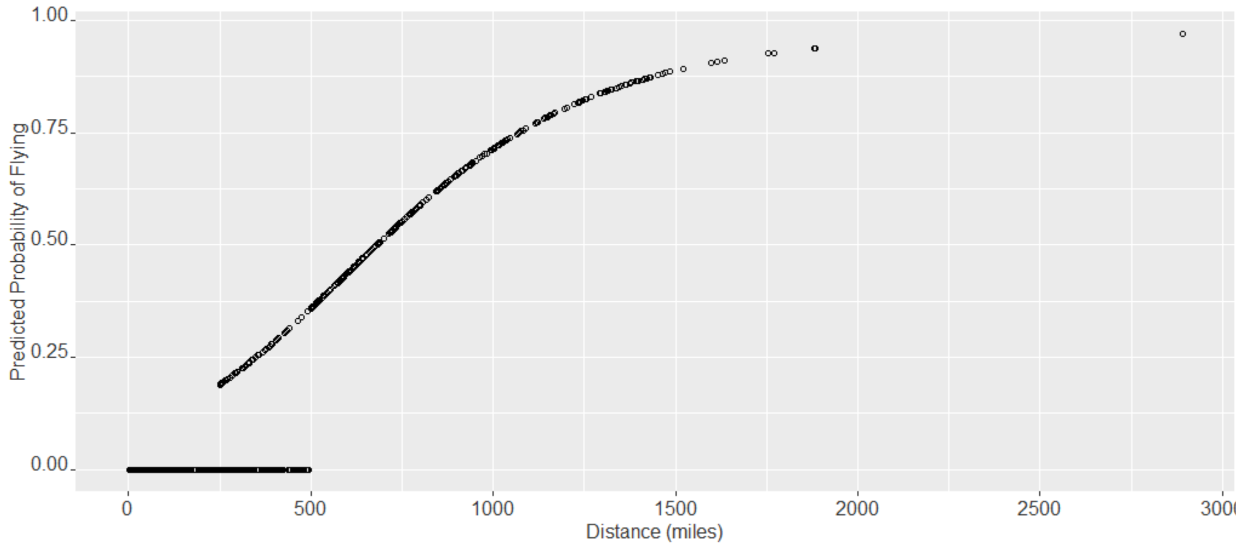
Multiple Ports

The vast majority of respondents only visited one port. Respondents visiting more than one port, the different ports are usually close by. For individuals that traveled to more than one port, we average the travel costs over visited ports to derive an average cost of a trip to the Gulf of Mexico.

Second Homes

For respondents reporting a second home in the region, we also calculate the expected travel costs from their second home to each visited port. A total of 53 respondents reported second homes in the region with valid zip codes. We used the travel costs from the second home if these expected costs are lower than the travel costs estimated from the main residence.

Figure B1: Predicted Probability of Flying for Individuals as a Function of Distance



Total Costs of a Fishing Trip

In addition to the costs of traveling to the port, headboat fishermen also pay a trip fee to go fishing. Thus, the total costs of a headboat fishing trip for individual i is comprised of the costs of traveling from origin o to port j and the costs of a fishing trip of length l from port j in time period t:

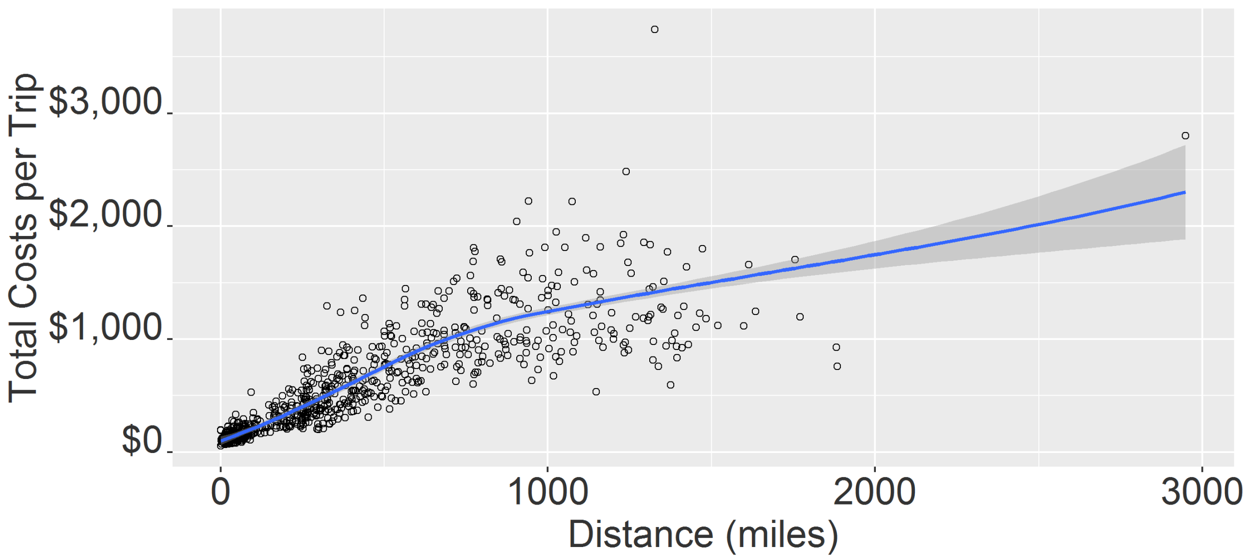
$$C_{ijtl} = C_{iojt}^{TC} + C_{jtl}^{Fish}$$

These fees typically depend on the specific port and the length of the fishing trip but may also vary seasonally. For the recall data, we collect information on the rates charged by headboat operators in 2014 and 2015 at each port from an online survey of headboat operators. The average trip fees for headboat trips in each port ranged from \$50 to \$130 for partial day trips to \$80 to \$250 for full day trips. For ports with missing trip fee information, we used the closest port's trip fee data in its place.

Travel Cost Summary

Figure B2 shows the relationship between the total costs per trip and distance for all individuals using the VOT_{ISS} estimates. As shown, travel costs have a nonlinear relationship with distance due to the high fixed costs of flying.

Figure B2: Relationship between Total Travel Costs per Trip and Distance



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