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"Intertemporal Substitution in Travel Cost Models with Seasonal Time Constraints"
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Appendix A

Role of on-site time in Kuhn-Tucker Models

Before constructing the Lagrangian function, we can simplify the problem by substituting the vacation constraint into one of the leisure time period constraints and removing the vacation time choice variable so that individuals are choosing only recreation and non-recreation time in each period. The Lagrangian equation is then given by

$$L = \sum_{t=1}^{T} U(r_t, l_t, Q_t, x + r_t\delta(o_t)) + \lambda(y - \sum_{t=1}^{T} r_t c_t - x) + \sum_{t=1}^{T} \mu_t(L_t + \nu_t - r_t(d + o_t) - l_t)$$

We assume that the numeraire good and non-recreation leisure time have positive demand and thus the constraints are always binding and the associated Lagrangian multipliers are positive. The resulting Kuhn-Tucker first-order conditions are

$$\frac{\partial L}{\partial r_t} = U_{r_t} + U_x\delta(o_t) - \lambda c_t - \mu_t(d + o_t) \leq 0, r_t \geq 0, \qquad r_t \frac{\partial L}{\partial r_t} = 0, t = 1, \ldots . T,$$

$$\frac{\partial L}{\partial o_t} = U_x\delta'(o_t)r_t - \mu_t r_t = 0, t = 1, \ldots . T,$$

$$\frac{\partial L}{\partial x} = U_x - \lambda = 0,$$

$$\frac{\partial L}{\partial l_t} = U_{l_t} - \mu_t = 0, t = 1, \ldots . T,$$

$$\frac{\partial L}{\partial \lambda} = y - \sum_{t=1}^{T} r_t c_t - x = 0,$$

$$\frac{\partial L}{\partial \mu_t} = L_t + \nu_t - r_t(d + o_t) - l_t = 0, t = 1, \ldots . T - 1,$$

$$\frac{\partial L}{\partial \mu_T} = L_T + H - \sum_{t=1}^{T-1} \nu_t - r_T(d + o_T) - l_T = 0.$$

We can simplify the first four FOCs to yield

$$\frac{U_{r_t}}{U_x} \leq c_t + \frac{\mu_t d}{\lambda} + \frac{\mu_t o_t}{\lambda} - \delta(o_t),\ t = 1, \ldots . T, \quad (1)$$

$$\delta'(o_t) = \frac{\mu_t}{\lambda}, t = 1, \ldots . T, \quad (2)$$

$$U_x = \lambda \quad (3)$$

$$U_{l_t} = \mu_t, t = 1, \ldots . T, \quad (4)$$

$\delta'(o_t)$ represents the incremental value of time spent on-site and it is equal to the opportunity cost of time for time period t (μ_t/λ). If we assume that $\delta'(o_t)o_t \approx \delta(o_t)$ as in Phaneuf and Requate (2017), then the last two terms of Equation (1) are equal to each other and drop out of the equation. Thus, people adjust their behavior such that the benefits of on-site time is equal to its cost and on-site time does not enter the estimating equations for the demand for recreation trips. Equation (1) above is thus equal to the first KT condition in Equation (1) of the paper.

Weighting Strategy

We use a three-stage strategy to construct survey weights. The first stage aims to ensure the spatial and temporal distribution of our sample reflects the headboat angler population. We use logbook data from all headboat vessels in the GOM to calculate the percentage of anglers in each of the four seasonal periods and GOM regions (Texas, Alabama, Northwest Florida, Southwest Florida). We then compute spatial-temporal post-stratification survey weights. The second stage addresses non-response bias, where non-response includes failure to provide an email on the 2-page onboard survey or failure to complete the internet survey, by using data on characteristics from those individuals who completed the onboard survey, but did not complete the online survey. We weight individuals using estimated propensity scores using the following characteristics: gender, age, income, number of years fishing, how often an individual goes fishing, and where the individual lives. The third stage accounts for the sampling design that used different probabilities to randomize whether respondents received a red snapper or gag grouper survey version based on what region they completed the 2-page onboard survey. Respondents with trips in Texas, Alabama, and Northwest Florida received a red snapper version with an 80% probability and a gag grouper version with a 20% probability while respondents with trips in Southwest Florida, where gag grouper is more prevalent, received the red snapper version with a 20% probability and a gag

grouper version with an 80% probability. The sampling weight is equal to the reciprocal of this probability for each respondent. Weights from the three stages are multiplied together and normalized such that the sum equals the sample size. These weights are used to define the probability of an individual being sampled in the bootstrap procedure. The sampling weight summary statistics are provided in Table A-1.

Figure A1: Sample Policy A Contingent Behavior Question

In recent years recreational anglers could only retain red snapper during a 1 to 1.5 month season starting June 1st. The season length and bag limit of a typical red snapper season in the recent past are presented in Policy A below.

Policy A

Season when red snapper can be retained	June
Red snapper bag limit	2
Price of one partial day (4-8 hrs) headboat trip	$80
Price of one full day (8-15 hrs) headboat trip	$130

If the Gulf of Mexico red snapper fishing policies were as described in Policy A, how many headboat trips would you have taken in 2015 in the different seasons? In considering your responses, please assume that any features about the fishing trips that are not mentioned such as sea conditions, the quality and size of the boat, the number of passengers, and bag limits and regulations for other species are the same as your 2015 experience.

2015 Gulf of Mexico Headboat Trips under Policy A

	January to end of May Holidays: New Year's, Spring break, Easter, Memorial day	June	July to end of August Holidays: Independence Day	September to end of December Holidays: Labor Day, Columbus Day, Thanksgiving, Christmas
Number of **partial day (4-8 hrs)** headboat trips in 2015 under Policy A				
Number of **full day (8-15 hrs)** headboat trips in 2015 under Policy A				

Figure A2: Sample Willingness-to-Accept Time Valuation Question

Many research companies pay people to participate in a focus group.

Suppose you've been given the opportunity **to be paid a certain amount of money to participate in a full day (8 hours) focus group** near your home during one of your days off during the three summer months (June, July and August).

How likely is it you would participate in the focus group if the payment amount is…? Please select a response for each payment amount.

	Definitely Yes (100% chance)	Probably Yes (75% chance)	Not Sure (50% chance)	Probably No (25% chance)	Definitely No (0% chance)
$50	○	○	○	○	○
$100	○	○	○	○	○
$200	○	○	○	○	○
$400	○	○	○	○	○
$700	○	○	○	○	○

Figure A3: Sample Leisure Time Trade-Off Question

We are now going to ask you to choose between two options that change the number of leisure days between different seasons of the year.

Suppose you were given two options relative to your current situation in terms of the timing of your leisure days. Which of the options below do you *most* and *least* prefer?

Time period	Option A	Option B	Option C
January to May	No change	1 more leisure day	No change from your current situation
June to August	1 less leisure day	1 less leisure day	
September to December	1 more leisure day	No change	

	Option A	Option B	Option C
I **most** prefer...	○	○	○
I **least** prefer...	○	○	○

Table A1: Summary Statistics for Sample Weights Used in the Analysis

Statistic	Value
Minimum	0.1198
1st quartile	0.2034
Median	0.5119
Mean	1.0000
3rd quartile	1.5053
Maximum	3.1831

Table A2: Random Parameters Logit Model Estimates for Parameters of Value of Time (from Lloyd-Smith et al., 2019)

Variable	Estimate	
Nonrandom parameters		
Payment amount ($00s)[a]	1.050***	
	(0.029)	
Heterogeneity in means of random parameters (Scaled beta distribution[b])	Focus group[c]	Work contract[c]
Constant	-1.592***	-2.015***
	(0.425)	(0.433)
Work full- or part-time	1.644***	-2.24***
	(0.206)	(0.203)
Self-employed	-0.797***	-2.388***
	(0.289)	(0.291)
VOT_{Wage}	-0.029***	-0.005**
	(0.003)	(0.002)
Male	-0.456***	-1.140***
	(0.171)	(0.186)
Bachelor degree	-0.120	0.601***
	(0.142)	(0.149)
Graduate degree	-2.013***	-1.660***
	(0.182)	(0.207)
Age index	-3.808***	-6.859***
	(0.281)	(0.291)
Household size	-0.115*	0.733***
	(0.066)	(0.072)
Children	0.691***	-1.868***
	(0.182)	(0.188)
Number of observations	4,903	
Number of respondents	789	
Log-likelihood	-2,293.1	

Notes: Standard errors in parentheses. ***, **, * are significance at 1%, 5%, 10% level.
[a] Payment amount was rescaled to hundreds of dollars for computational reasons.
[b] The scaled beta distribution is represented as $\beta_q = \beta v_q$, $v_q \sim beta(3,3)$.
[c] Variable was multiplied by -1 prior to estimation to ensure the coefficient is negative, and the parameter estimates in the table have been multiplied by -1 again for interpretability.