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Habit Formation and Variety Seeking in a Discrete Choice Model of Recreation Demand

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The recreational site choice decision modeled in most economic analyses seldom contains previous experience with the site as a characteristic or attribute. A rational dynamic model is used to incorporate previous experience with the site in a model of the choice of recreation sites. Based on the comparison of dynamic and static models, it is apparent that dynamic elements influence choice. The use of previous consumption as an attribute (either in a naive or rational form) is an improvement over static models of choice. In welfare analysis, this effect may be a significant factor. For example, a change in prices or quality attributes may have a much larger impact on those individuals who have developed habits.

Key words: habit formation, recreation demand, variety seeking, welfare measures.

Introduction

Economic models of recreation demand (models of site choice, trip frequency, or recreation participation) typically ignore the dynamic aspects of choice.[1] In other literature, however, previous consumption habits are found to play a large role in consumer choice. In the recreation literature, for example, the fact that an individual is aware of a site (perhaps due to previous visitation) has been found to be a significant explanator of site choice (Perdue). Some economic examples have also found significant dynamic elements in recreation demand (McConnell, Strand, and Bockstael; Adamowicz, Jennings, and Coyne; Munley and Smith). Surprisingly, the recreation decision model in most economic analyses seldom contains previous experience with the site as a characteristic. The resulting welfare analyses have assessed the impact of site changes (attribute changes or site closures) without regard for consumption inertia, habit effects, or learning.

In this article, models that incorporate dynamic elements into consumer choice, and a static model, are analyzed. Simple dynamic models are estimated in which previous visits to a site are included as attributes of the site. A more complex dynamic model also is presented in which the consumer is assumed to be maximizing a multi-period utility function subject to multi-period budget constraints. This latter model is based on the work of Pashardes. In this rational dynamic model [arising from the literature on rational habit formation by Pollak (1970, 1976) and Spinnewyn], consumers gain utility from stocks of goods. The model allows for depreciation of the stocks in a particular fashion that is consistent with either habit forming goods or variety seeking goods. If the good is associated with variety seeking, some of the stock will carry over into the next period, and the consumer will be more likely to purchase a substitute. If the good is habit forming, none of the good will carry over into the next time period; in fact, the consumer will be

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induced to increase consumption in the subsequent period if the consumer wishes to maintain utility at a constant level. The determination of variety seeking or habit forming goods depends upon a parameter estimated from the observed behavior of the consumers. This parameter, essentially a depreciation factor, is estimated as part of the econometric procedure; thus, evidence of habit formation, variety seeking, or the lack of dynamic effects can be gleaned from the empirical results.

Habit formation or variety seeking associated with recreation sites may appear for a variety of reasons. Consumers may simply enjoy variety, independent of all other attributes of a site. Conversely, consumers may be "learning by doing" when they visit a site, and thus repeated visitation occurs (habits). Or they may have acquired information about a site on an initial visit and choose this site again in subsequent visits rather than take the risk of being disappointed at another site. In this article, a distinction is made between naive habit formation models and rational habit formation models. Naive models suggest that previous choices affect current choices. In essence, the consumer's history helps determine current demand. In a rational dynamic model, the consumer is aware of the fact that choice in one period will affect choice in future periods. Therefore, the consumer considers the impact of current choice on future choices and budgets. Rational dynamic models suggest that the consumer is aware of the habit forming or variety seeking effects a good may have.

Care must be taken to include all other relevant attributes of a site in the estimation of the demand. What appears to be habit forming behavior may simply be a misspecified demand. For example, if a site is of very high quality and it is close to the consumer's home, the consumer may always visit this site since it is the best alternative. This repeated choice of a single site may appear as habitual behavior, but it is only the result of the choice of quality attributes. Therefore, these models must include the relevant quality attributes as well as the dynamic demand effects in order to avoid misspecification.

Four models are estimated in this article: a static model, two naive models, and a rational model. The welfare impacts of quality changes are examined for each model. The results indicate that the dynamic models produce a wider variation (over the sample) in welfare effects, relative to the static model. In particular, it appears that if individuals have built up habits at a site, they will be sensitive to changes that affect that site but they will not be as sensitive to changes that affect other sites. This result may be quite important for economic valuation practices. Models of site choice that include many substitute sites provide welfare measures that are smaller than those which include few substitutes. If habits have developed at a site, however, the alternatives are not as attractive as they would be in a case without habits. The results from a model with habit formation, in some cases, may be similar to results from models with few substitutes because the habit effect is in some respects similar to placing relatively less weight on substitute sites. The converse may be true when variety seeking is the revealed behavior.

The Static Model and the Naive Model

The static model is developed using the theory applied to discrete choices of goods developed by McFadden (1973). One site, i, is chosen over another site, j, if the utility associated with site i is higher than the utility realized from site j. Utility is modeled as a conditional indirect utility function with income (M), price (P), quality attributes (Q), and a set of coefficients (B) as arguments, or $V_i(M, P_i, Q_i\colon B)$. In this application it is assumed that the researcher does not have complete information about the consumer's preferences and that omitted variables are captured in an error term.[2] This error term is added to the objective specification of utility. The probability of choosing site i over site j can now be expressed as

$$\text{Prob}[V_i(M, P_i, Q_i\colon B) + \epsilon_i \geq V_j(M, P_j, Q_j\colon B) + \epsilon_j]. \tag{1}$$

Following typical examples in this literature, utility is assumed to follow a linear functional form with the price effect modeled as income minus price. Since price in these models is the travel cost to the site and income is assumed to be constant over choice occasions (and thus drops out of the comparisons between sites), the model is estimated with travel cost and the set of quality attributes in a linear functional form. Given a functional form for utility and assuming that the error terms follow a type one extreme value distribution (see Maddala), the probability that site i is chosen by individual k takes on the form:

$$\pi_k(i) = \frac{e^{V_{ki}}}{\sum_{j=1}^{J} e^{V_{kj}}}. \tag{2}$$

Using this expression for the probability of choice, a likelihood function can be created as the product, over all trips by individuals, of the probabilities of site choice. Clearly, an assumption employed in this model is that trips are independent. This assumption is violated if there are dynamic effects at play.

One approach to modeling the dynamic elements of site choice is to include the number of previous visits to a site as a quality attribute. For example, equation (1) could be modified to be

$$\text{Prob}[V_i(M, P_i, Q_i, N_i: B) + \epsilon_i \geq V_j(M, P_j, Q_j, N_j: B) + \epsilon_j], \tag{3}$$

where N_i is the number of previous visits to site i. A positive coefficient on this attribute implies that previous consumption increases the probability of choosing a site. A negative coefficient implies that previous visitation increases the probability that a different site is chosen. While these interpretations are consistent with the notion of habits and variety seeking goods, there are a number of problems with this specification of choice. Modeling previous visits in this way suggests that the consumer is naive about the effect of visitation on future choices. A rational consumer will be aware of the habit formation or variety seeking effect on choice in an intertemporal context and will consider this effect when maximizing a multi-period utility function. The model developed below incorporates rational habit formation or variety seeking in recreational site choice based on a framework developed by Pashardes.

A Rational Dynamic Model

The consumer is assumed to maximize a utility function which spans several time periods, subject to a multi-period budget constraint. This utility function, however, is based on "stocks" of goods. Let Z_{it} represent the stock of good i in period t. Let X_{it} represent the quantity of good i purchased in period t. P_{it} represents the price of good i in period t.[3] The stock of good i in period t is the sum of current consumption (X_{it}) and "depreciated" previous consumption (X_{it-1}). This stock variable is defined as

$$X_{it} = X_{it} + d_i Z_{it-1}, \tag{4}$$

where d_i is a coefficient reflecting the degree of durability of the stock.[4] A value of d_i less than 1 but greater than zero indicates a variety seeking good; some portion of the stock of the good carries over into the next period. A habit forming good is represented by negative values of d_i. In such a case, the consumer must make purchases in period t that are larger than the stock in period $t - 1$ to maintain stocks at a constant level. In a longer term context, one may wish to incorporate discounting; however, this complication is suppressed here.

The intertemporal utility function (from period 1 to period T) of the consumer can be represented as:

$$U([Z_{11}, \ldots, Z_{n1}; Q_{11}, \ldots, Q_{n1}]; \ldots; [Z_{1T}, \ldots, Z_{nT}; Q_{1T}, \ldots, Q_{nT}]), \tag{5}$$

where Q_{it} is the quality attribute associated with good i in period t. The consumer maximizes utility subject to an intertemporal budget constraint, a constraint describing the link between current stocks and future stocks, and an initial condition. Suppressing the quality attributes, this problem can be specified as:

$$\begin{aligned} &\text{Max } U(Z_{11}, \ldots, Z_{n1}; \ldots; Z_{1T}, \ldots, Z_{nT}) \\ &\text{subject to } Z_{it} = X_{it} + d_i Z_{it-1}, \qquad i = 1, \ldots, n;\ t = 1, \ldots, T, \\ &\qquad W = \sum_{t=1}^{T} \sum_{i=1}^{n} P_{it} X_{it} \\ &\qquad Z_{i0} = 0, \qquad i = 1, \ldots, n. \end{aligned}$$

The Lagrangean for this problem can be written as:

$$(7) \quad L = U(Z_{11}, \ldots, Z_{n1}; \ldots; Z_{1T}, \ldots, Z_{nT}) + \lambda\left(W - \sum_{t=1}^{T} \sum_{i=1}^{n} P_{it}(Z_{it} - d_i Z_{it-1})\right).$$

The first order conditions are:

$$(8) \quad \begin{aligned} &\frac{\partial U}{\partial Z_{it}} = \lambda(P_{it} - d_i P_{it+1}), \qquad i = 1, \ldots, n; \quad t = 1, \ldots, T, \\ &\frac{\partial U}{\partial Z_{iT}} = \lambda P_{iT}, \qquad i = 1, \ldots, n, \\ &Z_{i0} = 0, \qquad i = 1, \ldots, n, \end{aligned}$$

plus the equality of the budget constraint.[5] The first order conditions illustrate that the consumer considers the impact of the habit forming (or variety seeking) nature of the good (d_i), current prices (P_{it}), and the future prices (P_{it+1}) in making current purchase decisions (in all periods except for the terminal period). Therefore, in estimating the dynamic demand function, the "dynamic prices,"

$$(9) \qquad \hat{P}_{it} = P_{it} - d_i P_{it+1},$$

are the relevant prices to include in the analysis.

In this intertemporal allocation problem, the consumer recognizes that habit forming goods imply costs due to future consumption requirements, while the stocks of variety seeking goods carry over into future periods. This is factored into budget constraints and consumption decisions by the consumer.

As in most dynamic analyses, separability of the time periods is assumed. In this case, we denote a single time period separable sub-utility function as:

$$(10) \qquad \hat{U}_t(Z_{1t}, \ldots, Z_{nt}).$$

Employing separability over time allows the maximization of each sub-utility function individually. However, the dynamic effect represented in the prices must carry over to maintain the dynamic nature of the problem. The maximization problem can be written as:

$$(11) \qquad \begin{aligned} &\text{Max } \hat{U}_t(Z_{1t}, \ldots, Z_{nt}) \\ &\text{subject to } \hat{M}_t = \sum_i \hat{P}_{it} Z_{it}, \end{aligned}$$

where $\hat{M}_t$ is an income term that uses the rational dynamic prices [equation (9)] rather than actual prices. This problem yields the demands for stocks of the goods:

$$(12) \qquad Z_{it} = \hat{g}(\hat{P}_t, \hat{M}_t),$$

where $\hat{P}_t$ is the dynamic price vector over all goods. Using equation (4), this demand for stocks can be converted into the demand for goods in the current period. This demand for goods is a function of dynamic prices, income, the dynamic parameters d_i, and the stock of goods accumulated in previous periods;

$$X_{it} = \hat{g}(\hat{P}_t, \hat{M}_t) - d_i Z_{it-1}. \tag{13}$$

Notice that the purchases of X_{it} will be increased, independent of price and income effects, if d_i is negative and stocks are positive. This illustrates the habit forming nature of a good. A habit forming good will be purchased to sustain the habit. Conversely, the effect of previous stocks of a variety seeking good ($d_i > 0$) will reduce current purchases. However, the dynamic parameter also influences the price vector and a habit forming good will have a dynamic price that is higher than the actual price. This is due to the fact that the consumer recognizes the habit forming potential of the good.

In applying the model to recreational demand, some additional assumptions are required. In particular, the model will be applied to a probabilistic model of site choice in which the dynamic effect will act as an attribute to the site. The probability of choosing one site over another will depend on site attributes (price, quality) as well as the depreciated stock of visits to these sites. If a site is habit forming, previous visits will increase the probability of choice relative to other sites.

Let the goods described above be choices to visit a recreation site. Now the choices become mutually exclusive. The restriction added to the model is:

$$X_{it} \cdot X_{jt} = 0, \tag{14}$$

and the consumer is assumed to obtain the optimal amount of the good (site) or consume zero within each period.[6]

$$X_{it} = X^*_{it}, \qquad \text{or } 0. \tag{15}$$

In this application, the optimal choice is assumed to be one trip. The choice problem can now be thought of as a problem of adding to "stocks" in each period by choosing a certain amount of one good (visit). It may be interpreted as choosing the site which adds most to utility, given the previous choices. The fact that choices are mutually exclusive in each period requires the development of a conditional utility function conditional on the choice of good or additions to stocks. Conditional on the choice of good 1 to add to stocks, the conditional indirect utility function [employing the separable utility function in equation (10),[7] the optimal demand in equation (12), and the assumptions in equations (14) and (15)] is:[8]

$$V_{1t}(\hat{M}_t - \hat{P}_{1t}X^*_{1t}, d_2Z_{2t-1}, \ldots, d_nZ_{nt-1} \mid Q_1), \tag{16}$$

where Q_1 is the set of quality attributes associated with good 1. The choice of good 1 over any other good implies that:

$$V_{1t}(\cdot) \geq V_{jt}(d_1Z_{1,t-1}, \ldots d_{j-1}Z_{j-1,t-1}, \hat{M}_t - \hat{P}_{jt}X^*_{jt}, \ldots d_nZ_{n,t-1} \mid Q_j). \tag{17}$$

Assuming a linear indirect utility function (as is common in discrete choice analysis) and rearranging the elements of the inequality, the choice of any site i over any other site j implies:

$$V_i = \hat{M} - \hat{P}_iX^*_i - d_iZ_{it-1} + Q_i \geq \hat{M} - \hat{P}_jX^*_j - d_jZ_{jt-1} + Q_j = V_j. \tag{18}$$

As in the discussion of the static and naive models, the assumption is made that the researcher does not observe all factors in the consumer's utility function. Therefore, a random error term is added to the indirect utility functions to represent this unobserved component. Augmenting each utility expression with type one extreme value error terms in the Random Utility Model fashion, and adding parameters to the price and quality terms, produces a discrete choice model in which site choices are a function of the quality attributes, the dynamic price, and the stocks of visits accumulated in the past (see Maddala; McFadden 1973; and Bockstael, McConnell, and Strand for details on discrete choice modeling).

Estimation of the Model Parameters

In the empirical analysis which follows, four models [a base (static) model, two naive models, and a rational model] are estimated for the case of recreational fishing site choice.[9] The static model is estimated as described above using choices of sites and standard multinomial logit maximum likelihood estimation. The naive models simply add attributes to each of the sites in the model, i.e., the number of previous visits to the site. The first naive model adds one attribute that includes the number of previous visits to the site. The second naive model interacts alternative specific constants with the number of previous visits to the site. This form produces a "previous visits" coefficient for each site and therefore is similar to the rational model that develops a habit formation or variety seeking effect for each choice.

Each of the models produces a conditional indirect utility function that can be employed in multinomial logit analysis. The conditional indirect utility functions for the models (suppressing the time subscripts in all but the rational model) are as follows:

$$\text{(19)}\quad \text{Static Model:}\qquad V_i = \beta(M - P_i) + \gamma(Q_i) + \epsilon_i,$$

$$\text{(20)}\quad \text{Naive Model 1:}\qquad V_i = \beta(M - P_i) + \gamma(Q_i) + \eta(N_i) + \epsilon_i,$$

$$\text{(21)}\quad \text{Naive Model 2:}\qquad V_i = \beta(M - P_i) + \gamma(Q_i) + \eta_i(N_i) + \epsilon_i,$$

$$\text{(22)}\quad \text{Rational Model:}\qquad V_{it} = \beta(\hat{M} - \hat{P}_{it}) + \gamma(Q_i) - d_i(Z_{it-1}) + \epsilon_i,$$

where β, γ, η, η_i, and d_i are parameters to be estimated, and ϵ_i is a type one extreme value error term. All other variables are as defined above.[10] Note that in Naive Model 1, the effect of previous visits to sites (N_i) is captured through a single parameter, η. In such a model, all goods are assumed to be habit forming if $\eta > 0$, and variety seeking if $\eta < 0$. In Naive Model 2, however, each choice has its own η parameter, η_i. In this case, the utility associated with current choice of each site may be positively or negatively affected by past choices of that particular site.

Given the form of the conditional utility function, and the assumption of type one extreme value error terms, the probability of choosing site i on trip t is:

$$\pi_t(i) = \frac{e^{V_{ti}}}{\sum_{j=1}^{n} e^{V_{tj}}}. \tag{23}$$

For each individual, the likelihood function for these models can be written as:

$$L = \prod_{t=1}^{T} \pi_t(1)^{y_{t1}} \cdot \pi_t(2)^{y_{t2}} \ldots \pi_t(n)^{y_{tn}}, \tag{24}$$

where $i = 1, \ldots n$ indexes sites; $t = 1, \ldots T$ indexes trips; and $Y_{ti} = 1$ if site i was chosen on trip t, 0 if not. To form the likelihood for the sample, the product of this expression over individuals is taken.

The rational dynamic model requires a slightly more sophisticated estimation approach. The likelihood function is the multinomial logit form as described above; however, the d_i parameters are used to construct the relevant level of stocks of goods [see equation (1)] and they affect the relevant prices. Given this more complex structure, the model is estimated in steps:

Step 1. The d_i parameters are assigned the value zero and initial stocks also are assumed to be zero.[11] Given these assumptions, the stock levels (Z_{it}) for each individual can be computed. The dynamic prices can also be computed.

Step 2. Placing the stock levels and the dynamic prices in the conditional indirect utility functions, the likelihood function is maximized to yield the optimal parameters, including the parameters on stocks (d_i).

Step 3. The new estimates of (d_i) are used to create new estimates of stocks and a new dynamic price term. The likelihood function is solved again using this new information. This process yields a new set of parameters, including new (d_i) parameters. Step 3 is repeated until the model converges (no change in the parameters).[12]

Empirical Model: Recreational Fishing

The data were obtained from a survey of recreational anglers in Alberta, Canada in 1990. Five thousand licensed resident anglers were sent questionnaires. Approximately 48% of these surveys were returned. The model developed here deals with a particular set of sites in the study area. These sites are mountain/foothill rivers and lakes in the southwest corner of the province. For this analysis, only those anglers who fished at least once in this region were included.

The anglers were asked to fill out a "diary" indicating when they went on fishing trips and where they went. For the model developed here, the time unit was fishing weeks, beginning with 1 May 1990. Only anglers who completed this diary were included in the analysis. Since the diary lists fishing trips, one can determine the weeks that no trip was taken. Not taking a trip is modeled as an alternative in this analysis. For each angler included in this sub-sample, nine weeks of choices are considered. The total sample is made up of weekly observations of 85 anglers.

The data used in this study are essentially panel data (cross-sectional time series). However, on some of the weekly observations, the anglers did not take a fishing trip. This raises the issue of participation/nonparticipation in models of recreation choice. This issue recently has been a topic of interest in the literature. Morey, Rowe, and Watson compare a variety of methods of including participation in logit models. They conclude that allowing for nonparticipation is important and models that do not include nonparticipation decisions produce biased welfare measures. In models without participation decisions, the impact of an environmental quality change can be much larger because the option of not participating is unavailable. However, the issue of how to model the participation decision remains. Morey, Rowe, and Watson use nested logit models (with nonparticipation as one of the upper branches of the tree) and repeated logit models with nonparticipation as an alternative. They model the nonparticipation decision solely as a function of socioeconomic characteristics of the individual.

In this article, nonparticipation is included as a choice, but it is only modeled as an alternative specific constant (plus zero attribute levels for other variables). While this does little to explain the reasons for nonparticipation, it accounts for the alternative of nonparticipation. In essence, the alternative specific parameter on nonparticipation is somewhat like employing an analysis of variance that includes the nonparticipation alternative. More sophisticated approaches to modeling nonparticipation (including socioeconomic attributes or attributes of nonfishing alternatives) should be explored in further research. However, excluding the nonparticipation option would not be desirable for two reasons. First, the welfare effects would be biased, and second, the time-series nature of the data (required for a proper analysis of habit forming/variety seeking behavior) would not be maintained.

This analysis examines the anglers' choice from nine fishing sites and the option of not fishing, for a total of 10 choices. Travel costs were computed by multiplying the round-trip distance to each site for each individual by $.27 per mile. Data on quality attributes at the sites were provided by the Alberta Fish and Wildlife Division.

The base model is a simple discrete choice model in which the consumers choose one of 10 alternatives. The components of the indirect utility function are price (*Travel Cost*), number of camping spots at the site (*CAMP*), fish catch rate (*CATCH*), fish size (*SIZE*), and a choice specific dummy for the option of not going fishing (*S*10).[13] The parameters of this simple model are presented in table 1.

The first naive model includes the number of previous times this alternative was chosen (*Stocks*) as an attribute of each alternative, while the second naive model estimates a

Table 1. Results of the Recreational Fishing Base Model, Naive Models, and Rational Model

	Model Type			
Variable	Base Model	Naive Model 1	Naive Model 2	Rational Model
Travel Cost	−5.76	−6.35	−6.49	−8.93
	(2.09)	(2.26)	(2.20)	(4.65)
CAMP[a]	.006	.006	.006	.004
	(4.05)	(4.09)	(3.50)	(2.18)
SIZE[b]	.15	.15	.12	.11
	(2.42)	(2.45)	(1.73)	(1.30)
CATCH[c]	.27	.26	.33	.64
	(.74)	(.74)	(.84)	(1.40)
*S*10[d]	4.32	4.90	5.26	5.30
	(13.74)	(14.01)	(13.78)	(11.30)
Stocks[e]	—	−.17	—	—
		(4.10)		
*d*1			.83	−.38
			(1.84)	(.80)
*d*2			1.43	−.35
			(1.54)	(.70)
*d*3			.90	−.08
			(.97)	(.12)
*d*4			1.27	−1.24
			(3.66)	(17.93)
*d*5			.80	−.50
			(2.53)	(1.70)
*d*6			.72	−1.08
			(1.75)	(10.49)
*d*7			1.43	−.97
			(3.37)	(4.03)
*d*8			1.44	−.95
			(3.02)	(4.22)
*d*9			1.05	.31
			(6.13)	(1.75)
*d*10			−.24	.73
			(.541)	(18.25)
VOF[f]	−708.68	−700.04	−659.36	−681.00

Notes: Numbers in parentheses are *t*-statistics. Variables *d*1 through *d*10 are the alternative specific parameters for number of previous visits in Naive Model 2, and depreciated stocks are as defined in the rational model. Note that positive coefficients represent habit formation in the naive models, while negative coefficients represent habit formation in the rational model.

[a] *CAMP* refers to number of campsites.

[b] *SIZE* refers to size of fish caught.

[c] *CATCH* refers to fish catch rate.

[d] *S*10 is the alternative specific constant for "not fishing" choice.

[e] *Stocks* in the naive models are the number of previous visits.

[f] VOF is value of the objective function.

parameter (*d*1 through *d*10 in table 1) for the effect of previous visits for each site. The results from this model also are presented in table 1.

The rational model includes 10 site-specific depreciated previous stock variables [computed as in equation (1)] instead of the naive *Stocks* variable. These stock variables are associated with the dynamic parameters *d*1 through *d*10. Note that the d_i parameters indicate habit forming goods if they are negative in the rational model and positive in the naive models. This arises from the specification of d_i in the rational demand model [see equations (13) and (22)].

Results

The base model results indicate that price (*Travel Cost*) is a significant explanator of site choice, as is number of camping spots (*CAMP*), fish size (*SIZE*), and the alternative specific dummy for not choosing to fish. Catch rate (*CATCH*) is not significant, but is retained to avoid specification error. A chi-squared test of the significance of the overall model is rejected at the 1% level.

Adding previous visits to the specification (the naive model) produces a better model. A likelihood ratio test of Naive Model 1 versus the base model suggests that the naive model is significantly different at a 1% level. The inclusion of previous visits affects the coefficient on price more than any other coefficient in the model. This effect will result in significant changes in welfare effects which will be examined below. Note that the sign of the *Stocks* variable, however, is negative. This indicates variety seeking behavior, rather than habit behavior. The model suggests that the more times an angler chooses a particular alternative, the less likely that angler is to choose the same alternative in the next period.

In Naive Model 2, the coefficients on *Travel Cost, CAMP, CATCH, SIZE,* and the nonparticipation dummy are very similar to those in the first naive model. The "stock effects," however, are separated over the 10 choices. All of the fishing alternatives indicate habit forming behavior (positive parameters), although only five are significantly different from zero at the 5% level. The nonparticipation alternative appears to be variety seeking; the $d10$ coefficient is negative and significant. After stocks of nonparticipation build up, the recreationist is more likely to choose a fishing alternative, everything else held constant. It is also worth noting that this model has the highest likelihood of all of the models and is significantly different from the base model and the first naive model.

The rational habit model is also significantly different from the base model. Restricting the value of the parameters d_i to zero in the rational model will produce the base model. The likelihood ratio statistic based on the null hypothesis that the rational model and the base model are equal is significant at the 1% level. A simple comparison between the rational and naive models, however, cannot be made. The naive and rational models are not nested models since the rational dynamic effects enter into the price variables and the stock variables in a complex fashion relative to the stock effects in the naive models. Nevertheless, examination of the likelihood functions suggests that all the dynamic models perform adequately in explaining site choice.

Both the second naive model and the rational model indicate that habit effects and variety effects occur over the range of alternatives. The parameters on fishing site 9 and alternative 10 (not fishing) in the rational model suggest variety seeking (although the coefficient on site 9 is not significant at the 5% level). The interpretation of variety seeking with respect to alternative 10 (not fishing) is that as stocks of "not fishing" build up, the probability of choosing to go fishing on the next trip goes up. In terms of the coefficient on site 9, the finding of variety seeking behavior may be related to the type of site. Site 9 is the largest lake in the region and does not provide the wild river experience that some of the other sites provide. After building up stocks at this site, the angler seeks a more challenging alternative. Sites 1 through 8 indicate habit forming behavior; however, not all effects are significant. Note that the only quality attribute that is significant at the 5% level is the number of camping spots. Fish size and catch rates are only significant at the 20% level.

The finding that "not fishing" is variety seeking while most choices of fishing sites are habit forming may help explain why the first naive model suggests variety seeking behavior for the entire group of choices. The "not fishing" alternative, for some anglers, is chosen relatively often. In fact, the probability of choosing not to participate is approximately 70%. Therefore, the effect of variety seeking for this alternative may be overriding any habit forming effects to produce the negative sign on previous stocks in the naive model. Note that a similar modeling exercise which did not include participation resulted in all choices being habit forming (Adamowicz). It appears that participation should be modeled,

Table 2. Welfare Impacts of Selected Quality Changes on Recreational Fishing (per trip)

	Model Type			
	Base Model	Naive Model 1	Naive Model 2	Rational Model
Close Site 1:				
Mean[a]	−2.15	−1.95	−1.92	−1.57
Std. Dev.[b]	.26	.63	1.43	.86
Max. Absolute Value	−2.71	−3.76	−14.76	−4.12
Min. Absolute Value	−1.55	−.79	−.53	−.18
50% Increase in Campsites, Site 1:				
Mean[a]	.90	.82	.77	.43
Std. Dev.[b]	.11	.26	.54	.23
Max. Absolute Value	1.13	1.57	5.36	1.13
Min. Absolute Value	.65	.33	.21	.05
10% Increase in Travel Costs (all sites):				
Mean[a]	−.68	−.68	−.68	−.87
Std. Dev.[b]	.23	.32	.44	.52
Max. Absolute Value	−1.07	−1.87	−2.61	−5.76
Min. Absolute Value	−.15	−.10	−.06	−.08

[a] Mean over all trips in the sample.

[b] Standard deviation over all trips in the sample.

in some form, in discrete choice recreation demand analyses (see Morey, Rowe, and Watson for a discussion of the implications of excluding participation from the model).

Welfare Effects

In order to investigate the impact of dynamic effects on welfare measures, the three models estimated above are used to develop measures of compensating variation for attribute changes. The welfare measures are based on the expression developed by Hanemann (1982, 1984):

$$CV = \frac{-1}{\mu}\Big[\ln\Big(\sum e^{V_j^0}\Big) - \ln\Big(\sum e^{V_j^1}\Big)\Big], \tag{25}$$

where CV is the compensating variation, μ is the marginal utility of income (derived from the price coefficient in the discrete choice model), V^0 is the utility in the initial state, and V^1 is the subsequent state utility.

The effects of a 10% increase in travel costs to all sites, the closure of site 1, and a 50% increase in the number of campsites are examined (table 2). Four statistics are presented (in table 2) for each welfare change (mean, standard deviation, maximum absolute value, and minimum absolute value). These statistics are calculated over the sample of weeks and anglers (i.e., each angler week represents an element of the sample).

Examining the closure of site 1, the base model provides the largest measure of impact per trip, while the rational model provides the lowest. The distributions of these impacts are interesting. The variations in the base model estimates are quite small when compared to those of the naive models. For example, the maximum loss for closing site 1 in the base model is $2.71, while the maximum loss for the second naive model is $14.76. This may be interpreted in the following fashion. After building up stocks in a particular site, an individual will suffer a larger welfare loss from the closure of that site (site 1 is habit forming) than will an individual who has not built up stocks in that site. Conversely, individuals who have not built up stocks in that site will be less adversely affected by closure. The result is a larger variance in the welfare measure and a larger range.

The rational model also produces a variance that is large relative to the base model. This is due to the fact that the parameter for site 1 indicates habit forming behavior. Individuals who have built up stocks are more adversely affected by site closure than those who have not. Also, this effect may be due to the price term in the rational model which requires that the consumer be cognizant of the habit forming potential of the good in question.

The results for a 10% increase in travel costs to all sites are quite different than the results for site closure. The differences between the base and naive models are quite small. This is due to the fact that all sites (and all individuals) are subject to the same change in this case. The impact of the naive habit is minimal on the average welfare change, but the variance and range are larger. The rational model provides larger estimates of welfare impact. This arises because there is a large difference in the price coefficients between the rational model and the other two models.

The impact of changing the number of camp spots has the same pattern as site closure, although less pronounced. The welfare impacts of the base model are smaller in variance than those of the rational and naive models.

Conclusions and Extensions

Based on the comparison of dynamic and static models, it is apparent that dynamic elements influence choice. The use of previous consumption as an attribute (either in a naive or rational form) seems to be an improvement over static models of choice. The empirical examples presented here provide evidence of both habit forming behavior and variety seeking behavior. In more detailed analysis, it may be possible to discover that some individuals form habits for a good while others seek variety from the same good. This difference may be due to differences in the attributes of the individuals (experience in the market or activity, for example). In the models presented here, a good is either habit forming or variety seeking for all individuals in the sample.

In reality, we often observe consumption inertia or what appears to be consumption habits. Individuals visit their favorite lake or campground even though there may be "better" sites that are closer. Consumers may require significant reductions in price to choose a brand of goods that is different from what they are used to. In welfare analysis, this habit effect may be a significant factor. A change in prices or quality attributes may have a much larger impact on those individuals who have developed habits.

There are several ways that this work can be extended. First, there have been other forms of rational dynamic models presented in the literature. While the model used in this article can estimate either habit or variety good effects, it requires a strong degree of rationality on the part of consumers. Other models may be developed which require less than perfect foresight. Some examples of more flexible models are in the product choice literature. The newest versions of these models simultaneously solve stochastic dynamic programming problems and discrete choice econometric problems. The consumer is assumed to be maximizing a stochastic dynamic programming problem and the observed choices are made on the basis of parameters estimated from a discrete choice econometric model (e.g., Rust 1988a, b; McFadden 1991; Rust 1987). In these models, a much more flexible process can be adopted. For example, information about the site can be modeled as a state variable and visits to the site change the mean and variance of this state variable.

One additional question for further researchers to consider is how well the naive models (particularly completely specified naive models like model 2 presented here) perform relative to rational models. The naive model is relatively easy to estimate and may be a practical alternative to rational models. Some of the evidence presented here suggests that the naive model performs at least as well as the rational model in explaining site choice.

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Notes

[1] Notable exceptions are McConnell, Strand, and Bockstael, who incorporated habits into a traditional travel cost model, and Weber, who performed some preliminary analysis of habits using data similar to those analyzed in this study.

[2] Another source of randomness is often assumed in random utility models, that the consumer's preferences are in fact random to a certain degree. In order to maintain the consistency with the notion of rational consumers planning over longer time spans, this model assumes that the consumer is aware of all attributes and the researcher is not aware of all factors.

[3] Since the price variation in this model is spatial (no temporal effects or discounting effects are considered), an additional restriction placed on the empirical models in this section is that $P_{it} = P_{it+k} \; \forall \; k$.

[4] In this form, $(1 - d_i)$ is the depreciation rate. Any value of d_i less than 1 can be considered a "durable good." However, negative values of d_i (depreciation rates greater than 1) are not typically considered in the analysis of durable goods. As is shown below, negative values of d_i correspond to habit forming goods.

[5] To reflect the fact that the terminal time period is treated differently than all previous time periods, the budget constraint can be rewritten as:

$$W = \sum_{t=1}^{T} \sum_{i=1}^{n} P_{it}X_{it} = \sum_{i=1}^{n} \left[\sum_{t=1}^{T-1} (P_{it} - d_i P_{it+1})Z_{it} + P_{iT}Z_{iT} \right].$$

[6] These assumptions, and their role in discrete choice modeling, are described more completely in Hanemann (1982).

[7] In most examples of discrete choice analysis, the quality attributes of all other sites are suppressed in the conditional utility and conditional indirect utility functions. This is an assumption about the structure of preferences that is maintained here.

[8] The time subscripts on all elements are suppressed. This operation is relevant for every time period.

[9] This empirical analysis considers site choice and participation. The analysis uses weeks as the unit of time and within each week the recreationist has a choice between fishing (at one of the sites available) and not fishing. More detail is provided in the next section of the article.

[10] Q_i represents a quality attribute of site i in this form, but in practice, this can be a vector of quality attributes with γ defined as an appropriately conformable parameter vector.

[11] The data are available for only one season. A more realistic approach would include information from several periods. The issue of model sensitivity to initial conditions has been a problem in the dynamic consumer choice literature for some time. It is very difficult to determine exactly what the initial time period should be. In this model, the sensitivity to initial conditions was examined using randomly generated initial stocks. Two results emerged. First, the dynamic parameters are sensitive to the initial conditions. Second, the dynamic parameters tended to be insignificant for model runs with randomly generated stocks. Note that this initial conditions problem affects the naive models as well as the static models. This topic is certainly an issue for future researchers to explore.

[12] Since the d_i parameters are held constant in each round of estimation, this iterative procedure does not generate consistent estimates of the standard errors of the coefficients. Therefore, these estimates should be viewed as an approximation.

[13] A number of other quality attributes were examined in initial estimates, but only this set of variables significantly affected choice.

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