Evaluating Outdoor Recreation Parks Using TCM: On The Value of Time

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Abstract

The value of time is of importance in evaluating the benefits from outdoor recreation parks. Similarly, the question of the value of time is crucial in evaluating investments in the road system, where the major benefit is shortening the time spent by drivers and passengers. A low value for time will result in rejecting many projects on the ground that the benefits (the value of the saved time) are lower than the costs.

The paper suggests an alternative to the methods used in evaluating time. If we evaluate the economic benefits of a park by revenues from entrance fees, we often receive a low value since entrance fees are relatively low (or don't exist). Travel Cost Method (TCM) is a well-established technique for valuing outdoor recreational benefits. In TCM we measure the total cost of the visit that includes monetary and non-monetary costs, and through simple assumptions we derive the demand curve for the site and can estimate recreational benefits.

The costs of visit in a park include: (a) out of pocket expenditures: entrance fees, fuel costs, equipment costs, accommodation costs and (b) non-monetary expenditures: value of enjoyment or discomfort while travelling and value of time consumed in travel and stay on-site.

The question how to value time remains debatable. What is the appropriate value to impute on time? While the literature argues the use of wage rate to evaluate the time, there are reservations from this approach when a person does not have a discretionary power over his work time, and works a ‘dictated’ number of hours. Likewise, reservations arise when a person doesn't work, a wage rate is not available and cannot serve as a value for leisure time (unemployed people, housewives, retired people).

By combining TCM and Household's Production Approach we examine the allocation of time in a family between work, household production (cooking, cleaning, taking care of children and elderly) and outdoor recreation (both the journey to the site and the time on-site).

The paper suggests solution to the problem of the value of time, and infers from a model analyzing outdoor recreation to the general case.
1. Introduction

Parks are approached as a public good - their consumption is without rivalry or exclusion (only few parks are congested enough to lose these qualities). As with many public goods we are faced with the question of evaluating their benefits. Too often, the parks are provided at a low (or no) entrance fee and the revenues cannot provide a measure of the value of the commodity.

The question ‘what are the economic benefits of providing the commodity’ are especially troubling when investment in a park is considered versus alternative land-uses (competition between recreation and quarrying was discussed by Shechter and Baron, 1976).

The Travel Cost Method (TCM) is a technique for valuing outdoor recreational benefits (among others, Clawson and Knetsch, 1966, Hanley, 1989, Willis and Garrod, 1991, Beal, 1995). In TCM we use revealed behavior, the actual visits in parks. We measure the total cost of a visit that includes monetary and non-monetary costs, and through simple assumptions we derive the demand curve for the site and can estimate recreational benefits as consumers’ surplus.

The costs of visits in a park are composed of: (a) out of pocket expenditures: entrance fees, fuel costs, equipment costs, accommodation costs and (b) non-monetary expenditures: value of enjoyment or discomfort while travelling and value of time consumed in travel and stay on-site.

The question how to value time is debatable. What is the appropriate value to impute on time? While the literature argues the use of wage rate to evaluate time, there are reservations from this approach. When a person does not have a discretionary power over his work time, it is argued that the use of the wage rate is misleading. Likewise, reservation arises when a person doesn't work, a wage rate is not available and cannot serve as a value for leisure time (unemployed people, housewives, retired people).

In this paper, measures for the value of time are proposed for different scenarios. The model derives a solution to the value of time for people working fixed hours, where hours are constrained, and the wage rate is likely not the proper opportunity value of their time. As expected, for people working flexible hours, who are able to freely adjust the hours
they work, the model derives that the opportunity value of time is the wage rate. A value is offered, also, for people with no market value to their time.

In calculating the imputed value of time in TCM, we have to address two questions: what is the quantity of time consumed, and what is the value per unit of time. Regarding the amount of time, do we need to consider the time in travel or the time on-site as well? Cesario and Knetsch (1970) referred only to time in travel. McConell (1975) argued that we have to consider the time on-site as well, and should consider the total time required for completing the recreation activity. We adopt the later approach.

In discussing the value of a time unit, we could arbitrarily adopt the average wage rate, the minimum wage rate, or a portion of an individual’s wage. The value we adopt will have a significant influence on the estimate of benefits, see Cesario, (1976), Bishop and Heberlin (1979). McConnell and Strand (1981) looked on the ratio between the wage rate and the opportunity value of time as an empirical question (in their sample 61%). Smith et al. (1983) tested the ratio between the opportunity cost of time and the wage rate in different sites and samples, and found the ratio varies considerably. They conclude that these ratios are not significant.

To calculate the value of time, we look at the labor supply literature. Heckman's (1974) model of labor supply was the first to address the value of time. Heckman argued that the opportunity cost of leisure is the wage rate. This result stems from a model where the individual's utility is a function of consumer goods and leisure, and the individual maximizes his utility under two constraints - time and income. The decision to spend an extra hour in leisure means giving up the wage rate and the utility derived from the goods that can be purchased in this amount of money.

Feather and Shaw (1999) survey thoroughly the use of wage-rate as the opportunity cost of time. They agree to the use of wage rate, when individuals can freely adjust the work-hours. However, the hours of work are often constrained, a source to corner solutions (Moffitt, 1982, Zabel, 1993, Bockstael, 1987). Some individuals would prefer not to work, and then no value is given to their time. Others would prefer to work less or more
than the constrained work-hours. In the corner solutions, the wage rate is not the alternative value of time. It can be an under- or over-estimate. Our paper addresses the cases where work-hours are not flexible, specifically.

Johnson (1966) modified the basic labor supply model and included the time spent in working as an argument in the utility function, i.e. time is a commodity generating utility, and not just a constraint. The result is that the opportunity cost of time equals the wage rate plus a function of the marginal utility of work. When the marginal utility of work is positive the wage rate is lower than the opportunity cost of time.

As in the labor supply literature, the outdoor recreation literature approaches time as a commodity and as a resource (Wilman, 1980). We have to allocate time, the scarce resource, between many activities, i.e. we have a time constraint in addition to a monetary constraint. Since the resource is limited, it has an opportunity cost which is the net benefit of time spent in the best alternative activity.

The other aspect of time is its commodity characteristic. We derive utility or dis-utility from the time spent in activities. Since we look upon outdoor recreation as having two components, trip and on-site stay, we can ask about the impact of time on the utility from each. The utility of travel time can be positive or negative depending on the landscape, the quality of the road, the congestion, etc. Usually we assume that the time on-site generates positive utility, see De Serpa (1971). The commodity aspect of time is measured by marginal utility. In our model we approach time as a resource, and the model includes a time constraint. However, travel is for us both input and a commodity, and has the dual roles.

In order to calculate the value of time in outdoor recreation, we need an opportunity cost, which can be derived from alternatives to the use of time. Work is an alternative, for those choosing to work (and choosing the work-hours) - what about the others? We solve it by dividing the composite good into two components: goods purchased in the market and homemade goods. Modeling the homemade goods is in the tradition of the literature on Household Production Functions (see Becker, 1965 and Muth, 1966, Gronau, 1973, 1980, 1986).
The individual allocates money and time between commodities purchased in the market and commodities produced by the household (HH). The dilemma facing the members of the HH is whether to purchase ready meals or prepare them at home, whether to purchase services to take care of family or to provide them. The model assumes that an individual uses time and raw materials to produce commodities in the HH.

The substitution depends on the market price of commodities, on the marginal productivity of own production and on the value of time invested in own production.

The unique characteristics of the proposed model are:

i) The model examines work, household production (cooking, cleaning, taking care of children and elderly) and outdoor recreation (both the journey to the site and the time on-site). The modeling enables us to derive the value of time under different scenarios.

ii) The literature on outdoor recreation ignores the fact that outdoor recreation is often a family experience where husband, wife and children participate together. They spend either the same time in travel and on-site or different times. The proposed model is flexible, and can solve for cases where both husband and wife travel together, or each on his own.

In Section 2, we present the general model and in Sections 4-7, we solve the model under different assumptions. Sections 3 and 6 are analyzed under the assumption that the members of the family work on flexible hours and can choose the number of hours worked. One case examined (Case A, Section 3) is when the whole family spends time together (and the same time) in outdoor recreation. Another case examined (Case D, Section 6) is when the members of the family do not spend the same time, and do not necessarily travel the same number of visits. An example is perhaps a visit to a playground next to the house, in which only some of the family members participate.

In Case B (Section 4) it is assumed that both members of the family are at a corner solution and work in non-flexible arrangements (fixed working hours). In Case C (Section 5) it is assumed that one member is on flexible working hours and the other is not working. Section 7 draws general conclusions from this model.
2. The Model

Outdoor recreation is often a family experience where all the members of the family (adults and children) participate. They spend either the same time or different periods. The model presents it as a family experience, in Sections 3-5, where the members spend the same time, and as an experience with different time contributions by members of the family in Section 6.

In the tradition of the HH Production Theory, the two members in the family are regarded in calculating the cost of time and children are disregarded (Gronau, 1980, Graham and Green, 1984, Solberg and Wong, 1992, Maassen van den Brink and Groot, 1995).

The components in the utility function

The HH's utility function has three components, each composed of commodities purchased in the market and of time: the outdoor recreation experience in the park, the travel to and from the park and the consumption of the composite commodity (the other commodities).

i) The HH consumes visits, \( Z_V \) (measured in terms of number of visits). The HH produces the 'package' using market commodities and time. Examples are ‘producing’ a picnic by combining purchased food and time or ‘producing’ fishing with rods, bait and time.

ii) The HH produces a trip back and forth to the site, commodity \( Z_J \), using market goods (a vehicle, fuel) and the time of the participating members (alternatively, two adults or one adult). The travel has two roles: a commodity that contributes utility or disutility and a resource, or an input, which enables the production of the visit experience.

iii) The other commodities and services are represented by the composite commodity, \( C \). The commodities consumed include both commodities purchased in the market, \( X_{MAR} \) and commodities produced by the HH, \( Z_H \), a combination of market commodities and time. For example, \( X_{MAR} \) includes purchasing a car and \( Z_H \) ‘homemade food’ which requires purchasing products, \( X_H \) (meat, vegetables, flour, etc.) and an investment of time.

Constraints
Two constraints apply in maximizing utility: the time constraint and the monetary constraint. In the time constraint, \( T \), the amount of the resource, has to be allocated between time devoted to work, to production of commodities in the HH, to the stay in a park and to travel to the park. The monetary constraint shows that the money spent on commodities purchased for consumption and as inputs in the HH's production of recreation, travel and HH homemade goods, sum to the HH's income. The HH's income includes the wages of all the members of the family and the endowment.

The general model

\[ \text{Max} \ U = U(Z_V, Z_J, C) \]

\[ \text{s. t. } Z_V = Z_V(X_F, T_{FM}, T_{VF}, Z_J) \text{ Visit on-site commodity. Input times by husband and wife, market commodities and the trip commodity.} \]

\[ Z_J = Z_J(X_J, T_{JM}, T_{JF}) \text{ Trip commodity. A combination of time (by husband and wife) and market goods} \]

\[ C = X_{MAR} + Z_H \text{ Composite commodity. Goods purchased in the market or produced by HH.} \]

\[ Z_H = Z_H(X_H, T_{HM}, T_{HF}) \text{ Homemade commodities. A combination of time and market goods} \]

\[ P_V X_F + P_J X_J + P_H X_H + P_{MAR} X_{MAR} = E + W_m T_{WM} + W_F T_{WF} \text{ monetary constraint} \]

\[ T_{VM} + T_{JM} + T_{HM} + T_{WM} = T \text{ Husband's time constraint} \]

\[ T_{VF} + T_{JF} + T_{HF} + T_{WF} = T \text{ Wife's time constraint} \]

Where:

- \( Z_V \) - number of visits to parks;
- \( Z_J \) - Number of trips to parks and back;
- \( C \) - Other goods and services (composite good);
- \( Z_H \) - Commodities produced in the household;
- \( X_{MAR} \) - Commodities purchased in the market;
- \( X_I \) - Market good, which is an input in production of \( Z_I \): \( I = V, J, H \);
$T_{IM}$ - Husband's time that is an input in production of $Z$: $I = V, J, H$

$T_{IF}$ - Wife's time that is an input in production of $Z$: $I = V, J, H$

$T_{WM}$ - Husband's time allocated to work;

$T_{WF}$ - Wife's time allocated to work;

$\overline{T}$ - Total time to be allocated between activities;

$P_I$ - Market price of $X$: $I = V, J, H$

$P_{MAR}$ - Market price of $X_{MAR}$;

$W_M$ - Wage rate (per hour) of husband;

$W_F$ - Wage rate (per hour) of wife;

$E$ - Non labor income, or endowment.

The problem of the HH is to choose the optimal allocation of time and the amount of composite good:

$$(T_{YM}, T_{VF}, T_{JM}, T_{IF}, T_{HM}, T_{HF}, T_{WM}, T_{WF}, C) \geq 0$$

3. CASE A, The Two Members of the Family Work in Flexible Hours, Always Recreate Together

This case is analyzed to show that our model replicates results which were derived in the literature (see Feather and Shaw, 1999).

Assumptions:

Assumption 1: The two members of the HH always recreate together, spend the same time together, both on site and in travel.

$$T_{YM} = T_{VF} = T_V$$

$$T_{JM} = T_{IF} = T_J$$

Assumption 2: The husband and wife determine independently the amount of time spent in work or in HH production.

Assumption 3: Both husband and wife work. The number of hours is flexible.

Under these assumptions we rewrite the family's maximization problem.
Using Assumptions 1-3, the utility function is replaced by equation 2.2 and the monetary constraint is rewritten, replacing Equation 1.6 by Equation 2.3. The time constraints, Equations 1.7, 1.8, were integrated into the monetary constraint and affect the solution of the system:

(2.2) \[ \text{Max} U = U \{ Z_v [T_v, X_v, Z_j (T_j, X_j)], Z_j (T_j, X_j), C \} \]

(2.3) \[
\begin{align*}
P_v X_v + P_j X_j + P_H X_H + P_{MAR} [C - Z_H (T_{HM}, T_{HF}, X_H)] &= \\
= E + W_M (\bar{T} - T_v - T_j - T_{HM}) + W_F (\bar{T} - T_v - T_j - T_{HF})
\end{align*}
\]

The F.O.C to be solved to attain optimal values for \((T_v, T_j, T_{HM}, T_{HF}, T_{WM}, T_{WF}, C) \geq 0\) :

(2.4) \[
\frac{\partial U}{\partial Z_v} \frac{\partial Z_v}{\partial T_v} = -\lambda (W_M + W_F) = 0
\]

(2.5) \[
\frac{\partial U}{\partial Z_v} \frac{\partial Z_v}{\partial Z_j} \frac{\partial Z_j}{\partial T_j} + \frac{\partial U}{\partial Z_j} \frac{\partial Z_j}{\partial T_j} - \lambda (W_M + W_F) = 0
\]

(2.6) \[
\lambda \left( P_{MAR} \frac{\partial Z_H}{\partial T_{HM}} - W_M \right) = 0
\]

(2.7) \[
\lambda \left( P_{MAR} \frac{\partial Z_H}{\partial T_{HF}} - W_F \right) = 0
\]

(2.8) \[
\frac{\partial U}{\partial C} - \lambda P_{MAR} = 0
\]

From Eq. 2.8 we get Eq. 2.9:

(2.9) \[
\lambda = \frac{\frac{\partial U}{\partial C}}{P_{MAR}}
\]

Eq. 2.9 shows that the ratio between the marginal utility of the composite good and its price, is as expected the value of the Lagrange multiplier, and equals the marginal utility of monetary income.

Equations 2.6, 2.7 show that at the optimum, in Case A, the market value of the marginal product of the husband (wife) in the HH (designated VMP) equals the shadow price of the husband's (wife's) time, the wage rate. It is a comparison between the value of
commodities produced in the HH by each member of the family in an additional hour, and the value of time in work by the same member.

If Eqs 2.6 and 2.7 do not hold, and there is inequality, the members of the HH shift between the time spent producing HH's commodities and the time spent in work. The ratio between these equations shows how the husband and wife substitute time among themselves in producing HH commodities. This result is consistent with Gronau (1980), Solberg and Woong (1992).

Comparing Equations 2.4 and 2.5 results in Eq. 2.10. Though Equations 2.4 and 2.5 are modified from one case to another, Equation 2.10 holds in all the cases discussed in the next Sections:

\[
(2.10) \quad \left( \frac{\partial U}{\partial Z_Y} \cdot \frac{\partial Z_Y}{\partial Z_J} + \frac{\partial U}{\partial Z_J} \cdot \frac{\partial Z_J}{\partial T_J} \right) \frac{\partial U}{\partial T_Y} = \frac{\partial U}{\partial Z_Y} \cdot \frac{\partial Z_Y}{\partial T_Y}
\]

Equation 2.10 shows that in the optimum, the marginal contribution of time in producing utility from visits (the right side of the Eq.) or from travel (the left side of the Eq.) must be equal. The left side of the Eq. shows that changing the travel time has two effects, due to the impact of travel as a commodity and as a resource: its impact on utility and on the stay. Both sides must be positive. If the marginal utility from travel time, when time is a commodity, is negative, the sum must be positive. The (positive) marginal utility of a stay (resulting from a change in the amount of time as a resource) must negate any travel discomfort. Frequently, the marginal utility of travel is positive and added to the marginal utility of the stay.

Comparing all the equations, we get that in equilibrium, Eq. 2.11 must hold:

\[
(2.11) \quad \frac{\partial U}{\partial Z_Y} \cdot \frac{\partial Z_Y}{\partial T_Y} \frac{\left( \frac{\partial U}{\partial Z_Y} \cdot \frac{\partial Z_Y}{\partial Z_J} + \frac{\partial U}{\partial Z_J} \cdot \frac{\partial Z_J}{\partial T_J} \right)}{W_M + W_F} = \frac{\partial U}{\partial Z_H} \cdot \frac{\partial Z_H}{\partial T_{HM}} = \frac{\partial U}{\partial Z_H} \cdot \frac{\partial Z_H}{\partial T_{HF}} = \frac{\partial U}{\partial C} = \frac{\partial C}{P_{MAR}}
\]
Eq. 2.11 is the major result of Case A (versions for each other scenario will be presented).

Eq. 2.11 shows that the ratios between the marginal utility of each 'commodity' and the appropriate shadow price (the denominator) are equal. It also shows that the shadow price in outdoor recreation when both members of the HH work in flexible hours is the sum of wage rates and not an individual’s wage rate.

Let us look at this equation from right to left:

The first ratio from right measures the marginal utility of a composite good vs. the cost of an additional unit, where $P_{MAR}$ is the market price of an additional unit.

The other four ratios refer to the allocation of time.

The second ratio from the right shows in the numerator the 'marginal utility product' of the wife’s HH production and in the denominator, the wage rate (the opportunity cost of time). While VMP measures the value of marginal product in monetary terms, 'marginal utility product' is in utility terms. The ratio measures the change in utility due to an increase in ‘HH homemade goods’ when the wife spends extra time in producing HH goods. The wife has to allocate her limited time between home production and work, and compares the benefit vs. her salary rate. The third ratio shows the same relation for the husband.

The two ratios from the left show in the numerator the 'marginal utility product' of extra time spent on the site (in travel) vs. the opportunity cost of time. According to Assumption 1 the husband and wife recreate together and spend the same time on the site and on travel. Consequently, the opportunity cost for on-site time and for travel equals the sum of the opportunity cost of time of each individual, their wage rate.

This result is consistent with Smith, Desvousgesand and McGivney (1983) and Bockstael et al. (1987), that when the individual is flexible in his work-hours the wage rate is the opportunity cost of time. The contribution of this model is in looking upon recreation as a family experience, and concluding that the opportunity cost is the sum of wage rates.

By combining Eqs. 2.6, 2.7 and 2.11, i.e., substituting between the wage rate and the value of the marginal product of time, Eq. 2.11 is rewritten as Eq. 2.12:
The ratios are between 'marginal utility products' and VMP of time spent at the HH. In Eq. 2.12 there are no wage rates. We shall return to this important result later.

4. Case B, The Two Members of the Family Work in Fixed Hours, Always Recreate Together

Too often, the individual does not have discretionary power over his work time. The individual is required to work a certain number of hours, and faces the dilemma of "take it or leave it". Assuming you chose to work, the number of hours worked is a constraint and not a decision variable. Consequently, the result is a corner solution. You are either over-employed or under-employed relative to the optimal number of working hours. How does this situation change the results of our model?

Assumptions 1 and 2 hold, but Assumption 3 is replaced.

Assumption 3a: Both husband and wife work. The number of hours is fixed, \( T_{WM} \), \( T_{WF} \).

\[
T_{WM} = \bar{T}_{WM} \quad T_{WF} = \bar{T}_{WF}
\]

To decrease the number of variables, we write the time spent at the production of HH goods as a function of the time spent in recreation for husband and wife respectively:

\[
T_{HM} = \bar{T} - \bar{T}_{WM} - T_y - T_j
\]

\[
T_{HF} = \bar{T} - \bar{T}_{WF} - T_y - T_j
\]

The HH has to choose optimal values for \((T_y, T_j, T_{HM}, T_{HF}, C)\).

If we do not include homemade commodities in the model, i.e., \( Z_H = 0, T_{HM} = 0, T_{HF} = 0 \), then according to Eqs. 3.2, 3.3, each member of the household spends a fixed number of hours on recreation (on travel and on-site). Such a model would not enable deriving the alternative value of time. Our model that assumes production of homemade goods
enforces the household to allocate time between recreation and homemade production. This choice enables us to calculate the alternative value of time. Since previous models looked upon the composite good only as commodities purchased in the market, they could not derive the opportunity value in the case of fixed hours.

Using Assumption 3a and Eqs. 3.2, 3.3, we rewrite the HH's monetary constraint. The HH's resources are now given, since the number of hours worked is given and not a choice variable and the pay per work results. As in case A, the time constraint is integrated into the monetary constraint. The utility of the HH is maximized under the combined constraint. The combined constraint is:

\[
P_v X_v + P_J X_j + P_H X_H + P_{MAR} \left[ C - Z_H \left( \bar{T} - \bar{T}_{WM} - T_v - T_J, \bar{T} - \bar{T}_{WF} - T_v - T_J, X_H \right) \right] = E + W_M \bar{T}_{WM} + W_F \bar{T}_{WF}
\]

Maximizing Eq. 2.1 subject to Eq. 3.4 we get the following F.O.Cs:

\[
\frac{\partial U}{\partial Z_V} \cdot \frac{\partial Z_V}{\partial T_v} + \lambda P_{MAR} \left( \frac{\partial Z_H}{\partial T_{HM}} \cdot \frac{\partial T_{HM}}{\partial T_v} + \frac{\partial Z_H}{\partial T_{HF}} \cdot \frac{\partial T_{HF}}{\partial T_v} \right) = 0
\]

\[
\left( \frac{\partial U}{\partial Z_V} \cdot \frac{\partial Z_V}{\partial Z_J} + \frac{\partial U}{\partial Z_J} \right) \cdot \frac{\partial Z_J}{\partial T_J} + \lambda P_{MAR} \left( \frac{\partial Z_H}{\partial T_{HM}} \cdot \frac{\partial T_{HM}}{\partial T_v} + \frac{\partial Z_H}{\partial T_{HF}} \cdot \frac{\partial T_{HF}}{\partial T_v} \right) = 0
\]

\[
\frac{\partial U}{\partial C} - \lambda P_{MAR} = 0
\]

We can see the similarity to the results of Case A.

Eq. 3.7 is identical to Eq. 2.8.

Comparing Eqs. 3.5, 3.6 we get the same equality as 2.10 regarding the equality of the 'marginal utility products' of time spent in travel or on-site (time as a commodity and as a resource)

Eqs 3.5, 3.6 are similar to Eqs. 2.4, 2.5, except for the difference in the opportunity value of time. Using Eqs. 3.2, 3.3 we can replace the derivatives in Eqs 3.5, 3.6 by -1, since:
Comparing Eqs. 3.5-3.7 we get Eq. 2.12. We cannot get 2.11, because the wage rates do not appear in the F.O.C., since the hours worked are not a ‘choice variable’.

Eq. 2.12 means that the shadow value of time spent in the trip or on-site can be measured by the value of marginal product (VMP) in the HH. In this case, Case B, where both husband and wife work in fixed hours, it is the sum of VMP of husband and wife.

We have to conclude that when the wage rate does not measure the alternative value of time, we can replace it with the productivity at the HH.

5. Case C, One of the Members of the Family does not Work, Always Recreate Together

The question of the value of time arises when one of the members of the HH does not work, or both do not work. The person can be unemployed, retired, on disability or a housewife. We don't have an opportunity value for time in terms of wage, but as we shall show there is nonetheless an opportunity value of time.

For simplicity, we assume that the wife is unemployed, and the husband works in flexible hours.

What is the applicable monetary constraint that combines the time constraints?

Assumptions 1 and 2 hold, but Assumption 3 is replaced.

**Assumption 3b**: The husband works in flexible hours, $T_{WM}$. The wife is not working, $T_{WF} = 0$ (The situation is symmetrical, and we could examine $T_{WM} = 0, T_{WF} > 0$).

(4.1) $T_{WF} = 0$

Using Assumption 3b, we rewrite the HH's monetary constraint. The HH's resources depend on the HH's endowment and on the husband's work-hours.

(4.2) $P_v X_v + P_f X_f + P_h X_h + P_{MAR} (C - Z_H(T_{HM}, T_{HF}, X_H)) = E + W_M T_{WM}$
From the time constraints we can calculate the number of hours worked in the HH by the
husband and wife:

\( T_{HM} = \bar{T} - [T_v + T_j + T_{WM}] \)  

(4.3)

\( T_{HF} = \bar{T} - [T_v + T_j] \)  

(4.4)

Integrating the time constraints, Eqs. 4.3, 4.4, we rewrite the monetary constraint:

\[ P_v X_v + P_j X_j + P_{HM} X_{HM} + P_{MAR} \left[ C - Z_{HM}(T_{HM}, \bar{T} - T_v - T_j, X_{HM}) \right] = E + W_M (\bar{T} - T_v - T_j - T_{HM}) \]  

(4.5)

The HH has to choose \( (T_v, T_j, T_{HM}, T_{HF}, T_{WM}, C) \) to maximize its utility.

The F.O.C are:

\[ \frac{\partial U}{\partial Z_v} \frac{\partial Z_v}{\partial T_v} - \lambda \left( W_M + P_{MAR} \frac{\partial Z_{HM}}{\partial T_{HM}} \right) = 0 \]  

(4.6)

\[ \left( \frac{\partial U}{\partial Z_v} \frac{\partial Z_v}{\partial Z_j} + \frac{\partial U}{\partial Z_j} \right) \frac{\partial Z_j}{\partial T_j} - \lambda \left( W_M + P_{MAR} \frac{\partial Z_{HM}}{\partial T_{HF}} \right) = 0 \]  

(4.7)

\[ \lambda \left( P_{MAR} \frac{\partial Z_{HM}}{\partial T_{HM}} - W_M \right) = 0 \]  

(4.8)

\[ \frac{\partial U}{\partial C} - \lambda P_{MAR} = 0 \]  

(4.9)

We can see (again) the similarity to the basic model.

Eqs 4.6, 4.7 are similar to Eqs. 2.4, 2.5, where the difference is in the opportunity value of time. Eq. 4.8 is identical to Eq. 2.6, and similarly Eqs. 4.9 and 2.8 are the same. There is no parallel to Eq. 2.7, the condition regarding the wife’s work-hours.

Comparing Eqs. 4.6 and 4.7 we get Eq. 2.10.

Eq. 4.8 shows that the husband, who works in flexible hours, compares his marginal utility product from producing in the HH to his wage rate.

From Eqs. 4.6-4.9 we get:

\[ \frac{\frac{\partial U}{\partial Z_v} \frac{\partial Z_v}{\partial T_v}}{W_M + P_{MAR} \frac{\partial Z_{HM}}{\partial T_{HF}}} = \frac{\frac{\partial U}{\partial Z_v} \frac{\partial Z_v}{\partial Z_j} + \frac{\partial U}{\partial Z_j}}{W_M + P_{MAR} \frac{\partial Z_{HM}}{\partial T_{HF}}} \frac{\partial Z_j}{\partial T_j} = \frac{\frac{\partial U}{\partial C} \frac{\partial Z_{HM}}{\partial T_{HM}}}{W_M} = \frac{\frac{\partial U}{\partial C}}{P_{MAR}} \]  

(4.10)
We see that as in cases A and B the opportunity cost of time spent in recreation, either in travel or on-site, equals the opportunity value of time of both husband and wife (the sum of the values). While the opportunity cost of the husband’s time is his wage rate, the opportunity cost of the wife is her VMP (value of marginal product equals price of a commodity times the marginal product) in producing HH commodities.

Though the wife is unemployed, and does not have a wage rate, an opportunity value for her time emerges in our model.


Cases A, B and C assumed that both husband and wife recreate together. This is a limiting assumption, and we relax it in this section, showing that the results of this model are more general.

We choose to analyze this case assuming that both husband and wife work with flexible work-hours (as in Case A). It is possible to assume fixed work-hours (Case B), or that one of the two members of the HH does not work (Case C). Table 1 will exhibit results of the different scenarios.

Assumption 1a: The two members of the HH don’t recreate together; the time spent on-site and in travel can be the same or different.

\[
T_{VM} \neq T_{VF} \quad T_{JM} \neq T_{JF}
\]  

(5.1)

Assumptions 2 and 3 hold. By maximizing the utility function we look for the optimal values of \(T_{VM}, T_{VF}, T_{JM}, T_{JF}, T_{HM}, T_{HF}, T_{WM}, T_{WF}, C\) ≥ 0

The combined constraint (combining the monetary and time constraints) is:

\[
P_v X_v + P_f X_f + P_h X_H + P_{MAR} [C - Z_H (T_{HM}, T_{HF}, X_H)] =
E + W_M (\bar{T} - T_v - T_j - T_H) + W_f (\bar{T} - T_v - T_j - T_H) + W_{v} (\bar{T} - T_v - T_j - T_H)
\]

(5.2) s. t.

The F.O.C. are:

\[
\frac{\partial U}{\partial Z_v} \cdot \frac{\partial Z_v}{\partial T_{VM}} - \lambda W_M = 0
\]  

(5.3)

\[
\frac{\partial U}{\partial Z_v} \cdot \frac{\partial Z_v}{\partial T_{VF}} - \lambda W_f = 0
\]

(5.4)
Solving Eqs. 5.3 and 5.5 or 5.4 and 5.6 we get a version of Eq. 2.10. In this case, the husband (wife) separately compares the marginal utility product of time in travel and time on-site. The times are not the same, as they were in Cases A-C.

Eqs. 5.7 (5.8) shows that the husband (wife) compares his (her) wage rate (we assume flexible work-hours) to his (her) VMP in producing HH products.

Dividing Eq. 5.3 by Eq. 5.4, 5.5 by 5.6, and 5.7 by 5.8, we get Eq. 5.10. We see that the husband and wife substitute each other in the time on-site, in travel time or HH production, at the ratio of their wage rates. The one who has a higher wage rate (e.g., wife) will require a higher marginal product of time. If both have the same 'production' function, it will imply less time of the wife in activities that the husband can substitute for her.

Comparing Equations 5.3 – 5.9, we get Eq. 5.11, the general result of this model:
Substituting (5.7) and (5.8) into (5.11), we get:

\[
\begin{align*}
\frac{\partial U}{\partial T_{IM}} &= \frac{\partial U}{\partial Z_{IM}} - \frac{\partial U}{\partial Z_{IM}} = \left( \frac{\partial U}{\partial Z_{IM}} \cdot \frac{\partial Z_{IM}}{\partial T_{IM}} + \frac{\partial U}{\partial Z_{IM}} \cdot \frac{\partial Z_{IM}}{\partial T_{IM}} \right) = \left( \frac{\partial U}{\partial Z_{IM}} \cdot \frac{\partial Z_{IM}}{\partial T_{IM}} + \frac{\partial U}{\partial Z_{IM}} \cdot \frac{\partial Z_{IM}}{\partial T_{IM}} \right)
\end{align*}
\]

(5.12)

These last Equations, 5.11, 5.12, resemble Eqs 2.11 and 2.12.

While 2.11 refers to the two members of the HH recreating together, Eq. 6.17 deals with each member making his own decisions. In both cases, work is in flexible hours, and the opportunity cost of time is the wage rate. However, in Eq. 2.11 we look for the sum of wage rates, and in 5.11 for each member’s wage rate.

Eqs. 2.12 and 5.17 are similar as well, but the opportunity cost of time is in VMP values in the production of HH commodities.

7. Concluding Remarks

The value of time is of importance in evaluating the benefits from outdoor recreation parks, where it is used in TCM to derive the demand function and the benefits of a park.

The literature argues for the use of the wage rate. However, it is argued that too often we have corner solutions, when a person works fixed work-hours and the wage rate is a wrong value of time. Similarly, in the case where the individual is not employed, the wage rate cannot serve, as it is not available.

A model is proposed that deals with the allocation of time between work, outdoor recreation (stay on-site and travel) and work in the HH, where each good has components that are purchased in the market and input of time. The model approaches time as both a
resource (constraint) and indirectly as a commodity. The model results are the optimal allocation of time between activities, and the opportunity cost of time in different scenarios. As found in the literature, when individuals work in *flexible* hours (Case A), the value of time is the wage rate, the opportunity cost of time. The model provides solutions to cases that were not solved previously. Using our model we find the value of time when individuals work in *fixed* hours (Case B) or do not work (Case C) - the value of marginal product (VMP) in the HH. VMP measures the value of goods produced in an additional hour spent in HH production, where the goods are evaluated in market prices. We suggest using the VMP as an alternative to the wage rate when the wage rate does not apply.

The derivation of the value of time was enabled due to two components in our modeling. i) We look upon each commodity as combining market goods with time, and the HH is limited in purchasing products and in the time allocated for each product, due to monetary and time constraints. ii) The outdoor recreation literature looks upon the composite good as composed of market goods only. We look upon the composite good as having two components: the market goods and the homemade goods. The addition of homemade goods, HH production, enables us to derive the value of time in the HH.

A unique characteristic of this model is its distinguishing between outdoor recreation activities in which all the members of the family participate and those activities in which only part of the family participates. When we deal with family activities, we need to consider the *sum* of the alternative values of time. When we deal with activities of part of the family, we need to refer only to the opportunity value of time of the participants.

The model allows also to present each individual differently in terms of work: working or not, working in flexible or fixed hours. The results of the different scenarios are presented in Table 1.

The results have implications for empirical work. As long as we study anglers' behavior, which is often an individual activity, then the value of time has to reflect the person participating. We have to inquire about the individual's income, but add questions on the type of work, flexible/fixed hours. If we are studying a camping ground, a family
experience, we cannot ask about the family income without being sure that both members of the HH work in flexible hours. Otherwise, the wage is a wrong value. The same method can estimate the value of time for non-working people.

This method has implications for evaluating investments in the road system, where the major benefit is shortening the time spent by drivers and passengers. A low value for time will result in rejecting many projects on the ground that the benefits are lower than the costs. We have to study productivity in the HH, since it is of importance to a high percentage of the population (only 30% work on flexible schedule according to Feather and Shaw, 1999).

References


Table 1. The alternative cost (shadow price) of on-site and travel time, when husband and wife recreate together.

<table>
<thead>
<tr>
<th>model assumptions</th>
<th>The opportunity cost of time</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$T_v$</td>
</tr>
<tr>
<td>$T_{IM} = T_{IF} = T_v$   $T_{JM} = T_{JF} = T_j$</td>
<td>$W_M + W_F$</td>
</tr>
<tr>
<td>couple works by flexible hours</td>
<td>$P_{MAR} \left( \frac{\partial Z_H}{\partial T_{HM}} + \frac{\partial Z_M}{\partial T_{IF}} \right)$</td>
</tr>
<tr>
<td>a) couple works fixed hours</td>
<td>$W_M + P_{MAR} \frac{\partial Z_M}{\partial T_{IF}}$</td>
</tr>
<tr>
<td>b) couple does not work</td>
<td>$W_F + P_{MAR} \frac{\partial Z_H}{\partial T_{HM}}$</td>
</tr>
<tr>
<td>a) husband works flexible hours; wife works fixed hours</td>
<td>$W_M + P_{MAR} \frac{\partial Z_M}{\partial T_{IF}}$</td>
</tr>
<tr>
<td>b) husband works flexible hours; wife does not work</td>
<td>$W_F + P_{MAR} \frac{\partial Z_H}{\partial T_{HM}}$</td>
</tr>
<tr>
<td>a) wife works flexible hours; husband works fixed hours</td>
<td>$W_M + P_{MAR} \frac{\partial Z_M}{\partial T_{IF}}$</td>
</tr>
<tr>
<td>b) wife works flexible hours; husband does not work</td>
<td>$W_F + P_{MAR} \frac{\partial Z_H}{\partial T_{HM}}$</td>
</tr>
</tbody>
</table>
Table 1. The alternative cost (shadow price) of on site and travel time of husband and wife in all cases - continue.

<table>
<thead>
<tr>
<th>model assumptions</th>
<th>The opportunity cost of time</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$T_{YM}$</td>
</tr>
<tr>
<td>couple works flexible hours</td>
<td>$W_M$</td>
</tr>
<tr>
<td>a) couple works fixed hours</td>
<td>$P_{MAR} \frac{\partial Z_H}{\partial T_{IM}}$</td>
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<tr>
<td>b) couple does not work</td>
<td>$W_M$</td>
</tr>
<tr>
<td>$T_{YM} \neq T_{vF}$</td>
<td>$T_{IM} \neq T_{jF}$</td>
</tr>
<tr>
<td>a) husband works flexible hours; wife works fixed hours</td>
<td></td>
</tr>
<tr>
<td>b) husband works flexible hours; wife does not work</td>
<td></td>
</tr>
<tr>
<td>a) wife works flexible hours; husband works fixed hours</td>
<td>$P_{MAR} \frac{\partial Z_H}{\partial T_{IM}}$</td>
</tr>
<tr>
<td>b) wife works flexible hours; husband does not work</td>
<td></td>
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