Demand in Leisure Markets

An Empirical Analysis of Time Allocation

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Motivation

• Leisure activities matter – 35% of waking time, 9.7% of personal consumption expenditures, 6.9% of GDP.

• Expenditures on recreation in U.S. estimated at 702 Billion $ (2004).

• Previous work either black-boxed it or treated one particular industry.
Objectives

• Valuate activities and leisure time as whole.
  – Welfare implications of activity price and quality changes.
  – Income and wage effects on time allocation.
  – Travel costs effects.
  – Labor supply.
Model

• On a given day individuals solve:

\[
\begin{align*}
\max_{X_L, x_z, y_z} & \quad U \left( X_L, x_z, y_z \mid \Theta, B, \epsilon \right) \\
\text{subject to:} & \\
(1) & \quad y_{ue} + w \cdot x_w = y_z + \sum_l x_l \cdot p_l + \sum_l I\{x_l > 0\} \cdot \text{Setup}_l + \\
& \quad + \text{Out} \cdot \overline{p}_{\text{travel}} \\
(2) & \quad 24 = x_z + x_w + \sum_l x_l + \text{Out} \cdot \overline{T}_{\text{travel}} \\
(3) & \quad X_L, x_z, x_w, y_z \geq 0
\end{align*}
\]
Model 2

• We take interest in the following:

\[ X_L = \{x_1, \ldots, x_L \} \quad x_l \text{ – hours devoted to } l^{th} \text{ activity} \]
\[ x_w \text{ – hours devoted to work} \]
\[ x_z \text{ – hours devoted to non-leisure activities} \]
\[ y_{ue} \text{ – unearned income} \]
\[ y_z \text{ – expenditure on non-leisure activities} \]

A few definitions:

\[ \text{Out} = 1 \text{ if not all activities are at home} \]
\[ B \text{ – a set of exogenous variables} \]
\[ w \text{ – wage rate} \]
\[ P \text{ – price data} \]

\[ \varepsilon \sim N\left(0, \sigma^2 \cdot I_L\right) \]
Main model features

• Binding non-negativity constraints ➔ Simultaneous decision on participation (if) and extent of use (how much).

• Nonlinear price schedules:
  – Per unit (hour) price is mostly zero.
  – Setup costs exist (e.g. ticket to cinema).
  – Commuting required for certain activities (out of home).

• Zeros are increasingly important in choice modeling - individual data more available.
Empirical Specification

• CES utility function:

\[
U = \left[ \sum_{l=1}^{L} e^{\varepsilon_l} (\phi_i \cdot x_l + \theta_l)^\rho + \psi_{xz} \cdot x_z^\rho + \psi_{yz} \cdot y_z^\rho \right]^{\frac{1}{\rho}}
\]

\[0 < \rho < 1; \quad \phi, \theta, \psi_{xz}, \psi_{yz} > 0\]

• \(\phi\) is a ‘repackaging’ parameter.
• \(\theta\) is a translating parameter. Inversely proportional to the “essentiality” of an activity.
• A taste for variety is embedded.
Estimation

- Under linear prices, we can use Kuhn-Tucker FOC to get a probability statement on the tuple $P^* = \{X_L^*, x_w^*\}$

$$\frac{\partial U}{\partial x_i} \bigg/ \frac{\partial U}{\partial y_z} \leq \frac{p_l}{p_{yz}}$$

- If LHS has only one random component – MLE is feasible (if separable => SML).
- It is more difficult to implement MLE under non-linear prices, as participation is jointly determined by both unit prices as well as setup costs.
Method of Simulated Moments

• Use ‘zero functions’ defined over $S^*$, the solution to utility max. problem:

$$E(S^{observed} - E(S^*; \Theta^0) | B) = 0$$

• With sample analog:

$$\frac{1}{n} \sum_{i=1}^{n} \left( S^o_i - \frac{1}{nS} \sum_{j=1}^{nS} S_i^* | \epsilon^j \right) \otimes B_i = 0$$

• Since $S^*$ has no closed form solution – use numerical methods, e.g. direct search (nelder-mead 1965).
## Basic Data – ATUS 2004, Weekends

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>p_x</th>
<th>p_st</th>
<th>Out</th>
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<tbody>
<tr>
<td>Out (xz)</td>
<td>965</td>
<td>219</td>
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<td>0</td>
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<tr>
<td>Watching TV</td>
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<td>176</td>
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<td>Social - Out of Home</td>
<td>46</td>
<td>102</td>
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<td>Read Book, Newspaper</td>
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<td>64</td>
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<td>Religious Activities - OUT of HOME</td>
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<td>Rest, Relax, Smoke</td>
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<td>10</td>
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</table>
Valuating Leisure

• Base valuation on Compensating Value.

\[ V(P, y_{ue}) \equiv \text{Max } U(\cdot), \text{ s.t. } (1) - (3). \]

• CV is implicitly defined by:

\[ V(P, y_{ue}) = \widetilde{V}(\widetilde{P}, y_{ue} + CV) \]

• E(CV) is the sum one will require to be as well off as they were at the base setting.

• Solve for CV using iterative mapping.
Valuating Leisure

• Value of all leisure activities $100/130$.
  – Increasing with unearned income (50-140$)
  – Decreasing with wage (134-10$).

• Value of TV $52/62$.
  – Decreasing with wage (60-11$).

• Value of Cinema $2.5/10.3$ (tickets at 6$).
  – Inverse U with income.
  – Decreasing with wage.

• Value of Computer use: $3.3/10$. 
24 Hours

• The marginal value of time – if we had 23 hrs/day?
  – 15.3$, average wage at 12.5$.
  – Increases with income 8-21$.
  – Increases sharply with wage 10-58$.

• Wake early? - If we had 25 hrs/day?
  – Leisure gets 60% (36 min.)
  – Work gets 34% (20 min.)

• Traffic & Congestion – if travel time was 1.5h instead of 0.5?
  – Results similar to above - 15$.
Wage and Income effects

• Wage increase 10%:
  – Leisure decreases 5%.
  – Other activities decrease 5%.
  – Work increases 14%.
  – Effects are inverse U in wage.

• Unearned Income increase 10%:
  – Leisure increases 2%.
  – Other activities increase 1.8%.
  – Work decreases 5%.
  – Effects diminish in wage.
Price and Quality effects

• If TV was 50¢ an hour?
  – TV time would decrease 17%.
  – Total leisure decrease 1%.
  – Other activities increase 1.7%.
  – Work increases 3%.

• If the quality of TV rose 10%?
  – TV increases 13%, total leisure +2.5%.
  – Work decreases 5%.

• If a ticket to the movies was 10$?
  – Average time drops 2.6%.
  – Other expenditure drops ~5$.