Microeconomic Modeling of Patient Decision Making

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“I have always been struck by the criticism that health economics … is the only application of economics that does not use the discipline of economics.”


Session Outline

1. Conventional microeconomic analysis and health economics – what is the difference?
2. Maximizing Utility and the Production Possibilities Curve
3. Factors Influencing Health Care Decisions
4. From Theory to Practice – An applied example

Health Economics - or Conventional Economics Applied to Health?

Microeconomic Models

• Inputs/income used to produce health care have alternative uses
• Microeconomic models assume households minimize the overall cost of producing a given level of health care, including all alternative uses of the inputs
• In health economics, we typically restrict this viewpoint to the production of health care only…

Gap between Health Economics and other Applications of Economics

• HE emphasis on drug approval and reimbursement
  – Need for simple concepts such as QALYs
  – Restrictive assumptions limit usefulness in understanding and modeling patient and physician behavior
• Conventional economic analysis relevant to modeling health-care decisions
  – Economics of human capital
  – Economics of production and consumption
  – Economics of risk and uncertainty
Some Applications of Conventional Economics to Health

- **Demand for health care**
  - Uptake for new pharmaceuticals, vaccines, screening
  - Monetary value to patient or willingness to pay
  - Adherence and persistence
  - Benefit-risk tradeoffs

- **Household decision making**
  - Insurance
  - Family caregiving
  - Children’s health

- **Health-care delivery**
  - Physician decision making
  - Hospital management
  - Drug development decision making

The Concept of Utility

Utility in Health Economics and Conventional Economics

- **Utility is index of satisfaction or well-being**
- **Health-state utility**
  - Assumes utility only from health
  - Used for QALY weights
  - Cardinal measure (absolute score on 0 to 1 scale)

- **Conventional utility**
  - Incorporates all factors contributing to satisfaction
  - Used in all empirical economics except health
  - Ordinal measure (relative ranking 1st, 2nd, 3rd, etc.)

QALYs Do Not Measure Preferences

- **QALYs assume preferences are:**
  - Linear in time
  - Separable and additive
  - Independent of health history, age, income, other personal characteristics
  - Not averse to bearing risk
- **All these assumptions have been rejected in empirical tests**
- **QALYs also ignore factors important to understanding health-care decisions**

Example: Cardinal vs. Ordinal Utility

<table>
<thead>
<tr>
<th>PRO Domain</th>
<th>Visual Analog Scale Rating [0, 100 mm]</th>
<th>Patient #1</th>
<th>Patient #2</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Pain while walking</td>
<td></td>
<td>75 mm</td>
<td>50 mm</td>
</tr>
<tr>
<td>B. Pain while resting</td>
<td></td>
<td>25 mm</td>
<td>25 mm</td>
</tr>
<tr>
<td>C. Stiffness in joints</td>
<td></td>
<td>10 mm</td>
<td>10 mm</td>
</tr>
</tbody>
</table>

- Cardinal utility requires that B is exactly 2.5 times worse than C for both patients
- Ordinal utility requires only that B is better than C for both patients

What Else Does Utility Depend on?

<table>
<thead>
<tr>
<th>Health Economics</th>
<th>Conventional Economics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Health state</td>
<td>Health state</td>
</tr>
<tr>
<td>Time in health state</td>
<td>Time in health state</td>
</tr>
<tr>
<td>Timing of health state</td>
<td>Timing of health state</td>
</tr>
<tr>
<td>Risk</td>
<td>Risk</td>
</tr>
<tr>
<td>Attitudes toward risk</td>
<td>Attitudes toward risk</td>
</tr>
<tr>
<td>Process factors</td>
<td>Process factors</td>
</tr>
<tr>
<td>Personal characteristics</td>
<td>Personal characteristics</td>
</tr>
<tr>
<td>Non-health consumption</td>
<td>Non-health consumption</td>
</tr>
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</table>
Introduction to Microeconomic Models

The Household-Production Model

- Households combine household members’ time and skills with purchased goods to produce “commodities”
- Households get direct utility from consuming commodities
- Time and purchased goods provide utility indirectly through the commodities they help produce

Household Objectives

- Households seek to maximize utility by producing commodities subject to constraints
  - Available time and effort
  - Available money
  - Available information
  - Technological constraints on how to produce commodities

Simple Example of Household Production

Inputs
- Ingredients (rice, meat, lettuce, etc.)
- Information (recipe)
- Equipment (stove, flatware, etc.)
- Time (duration of effort)

Output
- A Meal

Health Example: Management of Osteoarthritis Symptoms

Inputs
- Ingredients (OTC and Rx medications)
- Information (Doctor’s Instructions)
- Equipment (Assistive devices)
- Time (inc. other household members)

Output
- Pain Control

Treatment decisions depend on:
- Efficacy, side effects, convenience, and cost of treatment alternatives
- Relative value of household members’ time

Health in a Household-Production Framework

- Households’ production of health is affected by
  - Genetic endowments
  - Lifestyle decisions
  - Consumption of health-care services
  - Random events
- Investments in current and future health:
  - Increase current and future utility
  - But: reduce consumption of other goods and services
- Assumes households optimize expected utility depending on
  - Costs of medical care relative to other uses of time and money
  - Productivity of health expenditures relative to other uses of time and money
HPV Vaccine Uptake

Parents are less sensitive to cost than to duration and quality of protection.

Predicted Percent Uptake

- $300 (Quadrivalent)
- $100 (Quadrivalent)
- $0 (No wart protection)
- Lifetime (Quadrivalent, $300)
- Full cancer protection (Quadrivalent, $300)

Opportunity Cost

- Inputs used to produce health care have alternative uses in producing household commodities.
- The value of forgone opportunities is called “opportunity cost”.
- “Full” income (money + monetary value of time) often is used as an index of opportunity costs.
- Microeconomic models assume households minimize the overall opportunity cost of producing a given level of health care.

Choosing a Point on the Production-Possibilities Curve

- Households choose to produce a combination of commodities that gives the most utility possible.
- A constant-utility curve shows which combinations give the same utility as other combinations.
- Different constant-utility curves show which combinations give more utility than other combinations.

Different uses of available household inputs result in different combinations of commodities.

All Combinations on Curve Have the Same Utility

<table>
<thead>
<tr>
<th>Combination</th>
<th>Pain Control</th>
<th>Full Income</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>20</td>
<td>5</td>
</tr>
<tr>
<td>B</td>
<td>5</td>
<td>20</td>
</tr>
<tr>
<td>C</td>
<td>4</td>
<td>25</td>
</tr>
<tr>
<td>D</td>
<td>4</td>
<td>35</td>
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</table>

“By evaluating opportunity costs, we organize our lives.”

Comparing Different Constant-Utility Curves

All combinations on $U_1$ have more utility than combinations on $U_2$.

Examples of Utility Equivalents

- $1500 of income has the same average utility as participating in a diabetes prevention program that lowers diabetes risk by 30\%^{(1)}$
- 2\% reduction in risk of serious infection has the same average utility as improving Crohn’s Disease symptoms from severe to moderate\(^{2}\)
- Being on dialysis for 10 years has the same average utility as living with good health for 7 years\(^{3}\)

Factors Influencing Health-Care Decisions:

1. Efficacy of Health-Related Inputs
2. Treatment cost
3. Household differences in preferences for health

Changes in the Production Possibilities Curve

Technology: rules that determine how inputs can be turned into commodities

- A better stove reduces the time needed to finish meal preparation
- A more effective migraine treatment frees time to be used for other purposes
Improved pain-control efficacy improves household-production possibilities

Factors Influencing Health-Care Decisions

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<td>2. Treatment cost</td>
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<td>Increases in treatment cost reduce the optimal health level</td>
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Factors Influencing Health-Care Decisions:

2. Treatment Cost (Money and/or Time)

An increase in input cost worsens household-production possibilities

Factors Influencing Health-Care Decisions:

3. Differences in household preferences
Maximum Utility with Different Household Preferences

Empirical Examples: Different Preferences for Health Care

- Parents of children with Crohn’s disease are less tolerant of treatment risks than adult patients

- Patients with prior treatment experience with hepatitis C are more likely to adhere to an increase in the frequency of viral treatments

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<tr>
<td>3. Household differences in preferences for health</td>
<td>Form of the constant-utility curve</td>
<td>Stronger preferences for health increase the optimal health level</td>
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Microeconomic modeling applications

- The household-production framework can explain healthcare decisions using:
  - Household-production technology
  - Relative input costs
  - Household preferences

- Microeconomic models quantify the impact of changes in each of these factors

Meet John Watson

- John Watson:
  - Income $80,000
  - 46 years old, obese, sedentary
  - Married
  - Two children
  - Has failed on oral agents: current A1c level is 10%
  - Injects insulin at home once a day
What the Watsons consume
• A reduction in John’s A1c level can only be achieved at an opportunity cost
• The opportunity cost that the Watsons bear for John’s glucose control reduces their consumption of other goods and services

What determines cost of glucose control?
• To improve John’s blood-sugar control, the Watsons need to:
  – Modify diet
  – Spend more time preparing meals at home
  – Join a health club
  – Increase medication dose
  – Increase frequency of glucose monitoring
  – Reduce hours worked to alleviate stress and improve daily routine

Production-Possibilities Curve

Bringing the production-possibilities curve and the constant-utility curve together
The Watsons get the most value from reducing consumption by $10,000 to reduce John’s A1c by 2%

How do we know what the Watsons value?
• Utility is not directly observable
• Economists infer the shapes of constant-utility curves by analyzing observed choices
  – Choices involving real tradeoffs provide revealed-preference data
  – Choices involving constructed tradeoffs under experimental conditions provide stated-preference data

There is a new drug in the market
• A new Type-2 diabetes treatment
  – 50% improvement in glucose control
  – Administered by injection twice a month by a healthcare provider
  – No side effects
How does improved efficacy affect the Watsons?

<table>
<thead>
<tr>
<th>Money-equivalent opportunity cost of glucose control ($/year)</th>
<th>A1c level (%)</th>
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</thead>
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<tr>
<td>$0</td>
<td>10%</td>
</tr>
<tr>
<td>$5,000</td>
<td>7.7%</td>
</tr>
<tr>
<td>$10,000</td>
<td>7%</td>
</tr>
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</table>

The Watsons can bring John's A1c level to 7% at the same opportunity cost as current glucose control at 8%.

Example: Type 2 Diabetes Adherence

Perceived gain from improved glucose control is only half as important as avoiding an additional injection.

How can we bring John’s A1c level down to 7%?

What factors increase the optimal level of glucose control among patients?

What factors decrease the optimal level of glucose control among patients?

What alternatives can be proposed to compensate patients for the factors decreasing the optimal level of glucose control among patients?