Overview: Consumer Demand and Characteristics

- Estimation of Demand for Product Characteristics
  - Adjusting Prices for Quality Change
  - Consumer valuation and discrete choice

- Important Aspects of Demand
  - Dynamics
  - Network externalities

Demand and Product Characteristics

- Issues:
  - How do you sort out price effects when the quality of goods is changing over time?
  - How are changes in product design evaluated?

- Example of the problem: PCs
  - IBM analysis of the demand for computers
  - Demand for software (e.g. spreadsheets)
Concepts Underlying “Hedonic” Prices

- For products with several quality characteristics:
  - View the product as a composite “bundle” of characteristics
  - The price of the product (the “bundle”) reflects the amount of each characteristic and the (implicit) price of each characteristic

- ‘Hedonic price’ = ‘Price of characteristic’

Hedonic Price Analysis: The Basic Idea

- Estimate the “prices” of the characteristics in the bundled product, using price data and multiple regression.
- That is: Estimate \( P = f(\text{characteristics, time}) \)
  - Use regression parameters to find what characteristics are highly valued (I.e., high prices)
  - Use model to predict prices, compare observed price changes, and so forth
    - Constant product “quality” = Hold fixed the bundle of characteristics
Early Hedonic Price Analyses

• **Waugh** -- price of asparagus at Faneuil Hall in 1920’s.
  *Characteristics*: average diameter of stalks, dispersion in stalk diameter, inches of green color, etc.

• **Court** -- prices of auto models in the U.S., 1920-35.
  *Characteristics*: horsepower, length, weight of auto model, etc.

• **Chow** -- rental prices of mainframe computers in the U.S., 1960-65.
  *Characteristics*: multiplication time (MT), memory size (MEM) and access time (AT), etc.
Chow’s Analysis of Mainframe Computer Prices, 1960-65

- Data: rental prices of 82 computers in the U.S., 1960-65, as well as measures of MT, MEM, and AT
- Estimated Price Equations:
  \[ \ln P = -0.104 - 0.064 \ln MT + 0.579 \ln MEM - 0.141 \ln AT \]
  
  \[- 0.140D_{61} - 0.489D_{62} - 0.594D_{63} - 0.925D_{64} - 1.163D_{65} \]

  where \( D_{xx} \) is an indicator variable equal to one in year \( xx \), else equals zero
- How to interpret estimated coefficients
  - \( \ln MT \), \( \ln MEM \), and \( \ln AT \)
  - \( D_{61} \) through \( D_{65} \)

Value of Changing Product Characteristics

Approximate Price Changes for Changes in Characteristics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Change</th>
<th>( \Delta P )</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT</td>
<td>-10%</td>
<td>0.64%</td>
</tr>
<tr>
<td>MEM</td>
<td>+10%</td>
<td>5.79%</td>
</tr>
<tr>
<td>AT</td>
<td>-10%</td>
<td>1.41%</td>
</tr>
</tbody>
</table>
### Quality-Adjusted Price Index  
(holds constant all quality attributes)

<table>
<thead>
<tr>
<th>Year</th>
<th>lnP</th>
<th>P [= $e^{\text{lnP}}$]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1960 normalized</td>
<td>0</td>
<td>1.000</td>
</tr>
<tr>
<td>1961</td>
<td>-.140</td>
<td>0.870</td>
</tr>
<tr>
<td>1962</td>
<td>-.489</td>
<td>0.613</td>
</tr>
<tr>
<td>1963</td>
<td>-.594</td>
<td>0.552</td>
</tr>
<tr>
<td>1964</td>
<td>-.925</td>
<td>0.397</td>
</tr>
<tr>
<td>1965</td>
<td>-1.163</td>
<td>0.313</td>
</tr>
</tbody>
</table>

\[ \Delta P/\text{yr} = -20.8\% \text{ (quality adjusted)} \]
How Do Consumers Evaluate Different Products?

- Hedonic analysis gives market evaluations of product characteristics.
- How is this related to consumer evaluation?
- Suppose you had data on households that recently bought a PC.
  - Different households and different types of PCs.
  - How could you study this data?

(This is what marketing people do all the time!)

Discrete Choice Models

- Model the value of the PC type \( j \) to household \( k \) as
  \[
  U_{jk} = f(\text{characteristics of product } j, \text{ characteristics of household } k)
  \]
- Discrete Choice Model:
  Household \( k \) chooses \( j \) if \( U_{jk} \) is greater than \( U_{j'k} \), for all other \( j' \).
  - With unobserved (random) characteristics, model probability of purchase
  - Logit, Probit, Multinomial Logit (see Marketing).
Important Aspects of Demand

- Dynamic effects
  - Short run elasticity smaller than long run
  - Long run elasticity smaller than short run

- Network externalities
Dynamic Effects on Demand I

- Full effects (price, income, etc.) can take time to appear
  - Habits and persistence
  - Adaptation/adjustment of related goods
  - Adjustment costs

- SR Elasticity << LR Elasticity
  - Eventual impact is larger than initial impact

Figure 1: Typical Dynamic Demand Responses to Price Increase or Income Drop
Dynamic Effects on Demand II

• Durable goods can exhibit huge initial effects, that subsequently taper off
  – Purchase timing: Great Price NOW.
  – Adjustment of stock through new sales/investment

• SR Elasticity >> LR Elasticity
  – Initial impact on sales can be large relative to eventual impact

![Figure 2: Stock Adjustment Effect](image)
Network Externalities

• Suppose the value of a product to a consumer depends on how many others are using it

• How would this affect demand structure?
• How would this affect business planning?

Some Puzzles about Corporate Strategy and Pricing

• Expenditure on the Windows 95 launch

• Valuations of Internet Companies in 1999

• Huge Standardization efforts with hardware – DVD’s, USB versus Firewire, etc.
Network Externalities

• The product is *more* valuable to you if it is used by others. Your demand is greater with more users.
  – Direct network externality: email
  – Indirect network externality: Playstation

• Implication
  – Current demand depends on installed base (existing users)
  – Appearance of more price sensitivity/elasticity
Independent Consumers: The Standard Setting

What ‘2’ buys does not affect ‘1’s demand curve, or vice versa (Not true with interdependence)
### Network Externality in Spreadsheets

<table>
<thead>
<tr>
<th>Feature</th>
<th>Price Premium</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lotus brand premium</td>
<td>75%</td>
</tr>
<tr>
<td>Graph capability</td>
<td>58%</td>
</tr>
<tr>
<td>Compatible with Lotus</td>
<td>105%</td>
</tr>
<tr>
<td>Link to external data-bases</td>
<td>73%</td>
</tr>
<tr>
<td>Link to others through LAN</td>
<td>23%</td>
</tr>
<tr>
<td>Update multiple worksheets at once</td>
<td>23%</td>
</tr>
</tbody>
</table>
Becoming a Product ‘Standard’

- With network externalities, companies race to have their product become the only one used, the ‘standard.’
  - Example: Windows
  - Example: Ebay.com, B2B sites

- “Prime the Pump” for Explosive Growth

Snob Effects

- The product is less valuable to you if it is used by many others.
  - Rolex watches
  - Luxury automobiles

- Implication
  - Current demand depends on perception of usage of others
  - Appearance of less price sensitivity/elasticity
Take Away Points

• Hedonic analysis gives the market valuation of product characteristics, which is key to design and pricing.

• Dynamic effects can make you seriously over- or underestimate elasticity, leading to big pricing errors.

• Network externalities are an extreme source of competitive advantage. Distinguish direct and indirect externalities.