Lecture 5
Markups and Hedonics

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Outline

• Production function with scale (dis)economies and markups
• Demand system overview
  – Characteristic space
  – Product space
• Price indices
  – The problem
  – Hedonic regression
Scale and markup (1)

• References:
  – R. E. Hall (JPE 1988) – price-MC gap from cyclical data
  – Basu and Fernald (JPE 1997) – aggregation bias
  – Crepon, Desplatiz and Mairesse (2004) – rent-sharing evidence

• Assume firm operates under imperfect competition but is a price-taker on input markets
• Two inputs: $K$ and $L$ (easily generalized)
• First order approximation to production and demand in logs:
  – Cobb-Douglas production
  – Constant elasticity of demand
Scale and markup (2)

- Production: \( Q = AK^\alpha L^\beta \)

- Demand: \( P = Q^{-1/\eta} \)

- Firm problem (profit max but could be cost min):
  \[
  \text{Max}_L \left[ PQ - wL - rK = Q^{(\eta-1)/\eta} - wL - rK \right] \quad \text{s.t.} \quad Q = AK^\alpha L^\beta
  \]

- Solution:
  \[
  s_L \equiv \frac{wL}{PQ} = \beta \frac{\eta - 1}{\eta} \quad \text{and} \quad s_K \equiv \frac{rK}{PQ} = \alpha \frac{\eta - 1}{\eta}
  \]

  \[
  \Rightarrow \frac{\text{Cost}}{\text{Revenue}} = \frac{AC}{P} = (\alpha + \beta) \frac{\eta - 1}{\eta}
  \]
Scale and markup (3)

• Markup is $\frac{P}{MC}$ and $MC=MR$:

$$\mu = \frac{P}{MR} = \frac{Q^{-1/\eta}}{\eta - 1} \frac{\eta}{Q^{-1/\eta}} = \frac{\eta}{1-\eta}$$

$$\Rightarrow \frac{P}{AC} = \frac{1}{(\alpha + \beta)} \frac{\eta}{1-\eta} = \frac{\mu}{(\alpha + \beta)} = \frac{\text{markup \ scale}}{\text{MC \ scale}} = \frac{P}{MC} \frac{1}{\text{scale}}$$

Conclusion: when revenue is greater than cost and firms are cost minimizing, either they have market power ($\eta<\infty, \mu>1$) or there are diseconomies of scale ($\alpha+\beta<1$) or both.
Identification

• Absent price variation, either assume some outside instrument (as in Hall 1988) or take capital as fixed, labor as variable.
• FOC and prod fcn in logarithms, as function of the wage and capital stock:

\[
\begin{align*}
I_{it} & = \frac{1}{\mu} q_{it} + \log(\beta / \mu) - \log w_t + \nu_{it} \\
q_{it} & = a_0 + \alpha k_{it} + \beta l_{it} + \varepsilon_{it}
\end{align*}
\]
Identification (2)

- Solving for output and labor (jointly determined):
  \[ l_{it} = \text{const}1 - \frac{\mu}{\mu - \beta} \log w_t + \frac{\alpha}{\mu - \beta} k_{it} + u^l_{it} \]
  \[ q_{it} = \text{const}2 - \frac{\mu\beta}{\mu - \beta} \log w_t + \frac{\mu\alpha}{\mu - \beta} k_{it} + u^q_{it} \]

- Unless we assume away time variation except for wages, wage terms collinear with time dummies.
- Ratio of capital coefficients gives markup \( \mu \).
- \( \alpha, \beta \) identified iff markup or scale coefficient known (e.g., CRS), unless \( \mu = 1 \) (perfect competition)
- The original production function identifies \( \alpha \) and \( \beta \), but the estimates are biased.

\[ l_{it} = \text{const}1 - \frac{\mu}{\mu - \beta} \log w_t + \frac{\alpha}{\mu - \beta} k_{it} + u^l_{it} \]
\[ q_{it} = \text{const}2 - \frac{\mu\beta}{\mu - \beta} \log w_t + \frac{\mu\alpha}{\mu - \beta} k_{it} + u^q_{it} \]
Demand systems

• The second building block in a full structural model

• Of interest in its own right
  – Used for analysis of merger or regulatory change where costs do not change (or change slowly)
  – Pricing effects on welfare in any industry, given costs and market structure
  – Welfare analysis for new goods (WTP)
    • For price indices (CPI, PPI, etc.)
    • Comparing social and private benefits
    • Analysis of potential demand for new goods or old goods in new markets
Demand systems

• Single product (e.g., what we just did)
• Multi-product (next 3-4 weeks)
  – Product space
    • With many products, over-parametrized (number squared)
  – Characteristic space
    • Product a bundle of characteristics (dimension reduction)

• For either one:
  – Representative agent
  – Heterogeneous agents
Characteristic space - intro

- Product a bundle of characteristics (sometimes only one)
- IO theory – choice of product location
  - Hotelling on a line
  - Salop on a circle
  - Vertical model (single quality dimension, as in Bresnahan)
  - Anderson, De Palma, and Thisse (logit model in IO)
- Empirics
  - Bresnahan on autos
  - BLP – autos again, worry about simultaneity
- Problems
  - Obtaining data on char; too many characteristics
  - Unobserved characteristics
  - New goods and new characteristics in previously unoccupied space (e.g. laptop introduction in PC market)
- *Digression on price indices*……
Price indices

Cost of living index = cost to person $i$ with characteristics $z_i$ of obtaining base year utility ($U_0$) at time $t_1$:

$$c_{i1} = \min_{q_{i,1}} \sum_{j=1}^{J} p_{j1} q_{i,j1} \quad \text{s.t.} \quad U(q_{i,j1}, z_{i1}) = U_{i,0}$$

Yields true “Laspeyres” cost-of-living index:

$$CPI_1^L = \frac{c(\text{choiceset}_{1}, \text{prices}_{1}, z_{i1}, U_{i0})}{c_{i0}}$$

In practice, cost of living index is computed as

$$CPI_1^A = \frac{\sum_{j=1}^{J} w_j p_{j1}}{\sum_{j=1}^{J} w_j p_{j0}}$$

where weights come from CES and random samples of prices; if one individual and all goods available, ensures he/she can purchase base period goods in period 1.
Bias estimates

• (Boskin commission):
  – substitution bias ~ 0.4% per year
  – new good bias ~ 0.7% per year

• What can we do about this?
  – Faster sample rotation procedures? – what about introductory prices for new goods?
  – Hedonic price indices – hold good characteristics constant and compare prices over time.
Hedonic prices

Regress price on characteristics of a set of similar goods to obtain shadow price for each characteristic holding the others constant.

\[ h(x_j) = E[p_j | x_j] = \sum_{k=1}^{K} x_{jk} \beta_k \quad j = 1, \ldots, J \]

No reason for shadow prices \( \beta \) to be stable:

\[ p_j = mc(x_j) + \frac{D_j(.)}{|\partial D_j(.)/\partial p|} \]

Equilibrium price determined by marginal cost of good plus a markup that varies inversely with demand elasticity.
Applications of hedonics

• Theory
  – Lancaster (1971) – consumer demand
  – Rosen (JPE 1974) – product differentiation

• Early empirical work:
  – Waugh (1928) – vegetables
  – Court (1939) – autos, revived by Griliches (1959, 1961)
  – Chow (1967) - computers
  – McFadden (1973) – logit econometrics, demand for BART
  – McFadden (1980) – houses (dimension reduction)
  – Griliches(1981), B. Hall – firm value

### Hedonic regression for PCs

Dependent variable: Price (in 100s $?)

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<thead>
<tr>
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<tbody>
<tr>
<td>Constant</td>
<td>12.8 (2.0)</td>
<td>-39.6 (8.9)</td>
<td>--</td>
</tr>
<tr>
<td>Speed (MHz)</td>
<td>-3.2 (0.9)</td>
<td>16.8 (2.5)</td>
<td>1.3 (0.3)</td>
</tr>
<tr>
<td>Speed squared</td>
<td>0.37 (0.10)</td>
<td>-1.6 (0.2)</td>
<td>-0.15 (0.03)</td>
</tr>
<tr>
<td>RAM (MB)</td>
<td>0.32 (0.09)</td>
<td>0.52 (0.12)</td>
<td>0.34 (0.06)</td>
</tr>
<tr>
<td>Max RAM</td>
<td>0.19 (0.05)</td>
<td>0.09 (0.05)</td>
<td>0.13 (0.03)</td>
</tr>
<tr>
<td>Hard disk (GB)</td>
<td>0.07 (0.07)</td>
<td>0.02 (0.09)</td>
<td>0.03 (0.04)</td>
</tr>
<tr>
<td>Observations</td>
<td>237</td>
<td>252</td>
<td>~1000</td>
</tr>
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Hedonic price indices

- Controls for selection (product exit)
  - matched models do not
  - In PC example, makes a huge difference
- Does not require a demand model
- Laspeyres-type: \( h^1(x_0) - h^0(x_0) = x_0 \beta_1 - x_0 \beta_0 \)
  - = income required in period 1 to buy same good as in period 0
  - Provides an upper bound to CPI in characteristic space, provided \( x_0 \) available in period 1
- What do we do when the set of characteristics described by the vector \( x_0 \) disappears?
  - No problem for hedonic (fitted value exists everywhere)
  - may be concern if characteristics lie outside choice set in period 1
PC Price Indices

Hedonic
Matched Model
Dummies
BLS hybrid

Year
Index
0 0.2 0.4 0.6 0.8 1 1.2