EC2212 Industrial Growth and Competition

Lecture 9

Firm size and age affect growth, and thus the firm size distribution.
Measures of Firm Size

• Different measures for different purposes
  – Financial or stock market value
  – Employees
  – Productive capacity
  – Value of production
  – Value added of production (output – inputs)

• Highly correlated

• Employees, production main focus today
No Equilibrium Firm Size

• Size changes gradually
  – No instant expansion to a desired size
  – Finance, hiring, training, purchase & set-up of equipment and operating methods take time

• Firm size apparently unlimited
  – U-shaped long run cost curves of firms are mythical
  – May be U-shaped short run curves, long run curves for a particular plant
  – Multi-product firms can keep expanding, reorganizing
  – Witness IBM, General Motors, Microsoft, etc.
Limits to Firm Growth

• Penrose (1959), *The Theory of the Growth of the Firm*

• No equilibrium amount of output

• Optimal growth rate instead

• Growth is limited
  – Managerial limits to expansion activities
  – Training of new employees by old
  – E.g., convex costs of growth, $g'>0$, $g''>0$
Simple Representations of Growth

• Gibrat’s “law”
  – All firms have same probability distribution for % growth (at a given time)
  – E.g., firms with 10 vs. 10,000 employees have same chance to grow 50% or more in a year

• Modifications:
  – Serial correlation
  – Merger
  – Effects of firm size, age, skill, technology, ...
Observed Growth of Firms & Plants

• Examine patterns for US plants
• Patterns are similar for firms
• Relation between % growth and age, size
• (Ignoring many other correlates of growth.)
• Dunne, Roberts, and Samuelson (1989)
### Average Five-Year Growth Rates among Surviving Plants

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>Plant Size (# of employees)</th>
<th>5-19</th>
<th>20-49</th>
<th>50-99</th>
<th>100-249</th>
<th>250+</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-5</td>
<td></td>
<td>61%</td>
<td>30%</td>
<td>19%</td>
<td>13%</td>
<td>7%</td>
</tr>
<tr>
<td>6-10</td>
<td></td>
<td>34%</td>
<td>14%</td>
<td>7%</td>
<td>1%</td>
<td>-1%</td>
</tr>
<tr>
<td>11-15</td>
<td></td>
<td>31%</td>
<td>6%</td>
<td>-1%</td>
<td>-2%</td>
<td>-2%</td>
</tr>
</tbody>
</table>
## Average Five-Year Exit Rates

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>5-19</th>
<th>20-49</th>
<th>50-99</th>
<th>100-249</th>
<th>250+</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-5</td>
<td>41%</td>
<td>40%</td>
<td>39%</td>
<td>33%</td>
<td>23%</td>
</tr>
<tr>
<td>6-10</td>
<td>35%</td>
<td>27%</td>
<td>28%</td>
<td>25%</td>
<td>16%</td>
</tr>
<tr>
<td>11-15</td>
<td>30%</td>
<td>21%</td>
<td>23%</td>
<td>21%</td>
<td>13%</td>
</tr>
</tbody>
</table>
## Average Five-Year Growth Rates, with Exit = -100% Growth

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>5-19</th>
<th>20-49</th>
<th>50-99</th>
<th>100-249</th>
<th>250+</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-5</td>
<td>-6%</td>
<td>-22%</td>
<td>-28%</td>
<td>-24%</td>
<td>-18%</td>
</tr>
<tr>
<td>6-10</td>
<td>-13%</td>
<td>-17%</td>
<td>-23%</td>
<td>-24%</td>
<td>-17%</td>
</tr>
<tr>
<td>11-15</td>
<td>-9%</td>
<td>-16%</td>
<td>-24%</td>
<td>-22%</td>
<td>-15%</td>
</tr>
</tbody>
</table>
Observed Growth of Firms in an Industry

- Measure size within the product industry
- Growth limited by market size
- Size at time of entry
  - Entrants at different times have similar sizes?
  - Or does initial size grow/fall over time? Why?
- Which firms grows how much, which exit?
- Hence how does size distribution evolve?
## Size 1 Year After Entry, US Tires

<table>
<thead>
<tr>
<th>Entry Year</th>
<th>No. firms by Initial capitalization (US $)</th>
<th>Total Firms</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>J</td>
<td>K</td>
</tr>
<tr>
<td>1905-09</td>
<td>17</td>
<td>2</td>
</tr>
<tr>
<td>1910-14</td>
<td>29</td>
<td>20</td>
</tr>
<tr>
<td>1915-19</td>
<td>23</td>
<td>1</td>
</tr>
<tr>
<td>1920-24</td>
<td>69</td>
<td>7</td>
</tr>
<tr>
<td>1925-29</td>
<td>19</td>
<td>0</td>
</tr>
<tr>
<td>1930-80</td>
<td>21</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>178</td>
<td>30</td>
</tr>
</tbody>
</table>

J=$2,500-9,999  K=$10,000-49,999  L=50,000-199,999  M=200,000-999,999  N=$1M+

Not adjusted for inflation. Some firms are multi-product firms. Median shaded.

Copyright ©2001 Kenneth L. Simons.
# Size Distribution, US Tires

<table>
<thead>
<tr>
<th>Year</th>
<th>No. firms by Capitalization (US $)</th>
<th>Total Firms</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>J=$2,500-9,999  K=$10,000-49,999  L=50,000-199,999  M=200,000-999,999  N=$1M+</td>
<td></td>
</tr>
<tr>
<td>1910</td>
<td>? 1 10 14 6 4</td>
<td>49</td>
</tr>
<tr>
<td>1920</td>
<td>59 9 23 53 51 35</td>
<td>230</td>
</tr>
<tr>
<td>1930</td>
<td>16 1 6 19 27 28</td>
<td>97</td>
</tr>
<tr>
<td>1940</td>
<td>6 0 3 10 10 23</td>
<td>52</td>
</tr>
<tr>
<td>1950</td>
<td>7 0 2 3 8 21</td>
<td>41</td>
</tr>
<tr>
<td>1960</td>
<td>3 0 2 4 2 28</td>
<td>39</td>
</tr>
<tr>
<td>1970</td>
<td>3 0 1 1 1 18</td>
<td>24</td>
</tr>
<tr>
<td>1980</td>
<td>7 0 0 1 3 18</td>
<td>29</td>
</tr>
</tbody>
</table>

Not adjusted for inflation. Some firms are multi-product firms. Median shaded.

Copyright ©2001 Kenneth L. Simons.
Firm Size Distributions

• How many firms are of each size
• Used to calculate measures of concentration
  – N-firm concentration ratio: $\Sigma s_i$, N largest firms
  – Herfindahl index: $\Sigma s_i^2$, all firms
• Affected by
  – Entry and exit (and sizes of entrants & exitors)
  – Growth
Skew Size Distributions Result

• Gibrat’s law + entry yields skew size distribution
  – Ijiri and Simon (1977), *Skew Distributions and the Sizes of Business Firms* (with Bonini)
  – Who produces each new unit of output?
    • Probability $\alpha$ of production by a new firm
    • Otherwise, probability proportionate to firm size

• Skew distribution (many small firms, few large) results as # of draws $\to \infty$
Skew Distributions: A General Phenomenon

- Ijiri & Simon point out generality:
  - Sizes of business firms (Fortune 500)
  - Populations of cities
  - How often words appear in a book

- Same principle works in each case
  - New entities appear with some probability
  - Likelihood of next appearance proportionate to number of past appearances
You Have Learned

• Penrose’s theory of limited firm growth
• Gibrat’s “law”: growth independent of size
• Growth faster for younger, smaller plants
• Within industry: entry, exit, growth
  – Entry size grew somewhat in tires
  – Surviving firms’ median size grew in tires
• Evolution of skew size distributions