Sustaining technology lets skilled early entrants destroy competitors.
Shakeouts

- New products: often rise then fall in number of producers
- Fall in number of producers often called a “shakeout”
- Most products have shakeouts, within 3+ decades of when the market forms
- Can be very dramatic: US automobiles went from 273 producers to 5
- Concentrated market shares tend to result
US Automobile Producers, 1896-1966
Why Do Shakeouts Happen?

• Focus on the main cause
• … in products with severe shakeouts
• You will see
  – Evidence on entry and exit
  – Theory that best fits the facts
    • approximately, Klepper (1996, 2001)
  – Evidence on early-movers, technology
• Then discuss ramifications
Firms, Entry, Exit in Four Products (US)
Price and Output in the Four Products

- **Automobiles**
- **Tires**
- **Televisions**
- **Penicillin**
Explanation of Shakeouts
Part 1 of 3

Entrants and Their Skills
More Skilled Firms Can Earn More Profit

Potential Entrants in Year X

% of potential entrants

Shaded region: firms have enough skill to earn profit > 0 after entry

low competence at R&D high
Entry & Growth Drive Down Price

• Limited number of firms have skills needed to enter, at any point in time
• Each year some number of firms can enter
• Firms enter fairly small, but then grow
• Entry and growth increase total output
• More output, lower price (demand curve)
Skill Needed to Enter Rises over Time

Potential Entrants in Year X

% of potential entrants vs. competence at R&D

Shaded region: firms have enough skill to earn profit > 0 after entry

With lower price, need more skill to earn a profit
Entry Eventually Stops

Entrants need increasing skill to earn profit > 0, since price falls

May be more potential entrants, but eventually no entrants

EXAMPLE:
60 potential firms 300 potential firms 800 potential firms
40 enter 70 enter 0 enter
Explanation of Shakeouts
Part 2 of 3

R&D, Size, and Profit
R&D with Imitation

• R&D improves quality, lowers cost
• Decreasing returns to R&D
• Cost-per-unit-of quality $c = c(R)$, $c' < 0, c'' > 0$
• Firms benefit from R&D during 1 time period
• Firms imitate all past innovations in the next period
Firm i’s Profit at Time t

\[ \Pi_{it} = \left( p_t - \left[ c_t - s_i c(R_{it}) \right] \right) Q_{it} - R_{it} - g(Q_{it} - Q_{it-1}) \]

- \( p_t \) price per unit of quality, \( p_t = f(\sum Q_{it}) \)
- \( [c_t - s_i c(R_{it})] \) cost per unit produced
  - \( c_t \) highest possible cost given imitation of past R&D
  - \( s_i \) firm i’s skill at R&D
  - \( c(R_{it}) \) cost decreases with current R&D, \( c'<0, c''>0 \)
- \( Q_{it} \) output produced
- \( R_{it} \) spending on R&D
- \( g(Q_{it} - Q_{it-1}) \) cost of growth, \( g'>0, g''>0 \)
Implications of the Profit Function

• Firms choose $R_{it}$, $Q_{it}$ to maximize profit
• Larger firms spend more on R&D
  – Spread cost of R&D over more output
  – Remember lecture 3
• Growth is limited
  – Firms grow each period
  – Increasing marginal cost limits growth
• Size ($Q_{it}$) and skill ($s_i$) enhance profit
Explanation of Shakeouts
Part 3 of 3

Exit (given Size and Skill)
Who Exits When?

• Firms exit if $\Pi_{it} < 0$

• Growth causes exit at every $t$
  – Growth $\rightarrow \Sigma Q_{it} \rightarrow p_t \rightarrow$ profit

• Exiting firms are smallest, least-skilled
  – Since size and skill enhance profit

• Earlier entrants are larger, *ceteris paribus*
  – Have had more time and incentive to grow

• Skilled early entrants are long-run survivors
How big are firms that entered in 1895-1904? How big... entered in 1905-1909? How big... entered in 1910-1916?

<table>
<thead>
<tr>
<th>Year</th>
<th>How Big</th>
</tr>
</thead>
<tbody>
<tr>
<td>circa 1904</td>
<td>small</td>
</tr>
<tr>
<td>circa 1909</td>
<td>medium (but 80% have exited)  small</td>
</tr>
<tr>
<td>circa 1916</td>
<td>large (but 90% have exited)  medium (but 80% have exited) small</td>
</tr>
</tbody>
</table>

Firms always enter at small sizes. As time goes on, surviving firms grow. At any point in time, earlier entrants are larger than later entrants.

Size and competence reduce a firm’s costs. Because of survival of the fittest, firms in each group are forced out until only competent early entrants remain.

(By mid-1920s, entry becomes impossible.)
Implications of the Theory

• Shakeout
  – Entry eventually stops
  – Exit continues forever, causing shakeout

• Earlier entrants have lower chance of exit
  – Maybe not at first (depends on skill distribution)
  – But eventually even high-skilled late entrants exit

• Earlier entrants do more R&D

• Firms successful at R&D survive better
% Survival by Entry Date of Automobile Producers

Firms Surviving

Entrants in 1895-1904

Years of Production
% Survival by Entry Date in the Four Products

Automobiles

Years of Production
Firms Surviving

Entrants in 1895-1904
1905-09
1910-66

Tires

Years of Production
Firms Surviving

Entrants in 1901-1906
1907-16
1923+

Televisions

Years of Production
Firms Surviving

Entrants in 1946-1948
1949-1951
1952+

Penicillin

Years of Production
Firms Surviving

Entrants in 1943
1945-52
1953+
% Survival by Entry Date in a Non-Shakeout Product

Pens, Ballpoint

Years of production

Entrants 1946-50

1968-79

1955-67

1951-54

Entrants 1946-50
Innovation, % Adoption, by Entry Time in the Four Products

Use same entry-time cohorts as previously, but divide tires cohort 1
Relative innovation rates by product & innovation type — compare cohorts

<table>
<thead>
<tr>
<th>Product</th>
<th>Innovation type</th>
<th>Cohort 1</th>
<th>Cohort 2</th>
<th>Cohort 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automobiles</td>
<td>Product</td>
<td>9</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Automobiles</td>
<td>Process</td>
<td>3</td>
<td>0</td>
<td>0.1</td>
</tr>
<tr>
<td>Tires</td>
<td>Product</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Tires</td>
<td>Cord 1917</td>
<td>36%</td>
<td>8%</td>
<td></td>
</tr>
<tr>
<td>Tires</td>
<td>Cord 1920</td>
<td>100%</td>
<td>73%</td>
<td>62%</td>
</tr>
<tr>
<td>Tires</td>
<td>Balloon 1923</td>
<td>63%</td>
<td>16%</td>
<td>7%</td>
</tr>
<tr>
<td>Televisions</td>
<td>Product</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Televisions</td>
<td>Process</td>
<td>63</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td>Penicillin</td>
<td>Process</td>
<td>5</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
Innovation and Exit
Automobiles

Smoothed Hazard

Non-Innovators

Innovators

1895 1913 1931 1949 1967
Innovation and Exit in the Four Products

**Automobiles**

- **Non-Innovators**
- **Innovators**

**Tires**

- **Non-Innovators**
- **Cord Tires**
- **Cord & Balloon Tires**

**Televisions**

- **Non-Innovators**
- **Innovators**

**Penicillin**

- **Non-Innovators**
- **Semisynthetic Producers**
Ramifications of Shakeouts

- In industries with strong sustaining R&D
- High-skilled early entrants dominate
- Other firms may profit for a while
  - But eventually forced to exit
- Enter early, keep up with R&D, to survive
- Concentration is a natural result
  - Anti-trust authorities often investigate
  - But expect concentration with legal behavior