Economics 124/PP 190-5/290-5
Innovation and Technical Change

Standards and networks (2)
Prof. Bronwyn H. Hall

Outline

- Review
- Competition among systems with different standards
- Some examples of the power of network externalities
  - PC operating systems
  - QWERTY keyboard layout

Summary

- Technological standards are specifications (of measures or a measurement system, of functions and the way they must be performed, or of the input/output parameters. These make it possible for different components of a system work together successfully.
- Network goods are systems whose value to one user depends on use by others.
  - Networks usually involve some use of standards.
  - Demand for a network good is a function of the price and the size of the network
Summary

Network externalities are the benefit or cost conferred on others when an individual chooses to purchase a network good.

- Positive externality arises from the fact that other people's utility is increased when someone joins a network.
- Negative externality exists if there is another competing network good. When an individual adopts the first one, the decision is negative for the users of the second.

Indirect network size and software

Standards competitions

Outcome of competition between two competing standards (systems) depends on whether firms prefer:

1. Incompatibility – likely when firms are symmetric, and when standards battle does not delay adoption too much.
2. Compatibility – likely when demand depends greatly on having a single standard (communications) and when battle will dissipate profits.
Game theoretic analysis

- Simple two player game
- Each player has two action or strategy choices (standard 1 or standard 2)
- There are different payoffs for each combination of choices
- Dominant strategy – a choice that is best regardless of what the other player does
- Nash equilibrium – choice of strategies where neither player finds it beneficial to deviate on his own (given the other player’s choice)

1. Standardization game

**Payoff Matrix (Incompatibility)**

<table>
<thead>
<tr>
<th></th>
<th>Firm 2</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Standard 1</td>
<td>Standard 2</td>
</tr>
<tr>
<td>Firm 1</td>
<td>100</td>
<td>150</td>
</tr>
<tr>
<td></td>
<td>100</td>
<td>150</td>
</tr>
</tbody>
</table>

There is no dominant strategy. Nash equilibria are incompatible standards: (1,2) and (2,1)

Example: consumer heterogeneity means differentiated products earn higher profits. Scotchmer shows that under some conditions this is not a stable equilibrium (each firm has an incentive to lower price or increase applications to drive the other out).

2. Standardization game

**Payoff Matrix (Compatibility)**

<table>
<thead>
<tr>
<th></th>
<th>Firm 2</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Standard 1</td>
<td>Standard 2</td>
</tr>
<tr>
<td>Firm 1</td>
<td>200</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>Standard 2</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>200</td>
</tr>
</tbody>
</table>

This is a coordination game. Best response depends on what other player does – there is no dominant strategy. There are two possible Nash equilibria, (1,1) and (2,2)

Example: communications network (fax, etc.)
Welfare with network competition

- Adoption rates for Pareto-improving standards (technologies) can be too slow (excess inertia) or too fast (excess momentum)
  - too slow because
    - Old technology has a large installed base and early adopters bear too large a share of the switching costs
    - New technology is unattractive with few users
    - New technology’s advantage positive, but relatively small
  - too fast because
    - First adopters like the new technology and ignore their negative effects on the users of old technology
    - Network advantage is not that large
    - Old technology has a small installed base

Examples of market tipping

- Color TV vs black & white TV
- Video recording: VHS versus Beta
- PC platforms: Apple vs IBM/MS-DOS (open standards)
- Browsers: Internet Explorer vs Netscape (vs Mozilla?)
- We look at these two more closely:
  - PC platforms: MS Windows OS vs IBM OS(2)
  - Keyboards: QWERTY vs Dvorak

IBM’s OS/2 vs MS Windows

Example of the power of network effects

- 1991 – OS/2 released
  - OS/2 sales 400K; Windows sales 18M
  - OS/2 technically superior – 32-bit OS, not available from MS until Windows 95
- OS/2 failed; withdrawn from market
  - Problem: lack of complementary software applications
QWERTY Example

- David asks why most keyboards have the QWERTYUIOP layout today, even though those trained on the Dvorak keyboard type more quickly.
  - Although note that there is some debate about this assertion.

- History:
  - Oct 1867 – Sholes primitive “typewriter” patented (typebar clash problem)
  - 1873 – manufactured by Remington
  - 1880s – only 5000 typewriters in US, proliferation of competing designs
  - 1890s – QWERTY four-row keyboard becomes dominant

Sholes-Glidden typewriter

Remington No. 2 (1878)
Why QWERTY?
- Touch typing invented late 1880s, made typewriters a network good because of
  - Technical interrelatedness between keyboard layout and typist' memory/skills
  - Economies of scale in user costs of typewriting due to training – each additional typist tends to join larger network
  - Quasi-irreversibility of investment in learning how to type (sunk costs)
- By 1890s, significant lock-in to QWERTY layout
  - Easier to reconfigure keyboard than typist

Welfare with networks
- Lock-in to a non-optimal standard is possible
  - The QWERTY keyboard
  - analog HDTV in Japan, now abandoned due to superiority of digital
  - perhaps the U. S. television standard (versus European)
- Small historical accidents can tip adopters to choose a standard that later users perceive as non-optimal.

Liebowitz and Margolis
- Two kinds of network externalities
  - Pecuniary – with increasing returns, when demand larger, price may fall because cost is lower – familiar, does not require new theory
  - Technological – "true" network externality, does not come through price system
- Network effects relatively uncommon
  - Frequently, NW externality inframarginal – externality from the 100,000th user is minimal, so multiple networks can be supported if market large enough
  - Exist but are internalized via ownership (as in our discussion of the static case with monopoly)
Liebowitz-Margolis critique of QWERTY

- Historically, not at all clear that Dvorak is superior
  - 1944 study cited by David was conducted by Dvorak himself
  - GSA study in 1956 found them to be about the same
- Benefit of switch may be small per typist
- If the standard is obviously inferior, users can coordinate to switch even after it is established
  - Nevertheless, in some cases the required benefit from switching will have to be very large to overcome both the cost and the coordination cost
  - For example, consider the cost of switching from the driving on the left to driving on the right in the United Kingdom
- What do you think?

Policy toward “tipping”

- Is a single standard a bad outcome?
  - Similar to natural monopoly discussion
- When do firms prefer closed standards and when do they prefer open standards?
  - Depends to some extent on existing market power
  - Control of the interface matters (IP)
- Which policy tools can achieve open standards?
  - Limited — antitrust when acts are egregious