Managing Digital Piracy: Pricing and Protection Strategies

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4th ZEW Conference on the Economics of Information and Communications Technologies
July 3rd, 2004

Digital goods are easy to pirate

- Software piracy rates are still very high
  - Eastern Europe: 71%
  - Latin America: 55%
  - Asia/Pacific: 55%
  - Middle East/Africa: 49%
  - Western Europe: 35%
  - North America: 24%
- Music, digital video, electronic textbooks, research, artwork, ...

Piracy is impossible to eliminate

- Digital goods are easily replicated, distributed, stored
- Inferior substitutes can always be created
- It is hard to enforce legal deterrents
- Technological deterrents are eventually hacked (at least partially)

Digital piracy needs to be effectively managed through a combination of pricing and time-varying technological deterrence

Summary of key results

Price screening in the presence of digital piracy
- Optimal pricing schedule is a combination of two simpler schedules:
  (a) Zero-piracy pricing schedule (adjusted downward)
  (b) Piracy-indifferent pricing schedule
- Piracy can induce short-term increases in total surplus from legal usage

Choice of appropriate levels of technology-based protection
- In the absence of price-discrimination: technologically-maximal level
- When price discriminating: strictly lower
  - Trade-off between deterrence and ability to price-discriminate
- Responses to weakening of underlying protection technology can be
  - Increase protection level, reduce prices
  - Reduce protection level, sometimes increase prices
  - Suggests need to preemptively over/under protect

Research agenda

- Price screening in the presence of digital piracy
  - Structure of optimal nonlinear pricing schedule
  - Variation in structure of schedule at different levels of piracy
  - Effects of piracy on seller profits, consumer surplus and total surplus

- Appropriate levels of technology (DRM) protection
  - Profit-maximizing protection levels with/without price discrimination
  - Optimal pricing and technology responses to DRM hacking

Recap: Nonlinear pricing

- If consumer surplus > d[1](q), then customer type 1 buys legal good
Seller, products and customers

- Monopoly seller of information good, used in varying quantities
- Legal good: quality \( v \), pricing chosen by seller
- Pirated good: quality \( x \), free

Heterogeneous customers
- Indexed by type \( t \in [0,1] \) distributed as \( F(t) \) with \( f(t) > 0 \), non-increasing inverse hazard rate
- Value from legal good: \( vU(q,t) \)
- Value from pirated good: \( xU(q,t) = q_x - q^2 \)
- Therefore, reservation utility
\[ U^*(q,t) = \max_v vU(q,t) = xU(q,t) \]

Pricing in the absence of piracy

- "Standard" nonlinear schedule of prices and usage
- Prices are concave in quantity
- All customer types with \( q^{2T}(q,t) > 0 \) get positive surplus

Optimal pricing with digital piracy

When \( j > \frac{\beta}{\alpha} \): 
- Pricing schedule is comprised of two distinct segments
  - piracy-indifferent (lower)
  - adjusted zero-piracy (higher)
- Customers who were priced out of the market are now included
- At a higher level of piracy \( s \): 
  - piracy-indifferent segment expands to include more types
  - prices fall for higher segment

Optimal pricing with digital piracy

The presence of digital piracy:
- decreases seller profits
- increases total surplus
- increases consumer surplus

Each of these effects is higher at higher levels of piracy
Digital rights management (DRM)

**Premise:**
- DRM allows sellers to control the level of piracy $s$, to some extent
- Implementing DRM always involves some form of degradation of the quality of the legal good

**Endogenous protection:**
- $p$: Level of DRM-based protection that the seller chooses
- $v(p)$: Quality of legal good at level of protection $p$
- $s(p)$: Quality of pirated good at level of protection $p$

Digital rights management

Assumptions about $v(p)$ and $s(p)$
- $v(p) > s(p)$: The seller can make a profit
- $v(p) < s(p)$: DRM ‘manages’ rights by restricting them
- $v_s(0) < v_t(0)$: The DRM technology is effective, at least initially
- $v_s(\theta) < s_t(\theta)$: The DRM technology has diminishing returns

Sequence of events
- Quality functions $v(p)$ and $s(p)$ becomes known to customers and seller
- The seller announces pricing scheme $q(\bar{q})$, $x(\bar{x})$, and DRM-based protection level $p$
- Customer types in set $\bar{x}$ purchase the legal good, others use the pirated good
- Customers and seller receive their surplus and profits

$\Theta = \{ q : r(p) = q(\bar{q}) \cdot v(\bar{q}) > 0 \}$

DRM: Technologically-maximal protection

- Level of DRM protection which maximizes $v(p) - s(p)$
- Maximizes the ‘effectiveness’ of the DRM technology
- Optimal level of protection when seller cannot price-discriminate

DRM: Profit-maximizing protection

- Level of DRM protection $p^*$ at which profits are maximized
- Always strictly lower than the technologically-maximal level $p^*$

$\eta(\bar{p}) = \eta_0 - \frac{2x(\bar{p})}{\pi} - \frac{2x^2(\bar{p})^2/\pi}{2}$

Responding to weakening DRM technology

- As a DRM technology gets hacked, $v(p)$ increases over time
- This is modeled as a continuous variation: $s_t(p)$, with $s_t(p) > 0$
- Sign of $s_t(p)$ influences direction of technological and pricing responses
Responding to weakening DRM technology

When $s_{12}(t) < 0$
- $p^*$ increases over time
- Total prices reduce across all customer types
- There may be reason to preemptively overprotect

When $s_{12}(t) > 0$
- $p^*$ reduces over time
- Total prices may either increase or reduce
- There may be reason to preemptively underprotect

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Moving ahead...

- Legal responses to piracy lag technology in a disturbingly significant way
- Technology determines the effective behavior of users as well as creators
- Modeling technology as the determinant of behavior is realistic but has potentially negative policy implications

Open issues
- Long-term effects on innovation and quality of legal goods
- The effect of piracy-induced usage externalities
- The impact of network effects

Moving ahead…