Managing Digital Piracy: Pricing, Protection and Usage Externalities

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Motivation: Digital goods are easy to pirate

- Software piracy rates are still high, worldwide
  - Eastern Europe: 71%
  - Latin America: 55%
  - Asia/Pacific: 55%
  - Middle East/Africa: 49%
  - Western Europe: 35%
  - North America: 24%

- Online music, digital video, electronic textbooks, research, artwork...

Motivation: Piracy is impossible to eliminate

- Digital goods are easily replicated, distributed, stored
- Creating inferior substitutes is generally not difficult
- It is hard to enforce legal deterrents (pure P2P...)
- Technological deterrents are eventually compromised, at least partially

Sellers of digital goods need to accept piracy as a business reality, and learn how to manage it

Research agenda

- Design of pricing schedules in the presence of digital piracy
- Structure of optimal nonlinear (usage-based) pricing schedule
- Variation in pricing structure for different levels of piracy
- Effects of piracy on seller profits, consumer and total surplus
- Choice of appropriate levels of technology-based (DRM) protection
  - Profit-maximizing protection levels with/without price discrimination
  - Optimal pricing and technology responses to hacking
- Effect of piracy-induced usage externalities
  - Pricing and protection changes when quality of pirated good is affected by the volume of legal usage

Summary of results

Design of pricing schedules 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 induces 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 possible need to preemptively over/under protect

Some related work, mostly recent

- Pirated goods as inferior, quality-differentiated substitutes for legal goods
- Optimal deterrence by a seller
Recap: Nonlinear pricing

If consumer surplus \( \geq d(q, s) \), then consumer type \( s \) buys legal good.

Pricing schedule, timeline

Structure of pricing schedule

- Menu of quantity-price pairs \( q(t), t \in [0, \bar{t}] \)
- Incentive-compatible: \( \theta = \arg \max_v v - t(q(t)) \)
  - \( \theta(s) \): Usage of customer type \( s \)
  - \( \tau(s) \): Total paid by customer type \( s \) for usage

Timeline

- Quality \( v \) and \( s \) becomes known to customers and seller
- The seller announces a pricing scheme \( q(\theta), t(\tau) \)
- Customer types in set \( \theta \) purchase the legal good, others use the pirated good

Customer types in set \( \tau \) use the pirated good

Customers and seller receive their surplus/profits

Pricing schedule which is:

- Incentive-compatible
- Always profitable for the seller, for any segment of customers, if \( v > s \)
- Allocates higher usage levels (and sometimes higher prices) at higher levels of piracy

Seller, products and customers

Monopoly seller of information good, used in varying quantities

Legal good: quality \( v \), pricing schedule set by seller

- Pirated good: quality \( s \), free

Heterogeneous customers

- Indexed by type \( \theta \) distributed as \( F(\theta) \) with \( \theta(\theta) > 0 \), \( F(\theta) - F(\theta') \) non-increasing
- Value from legal good: \( v(q, \theta) \)
- Value from pirated good: \( s - q(q, \theta) \)
- Reservation utility \( \hat{u}(\theta(s), s) = \max_v sU(q, \theta) = sU(q, \theta) \)

Piracy-indifferent pricing schedule

Building block for optimal contract

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Optimal pricing with digital piracy

When \( \lambda(\theta) = \frac{(t - \bar{t})v}{\bar{t}} \)

- 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
Digital rights management (DRM)

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

**Endogenous protection:**
- $v^*$: Level of DRM-based protection that the seller chooses.
- $v^*$: Quality of legal good at level of protection $v^*$.
- $l^*$: Quality of pirated good at level of protection $v^*$.

**Sequence of events:**
1. The seller announces pricing scheme $q^*(v^*, s^*)$ and DRM-based protection level $v^*$.
2. Customers and seller receive their surplus and profits.
3. The presence of digital piracy decreases seller profits.
4. Each of these effects is higher at higher levels of piracy.

DRM: Technologically-maximal protection

- Level of DRM protection $v^*$ at which $[v^* - l^*(v^*)]$ is maximized.
- Maximizes the 'effectiveness' of the DRM technology.
- Optimal level of protection when seller cannot price-discriminate.

DRM: Profit-maximizing protection

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

- The threat of piracy can increase total surplus
- These increases may be induced by pricing responses that increase legal usage
- Excessive reliance on technology to deter piracy can lead to socially sub-optimal outcomes

Open issues

- Long-term effects on innovation and quality of legal goods
- The effect of piracy-induced usage externalities
- The impact of network effects
- The effect of indirect appropriability from explicit copying