Flexibility as an Instrument in Digital Rights Management

joint with

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Introduction

- digital goods (audio, video, software, etc.) promise transferability and portability across various media and devices

- flexibility is often an essential aspect of consumer valuation

- flexibility carries risk of circulation of unlicensed copies
  - undermine revenue generating sales
Digital Rights Management

- DRM controls how consumers can use the good
  - how long customer can use the good
  - how often she can use it
  - how many devices she can use it simultaneously
  - how to copy and alter it

- DRM: response by content providers to increase users’ valuation without risking additional sales
Greynet, Security and Platform

- Internet is “greynet” without perfect security provisions

- challenge: how to design and sell without complete security provisions

- likelihood to receive unlicensed copy is increasing
  - in number of licensed copies, in permitted flexibility

- trusted platform: hardware-based, cryptographic support for proof that receiver’s machine is running approved software stack
Flexibility and iTunes

- iTunes DRM rules
  - each music file can be played on five devices authorized by the buyer of the file
  - individual files can be burned on CDs without restriction, but every playlist, i.e. specific arrangement of several files, can only be burned seven times

- high quality files bought from Apple and those extracted from a user’s own CDs using the iTunes software can be played by an iPod.
Platform and iPod - iTunes

- trusted platform: hardware-based, cryptographic support for proof that receiver’s machine is running approved software stack

- digital good runs on platform:
  - enhances the security of DRM system
  - restricts use of unlicensed copies
Complementary Products

- digital good and platform are complementary products

- conflict between platform and content provider:

  “Our music is not something to be given away to sell iPods.”

  Music Executive, Financial Times, 3/04
1. Model

2. Optimal Flexibility and the Greynet
   - Identical Customers
   - Heterogeneous Customers

3. Platform and Content Offered by Single Firm
   - Constrained Efficient Solution

4. Platform and Content Offered by Distinct Firms
   - Inefficient, yet Superior to Pure Content Provision
Model

- continuum of consumers

- flexibility in use of digital good: \( \lambda \in [0, \bar{\lambda}] \)

- utility of consumer \( i \) for digital good:
  \[ \theta_i u(\lambda) - p \]

- willingness to pay \( \theta_i \)

- \( u \) increasing and concave
Choices

- seller offers price for digital good $p$
- seller offers flexibility $\lambda$
- number of sold licenses $q$
- marginal cost of digital good $c = 0$
  - $\Rightarrow$ efficient solution $\lambda = \bar{\lambda}$
Greynet

• digital good can be obtained through two channels:
  
  – *licensed product purchased at price* $p$
  
  – *unlicensed copy received with probability* $\alpha q \lambda$

• probability of receiving unlicensed copy proportional to:
  
  – sold licenses $q$, flexibility $\lambda$, contact rate $\alpha$
  
  – $\alpha$ represent permeability of the content-distribution environment
Permeability and Contact Rate

- $\alpha$ influenced by technical and economic factors
  - more lenient copyright law,
  - less vigilant enforcement of existing copyright law,
  - more easily circumventable DRM,
  - higher Internet bandwidth and contact frequency
    - college students vs senior citizens
    - different access to a variety of sharing technologies
Identical Customers

- willingness to pay: $\theta_i = \theta > 0$ for all $i$

- equilibrium segmentation
  - some buy digital good
  - some get digital good
Market Equilibrium

- value of licensed copy:
  \[ \theta u(\lambda) - p \]

- (expected) value of unlicensed copy with flexibility \( \lambda_c \)
  \[ \alpha \lambda q \theta u(\lambda_c) \]

- identical consumers, indifferent across alternatives:
  \[ \theta u(\lambda) - p = \alpha \lambda q \cdot \theta u(\lambda_c) \]
Equilibrium Pricing

- increased circulation of copies through
  - higher flexibility $\lambda$, higher sales volume $q$

- critical level of contact rate $\alpha^*$

Proposition (Pricing with Identical Customers)

1. For $\alpha \leq \alpha^*$, all customers buy the product and price $p^*$ and flexibility $\lambda^*$ are decreasing in $\alpha$.

2. For $\alpha > \alpha^*$, the number $q^*$ of paying customers is decreasing in $\alpha$ and $p^*$ and $\lambda^*$ stay constant.
Differentiated Customers

- willingness to pay: $\theta_i \sim F(\cdot)$

- gross utility: $\theta_i u(\lambda)$

- market segmentation with critical customer $\theta^*$
  - high willingness to pay $\theta \geq \theta^*$: purchase licensed copies
  - low willingness to pay $\theta < \theta^*$: wait for unlicensed copies
Proposition (Pricing with Differentiated Customers)

The equilibrium price $p^*$, flexibility $\lambda^*$, and sales $q^*$ are decreasing in $\alpha$.

- market for sales becomes smaller
- increasing focus on high end customers
- yet quality of product offered decreases with increase in piracy
- socially inefficient allocation
Platform

- provision of platform to use digital good

- platform enhances security
  - digital goods can transferred but only on the platform
  - additional features

- complementary products, separate pricing
  - final utility from joint consumption
Integrated Provider

- price of software, hardware: $p_s^I$, $p_h^I$, $\lambda^I$

- market segmentation:
  - hardware and software
    \[ \theta_i u(\lambda) - p_s - p_h \]
  - only hardware
    \[ \alpha \lambda q_s \theta_i u(\lambda) - p_h \]
  - neither
Proposition (Integrated Platform)

In an integrated platform market:

1. $\lambda^I > \lambda^*$;

2. $\theta^I < \theta^*$;

3. $p_s^I < p_s^*$.

• with a platform:
  
  – flexibility is higher
  
  – market for software (and hardware) is larger than in pure digital goods market
Distinct Providers

• denote equilibrium choices by $p_s^D, p_h^D, \lambda^D, ...$

• timing:

$$p_s^D, \lambda_s^D \rightarrow p_h^D \rightarrow \text{consumer decides}$$

• aspects of double marginalization:

  – not quite...

  – content and platform provider have different market size
Proposition (Complementary Products)

In the platform/content market equilibrium:

1. $\lambda^I > \lambda^D$;

2. $\theta^I < \theta^D$;

3. $p^I_s < p^D_s, p^I_h > p^D_h$.

- with distinct providers:
  - flexibility is lower
  - market for software (and hardware) is smaller
Conclusion

- role of competing platforms in the context of DRM

- role of competing distribution channels for content

- more sophisticated pricing strategies:
  - monthly fees for limited/unlimited transactions
  - varying flexibility (nonlinear pricing)

- heterogeneous consumers with respect to contact rate $\alpha$
Strategies for Complementary Products

- Gillette makes money by selling blades not razors

- Cellular phone companies signing up cell-phone subscribers rather than selling phones

- Conflict between platform and content provider:

  “Our music is not something to be given away to sell iPods.”

  Music Executive, Financial Times, 3/04
Literature

- Parker and Van Alstyne (2005)
  - pricing of complementary products in two-sided markets
  - selling to software developers and end consumers
  - selling to entertainment industry and households
• Sundararajan (2004)
  – role of digital management to restrict digital piracy in optimal pricing model.
  – piracy acts as a constraint on the pricing policy
  – no interaction between flexibility and the implicit cost of piracy in terms of foregone sales

• Park and Scotchmer (2004)
  – cost of circumvention affects pricing of digital goods
Platforms in Security Context

- Microsoft Trusted Computing Platform (“Palladium”)
  - “hack-proof” by authorizing hardware
  - MPEG4 provides “hooks” for technical protection system

- Intel introduced serial number on Pentium III chips
  - identify computers for watermarking, encryption