Analysis of the effectiveness of preventive and deterrent piracy control strategies

Agent-based modeling approach

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Analysis of the effectiveness of preventive and deterrent piracy control strategies: Agent-based modeling approach

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2. Theoretical background
3. Suggesting Model
4. Analyses and results
5. Conclusions
Introduction

Background

Maybe.. We are living in Piracy world

<Table 1> Scale of piracy contents market

<table>
<thead>
<tr>
<th>Online</th>
<th>Rate</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>17억 9,630만 3,343개</td>
<td>85.53%</td>
<td>21억 27만 205개</td>
</tr>
<tr>
<td>Offline</td>
<td>3억 396만 6,862개</td>
<td>14.47%</td>
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</tbody>
</table>

<Figure 1> > Rate of Experience of Pirated Content in Korea

Source: Source: 2012 Annual Report on Copyright(Korea Federation of Copyright Organizations)
Introduction

This paper objective is

① **Provide an alternative methodology** for analyzing and comparing the effectiveness of piracy control strategies

② **Find effective piracy control and pricing strategies** in a market where some piracy is unavoidable

③ **Investigate the impact of different piracy control strategies** on consumers, retailers, record labels, and artists
In this paper, we consider **four generic strategies** to combat digital piracy.

- **Deterrent Control**
  - Legal strategy: regulations or laws by the government
  - Educational strategy: delivering public campaigns

- **Prevent Control**
  - Low price strategy: lowering the price to consumers
  - Value-added service strategy: providing added value or extended services to consumers
Model (Description)

- Agents in this problem include online retailers, record labels, artists, and consumers
  
  To easily understand  Record label: YG  Retailer: Melon  Artists: GD

- The record label also determines what anti-piracy strategy to use

- In the model, Decision variable is below

  \( n \): The number of anti-piracy law-suit per period  \((\text{Related legal strategy})\)

  \( m \): The number of anti-piracy educational-campaigns per period  \((\text{Related educational strategy})\)

  \( w_t \): Wholesale price per song in period t  \((\text{Related low-price strategy})\)

  \( \psi \): Level of value-added services  \((\text{Related value added service strategy})\)
Model (model of each agent)

- **The Consumer**

\[ V_i = y_i \mu_i^{k_i} \]

- **y\_i,t**: A scale parameter of the utility function of consumer i in period t
- **k\_i,t**: A shape parameter of the utility function of consumer i in period t
- **\mu\_i,t**: Number of songs consumer i is interested in obtaining in period t

- Consumer “i” is interested in obtaining \( \mu_i \) number of songs.
- If they pirate, **they are subject to piracy costs** (moral costs of pirating, search costs, download pirated copies)
- Fig.1 illustrates different consumer valuation function with respect to \( y, k \)

![Fig. 1. Consumer valuation for songs.](image-url)
Model (model of each agent)

- The record label

The record label can combine strategies to curtail piracy

1. Legal strategy

\[ \zeta_i = 1 - \frac{1}{e^{n\varphi}} \]

- Each time there is an anti-piracy law-suit, consumer "i" has a probability of \( \zeta_i \) of becoming aware of it

- \( \varphi \): Represents the effectiveness of legal
- \( n \): The number of anti-piracy law-suits per period
- \( e \): Natural logarithm

2. Educational strategy

\[ q_i = 1 - \frac{1}{e^{m\theta}} \]

- Consumer "i" has a probability of \( q_i \) of becoming aware of the educational campaign

- \( \theta \): Represents the effectiveness of educational campaigns
- \( m \): The number of anti-piracy law-suits per period
- \( e \): Natural logarithm
The record label can combine strategies to curtail piracy

③ Value-added service

\[ V_i = \psi y_i \mu_i^{k_i} \]

- Value-added service strategy encourage consumers to buy legal products and reduce incentive to pirate of consumers
  - \( \psi \): Level of value-added service
  - \( y_i \mu_i^{k_i} \): Valuation of consumer without value-added service

④ Low-price strategy

- Low-price strategy encourage consumers to buy the original products by low price
- This strategy is reflecting parameter M and w

\[ w = \text{wholesale price per song} \]
\[ M = \text{Percentage markup from wholesale price} \]
\[ p = (1 + M)w : \text{Retail price} \]
Model (model of each agent)

- Decision making of agents

1. Record label (profit function)

\[ \pi_{RL} = (w - (1 + M)wr) \bar{\mu} - I_\zeta - I_q - c_\psi \]

2. Retailer (profit function)

\[ \pi_{RT} = (M w - c_r) \bar{\mu} \]

3. Artist (profit function)

\[ \pi_A = (1 + M)wr \bar{\mu}, \]

4. Consumers (utility function)

\[(1 - \rho)(\psi y_i \mu_i^{k_i} - \mu_i p) \geq \rho(y_i \mu_i^{k_i} - z_i) \quad \text{and} \quad (1 - \rho)(\psi y_i \mu_i^{k_i} - \mu_i p) \geq 0 \]

- Purchasing the original product

\[ \rho(y_i \mu_i^{k_i} - z_i) \geq (1 - \rho)(\psi y_i \mu_i^{k_i} - \mu_i p) \quad \text{and} \quad \rho(y_i \mu_i^{k_i} - z_i) \geq 0 \]

- Purchasing the piracy product

\[(1 - \rho)(\psi y_i \mu_i^{k_i} - \mu_i p) < 0 \quad \text{and} \quad \rho(y_i \mu_i^{k_i} - z_i) < 0 \]

- NOT Purchasing the piracy product and original product

w: Wholesale price
(1+M)w*r : The cost for artist
\bar{\mu}: Total number of songs sold
I_\zeta: The cost for law suit
I_q: The cost for educational campaigns
c_\psi: The cost for value-added service
M: Percentage markup from wholesale price
C_r: Retailer’s variable cost per song
Analyses and results

• Impact of deterrent control strategies on record label’s profit

Finding 1 (See Table 3 vs Table 4)

- The optimal strategy for the record label may be suboptimal for the total supply chain.
- Larger supply chain profit can be achieved by sharing piracy control cost, and there will be a division of profit surplus under which both the record label and retailer can be better-off.

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<th># of Law-suits</th>
<th>Investment amount</th>
<th>Label profit</th>
<th>Retailer profit</th>
<th>Artist profit</th>
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Finding 2 (See Fig. 3)

- Educational piracy control strategy is more effective when the amount of the funds available for investment in piracy control is small

Fig. 3. Record label’s profit vs. the number of law-suits and educational campaigns, $r = 0.1$, $M = 0.15$, $\varphi = 0.2$, and $\theta = 0.2$. 
Analyses and results

• Impact of preventive control strategies on record label’s profit

Finding 3 (see Fig 7)

- Preventive control strategies are more effective than deterrent strategies
- Preventive strategies have larger positive effect on consumers’ desired legal behavior.

![Graphs showing impact of different piracy control strategies on consumer behavior](image-url)
Analyses and results

- Combined deterrent control strategies with value – added service

Finding 4 (see Fig 8)

- When deterrent control strategies are combined with value-added service, the combined strategy provides higher profit for the record label than deterrent controls alone.

\[\text{Fig. 8. Record label's profit vs. combined piracy control strategies, } r = 0.1, M = 0.15, \phi = 0.2, \text{ and } \theta = 0.2.\]
Analyses and results

- Combined deterrent control strategies with low price

Finding 5 (see Fig 10)

- When a low-price(0.2, 0.5) strategy is used, it is best not to combine it with a deterrent control strategy.
- Combined deterrent control strategy with value-added service is more effective when the retail price is high.

![Graph showing profit vs. number of lawsuits and educational campaigns with different wholesale prices](image-url)
Conclusions

• When consumers are resistant to piracy control efforts and budgets for combating piracy are low, the educational strategy is more effective than the legal one (Relate to objective ②)

• When deterrent strategies are implemented, many consumers decide to neither pirate nor purchase songs. These strategies are effective to deter piracy (move consumers from illegal file sharing to doing nothing) rather than promoting legal sales. (Relate to objective ②)

• When law-suits or educational campaigns are combined with value-added services strategy, it provides more profits for the supply chain (Relate to objective ③)

• When the low-price strategy is implemented, investments in legal and educational campaigns may not help in increasing the record label’s profit (Relate to objective ③)

• This paper is utilizing Agent based modeling and each agent has a mathematical model. This point is relating objective ①
Q&A

THANK YOU 😊
Appendix (Summary of Notation)

### Decision variables

- \( n \): The number of anti-piracy law-suits per period
- \( m \): The number of anti-piracy educational-campaigns per period
- \( w_t \): Wholesale price per song in period \( t \)
- \( \psi \): Level of value-added services

### Parameters

- \( t \): \( 1, 2, \ldots, T \), a period index
- \( i \): \( 1, 2, \ldots, N \), a consumer index
- \( \gamma_{i,t} \): A scale parameter of the utility function of consumer \( i \) in period \( t \)
- \( \kappa_{i,t} \): A shape parameter of the utility function of consumer \( i \) in period \( t \)
- \( \mu_{i,t} \): Number of songs consumer \( i \) is interested in obtaining in period \( t \)
- \( z_{i,t} \): Risk cost consumer \( i \) attaches to piracy in period \( t \)
- \( p_t \): Retail price per song in period \( t \)
- \( M \): Percentage markup from wholesale price
- \( r \): Royalty rate for artist
- \( \chi \): Cost of each anti-piracy law-suit
- \( \tau \): Cost of each anti-piracy educational campaign
- \( c_{sp} \): Cost of implementing value-added service
- \( c_r \): Retailer’s variable cost per song

### Calculated quantities

- \( q_{i,t} \): Probability that consumer \( i \) is exposed to educational campaign in period \( t \)
- \( \zeta_{i,t} \): Probability that consumer \( i \) is aware of law-suits in period \( t \)
- \( \rho_t \): Degree of anti-piracy social pressure in period \( t \)
- \( \mu_t \): Total number of songs sold in period \( t \)
- \( I_{\zeta,t} \): Total investment in anti-piracy law-suits in time period \( t \)
- \( I_{q,t} \): Total investment in anti-piracy educational campaigns in time period \( t \)