MANAGING PIRACY: DUAL-CHANNEL STRATEGY FOR DIGITAL CONTENTS

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Abstract. The Internet offers digital content disc producers the opportunities to design dual channels by introducing an online-direct store alongside traditional retail stores, but also leads related firms to suffer significant piracy problems. Using a game-theoretic framework, we explore dual-channel marketing optimality as a piracy-mitigating strategy for digital content sold in the physical disc format. We construct a price-setting game between a digital content producer and its independent retailer(s) in a pirated market by endogenizing the producer’s copyright protection investments. We show that dual-channel marketing, a complement or a substitute for conventional copyright protection, can strategically mitigate the piracy level by increasing the equal-size retail sales volume. We also investigate how firms’ pricing strategies and profits are influenced by the endogenous interaction of dual-channel marketing and copyright protection. We unexpectedly find that in a pirated market with insufficient copyright protection, dual-channel marketing can simultaneously raise firm pricing and sales volumes when the producer sells through a monopolistic retailer. We also identify the conditions under which dual-channel marketing benefits the producer and the monopolistic retailer because it mitigates double marginalization, in the pirated market, this win-win outcome occurs even if accompanied by aggravated double marginalization. Moreover, dual-channel marketing can mitigate all the firms’ profit losses caused by piracy only when it can complement conventional copyright protection, i.e., when the producer sells through a monopolistic retailer or duopolistic retailers. In each situation, counter-intuitively, as copyright protection becomes increasingly costly, although the retailer(s) is (are) more willing to accept dual-channel marketing, the producer has a decreased incentive to design such sales channels.

1. Introduction. Nowadays, digital content—ranging from movies, music, and TV shows to video games and computer software—has been enjoying growing popularity throughout the world. Digital content comes in two forms: physical discs and downloadable files. The former includes hardware such as CD, Vinyl, DVD, and

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Blu-ray, which are commonly found in traditional stores. The latter includes files such as MP3, MP4, AVI, and EXE, which are sold via online paysites. Although digital content sold in the downloadable format is growing, physical discs remain as the dominant distribution format. For instance, 241.4 million music albums were sold in the United States in 2015, of which CD sales were 125.6 million, accounting for 52% [16]. In the film industry, digital video discs (DVDs), including the Blu-ray format, continue to be the largest source of revenue. As Bill Clark, president of Anchor Bay Entertainment, said, “there is no indication that digital is going to surpass physical, and in any forecast, physical goods will remain the largest piece.” [12]

In fact, due to various reasons, many producers only use the physical disc format to sell their digital content. For example, if consumers consider most downloadable content to be low-quality, digital content producers may hesitate to sell their valued digital content as downloadable files and instead only provide the disc format [27]. Besides, selling digital content in both disc and downloadable formats will cause competition, and thus the producer would suspend or stagger the selling periods for different formats or sell the product only in a single format. Such practices are usual in the film industry, as movies are often sold as downloads only after the DVD versions have been available for a while, while others are never offered as downloads [13]. These producers often market their discs through wholesale arrangements with retailers [9], where the producers charge a wholesale price per disc, but the retailers set the final price.

However, piracy of digital content on discs has been a longstanding problem facing digital content producers, and at times, their retailers. In 2004, industry estimates of US lost sales in CDs, DVDs, VCDs, and software due to piracy in China range from about US$1.85 to US$2.54 billion annually [20]. The magnitude of piracy has been expanding rapidly. With the advance of digital technology, it is becoming unprecedentedly easy to digitize and copy physical discs virtually without quality degradation. Moreover, peer-to-peer sharing networks (e.g., Kazaa, Napster, YouTube, Baidu) provide consumers with more opportunities to obtain high-quality free copies. According to a recent report by Frontier Economics, the value of digital piracy in music, movies, and software was estimated to be US$213 billion in 2015 and is likely to increase to US$384 to US$856 billion in 2022. In the digital content industry, piracy causes substantial damages to firms’ profits. According to the Recording Industry Association of America (RIAA), global music piracy causes US$12.5 billion in losses every year [21].

Previous research on digital content piracy has generally focused on piracy-mitigating strategies for digital content sold in the downloadable format, such as sampling [6], versioning [27], and bundling [10]. These strategies' effectiveness lies in the negligible marginal costs of redesigning and distributing the different versions of downloadable digital content. Considering that it is costly to manufacture, transport, and distribute vertically segmented physical discs, these strategies may not be entirely applicable to alleviate piracy of digital content sold on discs. Furthermore, the growing difficulty in distinguishing the authenticity of downloadable content is only likely to consolidate the dominance of the physical disc format in the digital content industry. Hence, it is imperative to explore piracy-mitigating strategies for digital content sold in the physical disc format and examine the possibility of using such strategies to reduce profit losses caused by piracy for digital content producers and retailers.
The pros and cons of the Internet are instructive to us. Although the Internet has aggravated piracy issues, it also provides digital content producers with new sales channels. For example, statistics show that high broadband Internet penetration has led to a US$1.3 billion increase in DVD sales and a US$630 million increase in movie studios’ profits from 2000 to 2003 [22]. The increased sales and profits can be attributed to the introduction of online-direct marketing. With the rapid development of e-commerce and third-party logistics, many producers who distribute their products through traditional retail stores also consider engaging in such dual-channel marketing, and digital content producers are certainly no exception.

What is clear from the above is that two essentials exist in the digital content disc industry—piracy and dual-channel marketing. Nevertheless, previous research on dual-channel marketing fails to consider the presence of piracy. In this paper, we consider the producer’s dual-channel marketing as a potential piracy-mitigating strategy.

Specifically, we first develop a pricing model where a producer sells digital content in the physical disc format through a traditional retailer. As the copyright owner, the producer can invest in copyright protection to decrease consumer utility for using piracy. Considering the endogenous influences of copyright protection in a pirated market, firm pricing strategies and profits in dual-channel marketing should be re-evaluated. Using a game-theoretic framework, we address the following questions:

1. Does the introduction of online-direct marketing mitigate the piracy level? If yes, does it complement or substitute the producer’s copyright protection?
2. In a pirated market, how does dual-channel marketing affect the producer’s and the retailer’s pricing strategies and sales volumes?
3. Can dual-channel marketing raise firms’ profits and reduce their losses caused by piracy? If yes, when and why?

Answering these questions is of much significance. First, it has crucial implications for producers who sell digital content in the physical disc format through traditional brick-and-mortar retail stores to redesign the channel structure in a pirated market. Second, these answers can also provide digital content retailers with a new understanding of the producer’s online-direct marketing.

The answers also happen to be interesting. For question (1): We show that online-direct marketing can be strategically introduced for the piracy-mitigating purpose. That is, adding an online-direct channel can attract some piracy users to buy licensed discs sold in the retail channel, but no sales occur in this new channel. Moreover, we find that dual-channel marketing acts as a strategic complement role on insufficient copyright protection. Since stricter copyright protection allows the producer to charge a higher wholesale price, dual-channel marketing, which enlarges the retail sales volume, can raise the marginal return of copyright protection investments and inspire the producer to strengthen copyright protection.

For question (2): Previous research shows that in a market without piracy, dual-channel marketing leads to lower wholesale and retail prices than in the traditional channel, thus increasing retail sales. We unexpectedly find that in a pirated market with insufficient copyright protection, dual-channel marketing can lead both firms to set higher prices than in the traditional channel, but even so, it can simultaneously raise retail sales volume. This is because the introduction of an online-direct channel induces the producer to carry out stricter copyright protection, which mitigates the threat of piracy on firms’ pricing power and offers both firms the opportunities to simultaneously raise their prices and sales volume.
For question (3): We identify the conditions under which the strategic use of dual-channel marketing can reduce profit losses caused by piracy for the producer and (or) the retailer. We then analyze both firms’ willingness to engage in dual-channel marketing by considering endogenous copyright protection. From the retailer’s perspective, the introduced online-direct channel can segregate its competition with piracy, thereby protecting its profit from the harm of piracy. As copyright protection becomes increasingly costly, this protective effect becomes more prominent, and thus, the retailer is more willing to engage in dual-channel marketing. From the producer’s perspective, as copyright protection becomes increasingly costly, since the introduced online-direct channel cannot be competitive enough to endow it with the pricing power for affording the increased copyright protection investments, the producer is more unwilling to design dual-channel marketing.

In previous research, dual-channel marketing benefits the retailer because of the resulting decreased wholesale price, and benefits the producer because the increased retail sales volume induced by the decreased retail price offsets the wholesale price reduction. However, such logic is not always tenable in a pirated market with insufficient copyright protection. We find new economic rationales for the beneficial effects of dual-channel marketing on firms’ profits. The producer benefits from introducing a highly attractive online-direct channel because the resulting higher wholesale price can offset the increased copyright protection investments. Since the introduced online-direct channel protects the retail profit margin from the damage of piracy, dual-channel marketing can benefit the retailer despite the rise in the wholesale price.

We further investigate a model extension where the producer sells digital content discs through oligopolistic retailers who first simultaneously announce public the quantity preorder, and then engage in Bertrand price competition with the proviso that one cannot satisfy more demand than the quantity ordered in the first stage. This extension helps us to better assess the above results’ generality and understand more clearly the contexts in which these results apply.

There are many significant findings when we compare the results in the basic case and the model extension. First, as with the basic case, the introduction of an online-direct channel will strategically mitigate the piracy level, even in the case with downstream competition. However, apart from the complement effect of dual-channel marketing on conventional copyright protection identified in the basic case, we unexpectedly find that the complement effect decreases by degrees as the retailer quantity increases, and even turns to the opposite substitute effect in the case with more than three retailers. As a result, unlike the basic case where dual-channel marketing can sometimes increase both firms’ prices, it will always decrease all the firms’ prices in the case with downstream competition. We also examine whether the strategic use of dual-channel marketing can reduce firm profit losses caused by piracy for the producer and its oligopolistic retailers. Surprisingly, the online-direct channel’s introduction can raise all the retailers’ profits no matter the retailer quantity. However, the producer can only benefit from dual-channel marketing when it sells discs through duopolistic retailers. This result also reveals that the producer will consider designing dual channels to mitigate its profit losses caused by piracy only when dual-channel marketing can complement its copyright protection policy. However, the win-win region by dual-channel marketing for the producer and duopolistic retailers is smaller than that for the producer and a monopolistic retailer. Therefore, dual-channel marketing’s strategic value of mitigating piracy’s damage
to firm profits gradually disappears as the downstream competition approaches perfectly.

The contributions of this paper are fourfold. First, no research has explored piracy-mitigating strategies for digital content discs. We fill this gap by proving that the digital content producer’s dual-channel marketing is a feasible piracy-mitigating strategy. On the one hand, dual-channel marketing, a complement or a substitute for conventional copyright protection, strategically mitigates the piracy level by increasing the equal-size retail sales volume. On the other hand, the strategic use of dual-channel marketing can reduce profit losses for all firms in the sales channel when dual-channel marketing can complement the conventional copyright protection. Second, this paper differs from the dual-channel literature in that we consider the role of piracy on how dual-channel marketing affects firms’ pricing strategies, sales volumes, and profits. For one, unlike previous research showing that in a market without piracy, dual-channel marketing enlarges the retail sales volume by decreasing firm pricing, we find that in a pirated market with insufficient copyright protection, dual-channel marketing can simultaneously increase the retail sales volume and firm pricing when the producer sells through a monopolistic retailer. For another, unlike previous research showing that in a market without piracy, dual-channel marketing can benefit the producer no matter how many retailers it serves, we find that in a pirated market, the producer can benefit from dual-channel marketing only when it sells through no more than two retailers. Third, this paper contributes new economic rationales for dual-channel marketing’s beneficial effects on firm profits. Unlike previous research, which shows that dual-channel marketing benefits the producer and the monopolistic retailer because it mitigates double marginalization, we find that in a pirated market, dual-channel marketing can improve both firms’ profits even if accompanied by aggravated double marginalization. The producer benefits from introducing a highly attractive online-direct channel because the resulting higher wholesale price can offset the increased copyright protection investments. Moreover, since the introduced online-direct channel protects the retail profit margin from the damage of piracy, it can benefit the retailer despite the rise in the wholesale price. Fourth, we reveal how firms’ willingness to engage in dual-channel marketing changes considering endogenous copyright protection. Intuition suggests that as copyright protection becomes increasingly costly, the producer has a stronger incentive to use dual-channel marketing. We find that, counter-intuitively, with the increase of the marginal cost of copyright protection, the producer is more unwilling to introduce the online-direct channel, although the retailer is more willing to accept it.

The rest of the paper is organized as follows. In section 2, we discuss the relevant literature and the scientific contribution of this paper. In section 3, we first describe the basic model where the producer sells through a monopolistic retailer, and then study a benchmark case without piracy. In section 4, we study the influences of dual-channel marketing when the producer sells through a monopolistic retailer in a pirated market. In section 5, we extend the basic model to a situation where the producer sells through oligopolistic retailers to see whether the main results are still applicable. Section 6 concludes the paper with a discussion of the implications of the main results, managerial insights, and future research directions.

2. Literature review. Our research links two separate but classic literature streams, i.e., digital content piracy and dual-channel marketing.
In the digital content piracy literature, one vast theme explores possible piracy-mitigating strategies from copyrighted firms’ perspectives. Although the practice of producers selling digital content on discs is widespread, previous studies in this area have focused on mitigating piracy for digital content sold in the downloadable format rather than physical disc format.

Some papers investigate technology-based approaches for mitigating piracy of digital content sold as downloads, which typically refers to the digital rights management (DRM) systems. They examine optimal DRM protection levels in different contexts. Sundararajan [23] studies the optimal pricing and the DRM protection strategies of a monopolistic digital content producer, finding that price discrimination can substitute or complement DRM protection. Ahn and Shin [1] examine a monopolist’s optimal DRM protection level in the presence of government copyright enforcement. They find that the two piracy-mitigating approaches are substitutes for each other. Choi et al. [8] explore how public copyright protection and DRM protection similarity affects the optimal DRM protection levels of duopolistic digital content producers. Avinadav et al. [3] investigate firm pricing and DRM protection strategies in a two-echelon retail channel by considering demand uncertainty under different profit criteria and different Stackelberg leaders. Vernik et al. [26] study the optimal DRM protection strategy of a monopolistic digital music producer who not only distributes CDs through a traditional retailer but also sells downloadable versions through a digital retailer. They find that counter-intuitively, the piracy level can be decreased when the firm allows legal DRM-free downloads.

Other papers examine market-based strategy optimality for reducing downloadable digital content producers’ profit losses as a result of piracy. For example, Chellappa and Shivendu [6] re-examine the optimal free sampling strategy for selling a digital experience product by regarding piracy as an opportunity to provide consumers with the precise fit of the product. They identify the conditions under which the producer can benefit from offering free samples of an underestimated digital product in a pirated market. Wu and Chen [27] re-explore the producer’s optimal product line strategy in the presence of piracy. They find that the versioning strategy, which can substitute or complement other technological approaches that increase consumer costs of using piracy, is feasible for the producer to fight piracy and improve the profit. Gopal and Gupta [10] propose an additional market-based piracy-mitigating strategy, i.e., product bundling. They find that bundling is profitable even when it increases the piracy level of one product in the bundle.

However, the above market-based piracy-mitigating strategies may not entirely apply to digital content in a physical disc format. Downloadable products readily lend themselves to sampling, versioning, or bundling as producers can easily create quality differentiation by downgrading the high-end product designed first [25] and distribute other versions online with negligible costs. Therefore, in previous research, the costs of reproducing and marketing samples, multi-versions, and bundles are all assumed to be zero. However, it is costly to manufacture, transport, and distribute vertically segmented physical discs, and hence previous research that neglects such costs cannot provide rational suggestions for mitigating the piracy of the digital content sold on discs.

Jaisingh [14] is an exception, to some extent, for showing that a recording company that directly sells CDs to consumers can add online downloadable files for sales to fight piracy. This last paper is somewhat relevant to ours, as we too work to
mitigate piracy for digital content discs. Nevertheless, our context is wholly different. First, in this paper, the producer distributes digital content discs by assigning a wholesale arrangement with the retailer(s). Second, we study the case that digital content discs and downloadable digital content files do not coexist in the pirated market. That is, the producer only sells digital content in the physical disc format.

This paper contributes to the literature stream of digital content piracy in the following four respects. First, to the best of our knowledge, this paper is the first to propose a feasible piracy-mitigating strategy for digital content sold only in the physical disc format. We show that a monopolistic digital content producer who distributes its discs through the traditional retailer(s) can strategically alleviate the piracy level by introducing an online-direct channel. Second, we show that dual-channel marketing can complement or substitute conventional copyright protection. Third, we identify the conditions under which dual-channel marketing can reduce profit losses caused by piracy for the producer and its retailer(s). Fourth, we find that the strategic use of dual-channel marketing can reduce profit losses for all firms in the sales channel only when dual-channel marketing can complement the conventional copyright protection.

Another relevant literature stream explores the influences of dual-channel marketing. Although intuition suggests that the introduced direct channel will cause downstream competition and “channel conflict,” thus decreasing the retailer’s profit, some studies show that dual-channel marketing can benefit both the producer and the retailer. Previous research has explored the economic rationales for dual-channel’s positive effect on the retailer, but all the reasons come down to the wholesale price reduction caused by the introduction of an online-direct channel.

For example, Chiang et al. [7] show that introducing direct Internet marketing can reduce the inefficient double marginalization in the retail channel, and therefore the producer can benefit from dual channels. Since the producer commits a wholesale price reduction when adding the online-direct channel, the retailer can also benefit from this direct channel. Cattani et al. [5] explore several possible pricing strategies to mitigate the conflict in the dual-channel structure. They find that the equal-pricing strategy can induce the producer to grant the retailer a wholesale price reduction, thus connecting the producer’s and the retailer’s profit-optimization objectives. Tsay and Agrawal [24] re-examine the manufacturer-retailer relationship in dual channels by considering the positive externality that each channel’s sales efforts can exert on the other channel. They attribute the channel coordination to the producer’s incentive of reducing the wholesale price to retain the retailer’s selling effort. Arya et al. [2] show that when the producer has a sale cost disadvantage relative to the retailer, the wholesale price reduction can outweigh the direct reduction in retail demand in dual channels, which increases the retailer’s profit.

This paper contributes to the literature stream of dual-channel marketing in the following five aspects. First, we propose the piracy-mitigating role of dual-channel marketing that was neglected in previous research. We point out that dual-channel marketing, which acts as either a complement or substitute role on conventional copyright protection, can strategically mitigate the piracy level. Second, we have new findings on how dual-channel marketing influences firm pricing and sales. Previous research shows that dual-channel marketing will increase retail sales by decreasing the wholesale and retail prices. In a pirated market with insufficient copyright protection, dual-channel marketing can simultaneously raise firm pricing and sales.
Third, we re-examine firms’ willingness to engage in dual-channel marketing by incorporating endogenous copyright protection. Counter-intuitively, as the marginal cost of copyright protection increases, the producer is more unwilling to open the online-direct channel, although the retailer is more willing to accept it. Fourth, we reveal new economic rationales for dual-channel marketing’s beneficial effects on the producer and the retailer. Dual-channel marketing can benefit both firms even when it aggravates double marginalization. Finally, we show different influences of dual-channel marketing on the producer’s profit when it serves competing retailers. In the case without piracy, the producer who serves oligopolistic retailers can benefit from dual-channel marketing no matter the retailer quantity. In the pirated market, dual-channel marketing can improve the producer’s profit only when the producer sells through a monopolistic retailer or duopolistic retailers, i.e., when it can complement conventional copyright protection.

3. Model setup and benchmark. Consider a monopolistic producer who sells licensed digital content in the physical disc format through a traditional brick-and-mortar retail store (for brevity, we will call this a retailer throughout this paper). The interactions among the producer, retailer, and consumers are modeled using the Stackelberg game theory. The producer may sell discs through the retailer (i.e., by the traditional channel) or add an online store alongside the retail one (i.e., by dual channels). The digital content on discs can be copied, uploaded, and shared to the Internet without licenses. The development costs for the digital content are assumed to be sunk. The fixed and marginal costs of manufacturing and distributing digital content discs are normalized to 0.

The mass of consumers is normalized to 1. Consumers are heterogeneous in their valuations of licensed discs. We denote consumer valuations of licensed discs by $v$, which are uniformly distributed over $[0,1]$. Consumers can get pirated versions with negligible costs. Each consumer desires at most one unit of either a licensed disc or a free pirated version. In the traditional channel, consumers have three options: (i) to buy the licensed disc from the retailer, (ii) to use a free pirated version, or (iii) to forgo their uses entirely. Consumers have the fourth choice of buying the licensed disc from the the online-direct store if the producer operates dual channels.

The producer, retailer, and consumers maximize their expected payoffs in the presence of piracy. The retail channel’s licensed discs are marketed through a wholesale arrangement where the producer sets the wholesale price of licensed discs, and the retailer sets their final price. The producer can invest in copyright protection to reduce consumer valuations of the pirated version. Following previous research [4, 18, 11, 16], we assume that the reduced valuation is proportional to the licensed digital content’s valuation. Some practices can support this assumption: (1) The producer can invest the hardware-based piracy control, such as nonstandard disks, coder cards, and hardware locks [10], thus decreasing the pirated digital content’s quality and consumption value. (2) In the software industry, a producer can design a web-based anti-piracy system to reduce consumers’ willingness to use piracy by blocking the users with a pirated copy from receiving upgrades [4]. (3) The producer can invest in consumer education to increase consumer moral standards and decrease piracy valuations [27].

Based on the above assumptions, we can derive consumer utilities under different choices. The net utility of a consumer for buying a licensed disc from the retailer is $u_R = v - p_R$, where $p_R$ is the retail price. The net utility of a consumer using a
pirated version is \( u_P = (1 - e)v \), where \( e \in [0, 1] \) denotes the copyright protection level. We use a quadratic function, i.e., \( c_e^2 e^2 \), to describe the producer’s copyright protection investments, where \( c > 0 \) is the exogenous marginal cost. The utility of a consumer who buys a licensed disc from the online-direct store is \( u_M = \theta v - p_M \), where \( \theta \) is the online-direct channel’s attractiveness degree for consumers. Based on previous literature which shows that consumers prefer brick-and-mortar retail stores over the web-based direct channels (Liang and Huang 1998, Chiang et al. 2003), we assume \( \theta \in (0, 1) \). In particular, Kacen et al. [15] evaluate that consumer acceptance of web-based direct purchase for DVDs is 0.787.

The timing of events is as follows. In stage 0, the producer chooses to sell discs through the traditional channel or dual channels. In stage 1, the producer decides and ensures the copyright protection level \( e \). In stage 2, the producer who sells discs through the traditional channel sets the wholesale price \( w \), but the producer who sells discs through dual channels sets the wholesale price \( w \) and the direct price \( p_M \) simultaneously. In stage 3, the retailer sets the retail price \( p_R \). Finally, consumers make their choices. A few words are in order to support this framework. First, the timing of the producer’s decision on the copyright protection level precedes its pricing decision. This is because copyright protection policies are typically performed for the long term and cannot be quickly changed relative to pricing behavior. Second, to guarantee the retailer to not buy from the online store, the wholesale price should not be set higher than the direct price, i.e., \( p_M \geq w \).

### 3.1. No piracy benchmark.

We start from the benchmark without piracy. In the traditional channel, consumers buy licensed discs if \( u_R \geq 0 \), otherwise they completely forgo their uses. Thus, the demand for licensed discs is \( q_R = 1 - p_R \). The profits of the retailer and the producer in the traditional channel are \( \pi_R = (p_R - w)q_R \) and \( \pi_M = wq_R \), respectively. In dual channels, consumers buy licensed discs from the retailer if \( u_R \geq 0 \) and \( u_R \geq u_M \); buy licensed discs from the online-direct store if \( u_M \geq 0 \) and \( u_M > u_R \); otherwise, they completely forgo their uses. Thus, the demands for the retail channel and the online-direct channel are, respectively

\[
q_R = \begin{cases} 
1 - \frac{p_R - p_M}{1 - \theta} & \text{if } p_M \leq \theta p_R, \\
1 - p_R & \text{if } p_M > \theta p_R.
\end{cases}
\]

\[
q_M = \begin{cases} 
\frac{p_R - p_M}{1 - \theta} - \frac{p_M}{\theta} & \text{if } p_M \leq \theta p_R, \\
0 & \text{if } p_M > \theta p_R.
\end{cases}
\]

The profits of the retailer and the producer in dual channels are given by \( \pi_R = (p_R - w)q_R \) and \( \pi_M = wq_R + p_M q_M \), respectively. The equilibrium outcomes in the benchmark without piracy when the producer sells through the traditional channel and dual channels are detailed in Table 1 and proved in the appendix\(^2\). By comparing the equilibrium outcomes in the two channel structures, we can analyze the influences of dual-channel marketing on firm pricing and profits in the market without piracy. In Proposition 1, we use the superscript \( b \) to denote the benchmark case.

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1. Kacen et al. point out that, “Online stores are perceived as having competitive disadvantages with respect to shipping and handling charges, exchange/refund policy for returns, providing an interesting social or family experience, helpfulness of salespeople, post-purchase service, and uncertainty about getting the right item.”

2. The appendix is available from the authors upon request.
and use superscripts $T$ and $D$ to denote the traditional-channel and dual-channel structures, respectively.

**Proposition 1.** In the market without piracy, dual-channel marketing will decrease the wholesale price and the retail price, i.e., $w^{bD} < w^{bT}$ and $p^{bD}_R < p^{bT}_R$, increase the total (retail) demand of the licensed discs, i.e., $q^{bD}_R > q^{bT}_R$ and $q^{bD}_M = 0$, increase (decrease) the producer’s profit, i.e., $\pi^{bD}_M > (\pi^{bT}_M$ when $\theta > (\pi^{bT}_M$, and increase (decrease) the retailer’s profit, i.e., $\pi^{bD}_R > (\pi^{bT}_R$ when $\theta < (\pi^{bT}_R$.

| Traditional channel | Dual channels |
|---------------------|---------------|
| **Price**           |               |
| Wholesale price, $w^b$ | $\frac{1}{2}$ | $\frac{\theta}{2}$ |
| Online-direct price, $p^{b}_{M}$ | - | $\frac{\theta}{2}$ |
| Retail price, $p^{b}_{R}$ |               |
| **Demand**          |               |
| Online-direct demand, $q^{b}_{M}$ | - | 0 |
| Retail demand, $q^{b}_{R}$ | $\frac{1}{4}$ | $\frac{1}{2}$ |
| Total demand, $q^{b}_{M} + q^{b}_{R}$ | $\frac{1}{4}$ | $\frac{1}{2}$ |
| **Profit**          |               |
| Producer profit, $\pi^{b}_{M}$ | $\frac{1}{8}$ | $\frac{\theta}{4}$ |
| Retailer profit, $\pi^{b}_{R}$ | $\frac{1}{16}$ | $\frac{1-\theta}{4}$ |

The results in Proposition 1 are consistent with previous studies suggesting that mitigated double marginalization accompanied by the online-direct channel’s introduction leads to the win-win profit of both firms [7]. From the producer’s perspective, designing dual channels can indirectly increase the flow of profits through the retail channel by decreasing firm pricing, thus improving its overall profitability even when no direct sales occur. The retailer can also benefit from dual-channel marketing because a wholesale price reduction follows the online-direct channel’s introduction. Note that the online-direct channel’s high attractiveness retains a low level of wholesale price reduction, which helps the producer improve its overall profit but imperils the retailer to raise its profit. Therefore, only within a moderate range of the online-direct channel’s attractiveness, dual-channel marketing can benefit both the retailer and the producer, i.e., when $\theta \in \left(\frac{1}{2}, \frac{3}{4}\right)$, $\pi^{bD}_M > \pi^{bT}_M$ and $\pi^{bD}_R > \pi^{bT}_R$.

We have shown that in the market without piracy, dual-channel marketing can increase the sales volume and benefit both the producer and the retailer because it mitigates double marginalization. We then ask: In the market with piracy, can dual-channel marketing raise the licensed disc sales volume and benefit both firms? If so, when and why?
4. **Dual-channel marketing and pricing strategies to mitigate piracy.** The benchmark does not consider piracy or take copyright protection as endogenous factors. In this section, we investigate dual-channel marketing optimality as a piracy-mitigating strategy for the digital content producer that can invest in conventional copyright protection. We highlight the following three aspects:

1. The rationale of how the online-direct channel’s introduction influences the piracy level.
2. The interactions between dual-channel marketing and copyright protection in mitigating piracy.
3. The roles of endogenous copyright protection on how dual-channel marketing affects firm pricing and profits.

We first solve the equilibrium outcomes in different sales channels. When the producer sells licensed discs through the traditional retailer, consumers buy licensed discs if $u_R \geq 0$ and $u_R \geq u_P$; use pirated versions if $u_P \geq 0$ and $u_P > u_R$; otherwise, they completely forgo their uses. Thus, the demands for licensed discs and piracy are $q_R = 1 - \frac{p_R}{e}$ and $q_P = \frac{w}{e}$, respectively. The profits of the retailer and the producer in the traditional channel are $\pi_R = (p_R - w)q_R$ and $\pi_M = wq_R - \frac{c}{e^2}$, respectively. Using backward induction, we can derive the copyright protection level and firm pricing in equilibrium when the producer sells discs through the traditional channel in the pirated market.

**Theorem 1.** In the pirated market, when the producer sells discs through the traditional channel, the copyright protection level, wholesale and retail prices, retail and piracy demands, and producer and retailer profits in equilibrium are detailed in Table 2.

**Table 2.** Equilibrium outcomes in the pirated market when the producer sells discs through the traditional channel.

| $c \in (0, \frac{1}{8}]$ | $c \in (\frac{1}{8}, \infty)$ |
|-------------------------|------------------------|
| **Copyright protection level, $e^T$** | 1 | $\frac{1}{8c}$ |
| **Price** | | |
| Wholesale price, $w^T$ | $\frac{1}{2}$ | $\frac{1}{16c}$ |
| Retail price, $p_R^T$ | $\frac{3}{4}$ | $\frac{3}{32c}$ |
| **Demand** | | |
| Retail (Licensed) demand, $q_R^T(L)$ | $\frac{1}{4}$ | $\frac{1}{4}$ |
| Piracy demand, $q_P^T$ | $\frac{3}{4}$ | $\frac{3}{4}$ |
| **Profit** | | |
| Producer profit, $\pi_M^T$ | $\frac{1-4c}{8}$ | $\frac{1}{128c}$ |
| Retail profit, $\pi_R^T$ | $\frac{1}{16}$ | $\frac{1}{64c}$ |

Theorem 1 allows us to compare the equilibrium outcomes in the traditional-channel structure with and without piracy. Note that when the marginal cost of
copyright protection is relatively low, i.e., \( c \leq \frac{1}{8} \), the producer can perform complete copyright protection such that both firms set prices as if they are in a market without piracy. Otherwise, the producer’s copyright protection is insufficient to exclude the threat of piracy on firm pricing. In a market with insufficient copyright protection, both the producer and the retailer will decrease their prices to guarantee the sales volume of licensed discs. Therefore, both firms will suffer profit losses caused by piracy.

Next, we consider the situation where the producer introduces an online-direct channel alongside the retail channel to sell licensed discs. In this situation, consumers buy licensed discs from the retailer if \( u_R \geq 0 \), \( u_R \geq u_M \), and \( u_R \geq u_P \); buy licensed discs from the online store if \( u_M \geq 0 \), \( u_M > u_R \) and \( u_M \geq u_P \); use pirated versions if \( u_P \geq 0 \), \( u_P > u_R \); and \( u_P > u_M \). Thus, the demands for the retail channel, online-direct channel, and piracy are, respectively

\[
q_R = \begin{cases} 
1 - \frac{p_R - p_M}{1 - \theta} & \text{if } p_M \leq \frac{\theta - 1 + e}{e} p_R \text{ and } \theta > 1 - e, \\
1 - \frac{p_R}{e} & \text{otherwise}, 
\end{cases} 
\]

(3)

\[
q_M = \begin{cases} 
\frac{p_R - p_M}{1 - \theta} - \frac{p_M}{\theta - 1 + e} & \text{if } p_M \leq \frac{\theta - 1 + e}{e} p_R \text{ and } \theta > 1 - e, \\
0 & \text{otherwise}, 
\end{cases} 
\]

(4)

\[
q_P = \begin{cases} 
\frac{p_M}{\theta - 1 + e} & \text{if } p_M \leq \frac{\theta - 1 + e}{e} p_R \text{ and } \theta > 1 - e, \\
\frac{p_R}{e} & \text{otherwise}. 
\end{cases} 
\]

(5)

According to equations (3) and (4), the total demand of licensed discs in dual channels is

\[
q_L = \begin{cases} 
q_R + q_M = 1 - \frac{p_M}{\theta - 1 + e} & \text{if } p_M \leq \frac{\theta - 1 + e}{e} p_R \text{ and } \theta > 1 - e, \\
q_R = 1 - \frac{p_R}{e} & \text{otherwise}. 
\end{cases} 
\]

(6)

The profits of the retailer and the producer in dual channels are

\( \pi_R = (p_R - w)q_R \)

and

\( \pi_M = wq_R + p_M q_M - \frac{c^2 e^2}{\theta} \),

respectively.

By comparing equation (6) with the licensed disc demand in the traditional channel, we find that if the interaction among copyright protection and firm pricing satisfies the conditions of \( p_M \leq \frac{\theta - 1 + e}{e} p_R \) and \( \theta > 1 - e \), the introduction of online-direct marketing will increase total licensed disc demand and decrease the equal-size piracy level. Under this circumstance, the copyright protection level and firm pricing in equilibrium will change accordingly. Otherwise, the introduction of online-direct marketing will not influence the demand functions of the retail channel and piracy, and naturally, both firms will behave as if they are in the traditional channel. In this section, when we refer to “dual channel”, we assume the parameter space is limited to \( p_M \leq \frac{\theta - 1 + e}{e} p_R \) and \( \theta > 1 - e \). Using backward induction, we can derive the copyright protection level and firm pricing in equilibrium when the producer sells through dual channels in the pirated market.

**Theorem 2.** In the pirated market, when the producer sells through dual channels, the copyright protection level, wholesale, retail, and online-direct prices, retail and online-direct channel demands, piracy demand, and producer and retail profit in equilibrium are detailed in Table 3.

One may intuitively assume that the introduction of online-direct marketing would decrease the piracy level because some piracy users may decide to buy the
Table 3. Equilibrium outcomes in the pirated market when the producer sells discs through dual channels.

|                      | $c \in (0, \frac{1}{4}]$ | $c \in (\frac{1}{4}, \infty)$ |
|----------------------|---------------------------|-------------------------------|
| Copyright protection level, $e^D$ | 1                          | $\frac{1}{4c}$               |
| **Price**            |                           |                               |
| Wholesale price, $w^D$ | $\frac{\theta}{2}$       | $\frac{1-4c(1-\theta)}{8c}$ |
| Online-direct price, $p^D_M$ | $\frac{\theta}{2}$       | $\frac{1-4c(1-\theta)}{8c}$ |
| Retail price, $p^D_R$ | $\frac{1}{2}$             | $\frac{1}{8c}$               |
| **Demand**           |                           |                               |
| Online-direct demand, $q^D_M$ | 0                         | 0                             |
| Retail demand, $q^D_R$ | $\frac{1}{2}$             | $\frac{1}{2}$                |
| Licensed demand, $q^D_L$ | $\frac{1}{2}$             | $\frac{1}{2}$                |
| Piracy demand, $q^D_P$ | $\frac{1}{2}$             | $\frac{1}{2}$                |
| **Profit**           |                           |                               |
| Producer profit, $\pi^D_M$ | $\frac{\theta-2c}{4}$     | $\frac{1-8c(1-\theta)}{32c}$ |
| Retail profit, $\pi^D_R$ | $\frac{1-\theta}{4}$     | $\frac{1-\theta}{4}$         |

Proposition 2. The online-direct channel’s introduction will reduce the piracy level and increase the equal-size retail sales volume without generating any sales to the online-direct channel itself, i.e., $q^D_P < q^T_P$, $q^D_R > q^T_R$, and $q^D_M = 0$.

Proposition 2 shows that, counter-intuitively, adding an online-direct channel can attract some piracy users to buy the licensed discs sold in the retail channel, but no sales volume occurs in this new channel itself. This result indicates that online-direct marketing can be strategically introduced for the piracy-mitigating purpose.

However, it is still unclear how dual-channel marketing and copyright protection interact in mitigating piracy. In the next proposition, we investigate, on the one hand, whether dual-channel marketing can mitigate the piracy level even when no copyright protection is performed, and on the other hand, whether dual-channel marketing complements or substitutes copyright protection.

Proposition 3. (i) No matter what level the copyright protection is, the strategic introduction of the online-direct channel can always mitigate the piracy level, i.e., $\forall e \in [0, 1]$, $q^D_P < q^T_P$.

(ii) Dual-channel marketing acts as a complement to insufficient copyright protection, i.e., when $c > \frac{1}{e^D} > e^T$.

Part (i) of Proposition 3 indicates that the reduced piracy level induced by the online-direct channel’s introduction needs not come in the company of conventional licensed discs from the online-direct channel. However, as we show in the next proposition, this intuitive assumption does not occur.
copyright protection. Note that stricter copyright protection allows the producer to increase the wholesale price and the online-direct price by an equal amount, thus leading the retailer to raise the retail price by an equal amount. According to equation (3), the retail sales volume will not change with the copyright protection level. This means that the influences of dual-channel marketing on the retail sales volume in the cases with zero and complete copyright protection are the same. Therefore, even if the producer does not invest in copyright protection, introducing an online-direct channel can increase retail sales volume and mitigate the equal-size piracy level.

Part (ii) of Proposition 3 is logical based on the above observation. Note that stricter copyright protection raises the producer’s marginal profit in dual channels and the traditional channel by an equal amount. Since the online-direct channel’s introduction increases retail sales volume, the marginal return of copyright protection investments in dual channels is higher than in the traditional channel. Holding the marginal cost of copyright protection fixed, as long as the current copyright protection is insufficient, the producer will enhance copyright protection after introducing the online-direct channel. More specifically, dual-channel marketing acts as a complement to insufficient copyright protection.

Recall that in the market without piracy, dual-channel marketing leads both firms to set lower prices, increasing the retail sales volume. In the pirated market, the online-direct channel’s introduction also increases the retail sales volume. However, is the increased retail sales volume also the result of the relaxed price setting in the retail channel? Considering that dual-channel marketing induces the producer to strengthen copyright protection, which can reduce piracy’s threat on firm pricing, it may have different influences on firm pricing from the benchmark. We examine this in the next proposition.

**Proposition 4.** In the pirated market with insufficient copyright protection, (i) the strategic use of dual-channel marketing will increase (decrease) the wholesale price, i.e.,

\[ w^D > (\leq) w^T \text{ when } \theta > (\leq) \hat{\theta}, \text{ where } \hat{\theta} = \begin{cases} \frac{1}{8c} & \text{where } c \in \left(\frac{1}{8}, \frac{1}{4}\right] \\ 1 - \frac{1}{8c} & \text{where } c \in \left(\frac{1}{4}, \infty\right) \end{cases} \]

(ii) the strategic use of dual-channel marketing will increase (decrease) the retail price, i.e.,

\[ p^D_R > (\leq) p^T_R \text{ when } c > (\leq) \frac{3}{16}. \]

Proposition 4 shows the influences of dual-channel marketing on the wholesale and retail prices in the pirated market with insufficient copyright protection. Surprisingly, dual-channel marketing can raise both the wholesale and retail prices, but even so, it will increase the retail sales volume. Since dual-channel marketing can complement conventional copyright protection, the producer has the incentive to invest in stricter copyright protection, which weakens the threat of piracy on firm pricing. The decreased piracy threat affords both firms the opportunities to raise sales volume and pricing power simultaneously.

From the producer’s perspective, in the market without piracy, introducing a more attractive online-direct channel can lead to a larger \( \Delta w \) without changing \( \Delta q_R \). However, in the pirated market with insufficient copyright protection, not only introducing a more attractive online-direct channel but also the resulting stricter
copyright protection can achieve that effect\(^3\). In particular, if either \(\theta\) or \(\Delta e\) is relatively large, both \(\Delta w\) and \(\Delta q_R\) can be positive. Specifically, when \(c \in \left(\frac{1}{8}, \frac{1}{4}\right), \Delta e\) increases with \(c\), and thus either a relatively large \(c\) or \(\theta\) can lead the producer to charge a higher wholesale price and gain higher retail sales volume in dual channels than in the traditional channel (i.e., when \(\theta > \frac{1}{2c}, \Delta w > 0\) and \(\Delta q_R > 0\)), seeing examples in (b) and (c) of Figure 1. When \(c \in \left(\frac{1}{4}, \infty\right), \Delta e\) decreases with \(c\), and thus a relatively small \(c\) or large \(\theta\) can lead to the joint increase of the wholesale price and the retail sales volume (i.e., when \(\theta > 1 - \frac{1}{8c}, \Delta w > 0\) and \(\Delta q_R > 0\)), seeing an example in (d) of Figure 1.

\(^3\)Let \(\Delta w = w^D - w^T\) and \(\Delta e = e^D - e^T\). When \(c \in \left(\frac{1}{8}, \frac{1}{4}\right), \frac{\partial \Delta w}{\partial \Delta e} > 0.\)

\(^4\)Let \(\Delta p_R = p^D_R - p^T_R\) and \(\Delta e = e^D - e^T\). When \(c \in \left(\frac{1}{4}, \infty\right), \frac{\partial \Delta p_R}{\partial \Delta e} > 0.\)
\( \Delta e \) increases with \( c \), and thus a relatively large \( c \) can lead the retailer to simultaneously raise the retail price and sales volume (i.e., when \( \frac{3}{16} < c < \frac{1}{4} \), \( \Delta p_R > 0 \) and \( \Delta q_R > 0 \)), seeing an example in (c) of Figure 1. When \( c \in (\frac{1}{4}, \infty) \), \( \Delta e > \frac{1}{2} e^T \) is established, so the retailer can always set a higher retail price and gain a larger sales volume in dual channels than in the traditional channel, seeing an example in (d) of Figure 1.

In this proposition, we analyze the roles of endogenous copyright protection in how dual-channel marketing affects firms’ pricing strategies. We also want to know its role in how dual-channel marketing affects firms’ profits. In the next proposition, we investigate how the producer’s and retailer’s profits are influenced by the interaction of copyright protection and dual-channel marketing. From this, we can determine whether dual-channel marketing can reduce profit losses caused by piracy for the producer and the retailer. If yes, we can also analyze when and why such beneficial effects will occur.

**Proposition 5.** (i) The strategic use of dual-channel marketing can reduce the producer’s profit losses caused by piracy. Specifically, in the pirated market, dual-channel marketing will increase (decrease) the producer’s profit, i.e., \( \pi^D_M > (<) \pi^T_M \), when \( \theta > (<) \tilde{\theta} \).

(ii) The strategic use of dual-channel marketing can reduce the retailer’s profit losses caused by piracy. Specifically, in the pirated market, dual-channel marketing will increase (decrease) the retailer’s profit, i.e., \( \pi^D_R > (<) \pi^T_R \) when \( \theta < (>) \tilde{\theta} \).

(iii) There is always a non-empty interval of an online-direct channel’s attractiveness for consumers in which using dual-channel marketing can reduce both firms’ profit losses caused by piracy. Specifically, in the pirated market, dual-channel marketing will increase both firms’ profits when the introduced online-direct channel’s attractiveness for consumers is in a moderate range, i.e., \( \pi^D_M > \pi^T_M \) and \( \pi^D_R > \pi^T_R \) when \( \theta \in (\tilde{\theta}, \hat{\theta}) \), seeing Figure 2. Here, we define

\[
\tilde{\theta} = \begin{cases} 
\frac{1}{2} & \text{when } c \in (0, \frac{1}{8}] \\
2c + \frac{1}{32c} & \text{when } c \in (\frac{1}{8}, \frac{1}{4}] \\
1 - \frac{1}{32c} & \text{when } c \in (\frac{1}{4}, \infty)
\end{cases} \quad \text{and} \quad \hat{\theta} = \begin{cases} 
\frac{3}{4} & \text{when } c \in (0, \frac{1}{8}] \\
1 - \frac{1}{32c} & \text{when } c \in (\frac{1}{8}, \infty)
\end{cases}
\]

Proposition 5 shows that dual-channel marketing can reduce profit losses caused by piracy for both the producer and the retailer. However, compared with the benchmark without piracy, there are two main differences about when and why the producer and (or) the retailer can benefit from dual-channel marketing. First, for the producer, the beneficial region by introducing an online-direct channel in the pirated is narrower than that in the market without piracy; however, for the retailer, the situation is just opposite, seeing Figure 2. Second, recall that in the benchmark without piracy, dual-channel marketing can increase the retailer’s profit due to the resulting wholesale price reduction; it can also increase the producer’s profit because the increased retail sales led by the decreased retail price offsets its wholesale price reduction. However, as illustrated in (c) and (d) of Figure 1, in the pirated market, the decrease of wholesale and retail prices are not necessary for the beneficial effects of dual-channel marketing on both firms’ profits.

To explain these differences caused by piracy, we start with part (i) and part (ii) of Proposition 5 and analyze how copyright protection’s marginal cost influences firms’ willingness to engage in dual-channel marketing.
We first analyze when and why the producer in the pirated market can benefit from dual-channel marketing. Note that in the market with insufficient copyright protection, the producer would like to strengthen copyright protection after introducing an online-direct channel, and thus it needs sufficient pricing power to afford these costs. As the marginal cost of copyright protection increases, the online-direct channel’s introduction may not be competitive enough to endow the producer with the pricing power to afford the increased costs and improve its profit. Therefore, the producer’s incentive to introduce an online-direct channel decreases with the marginal cost of copyright protection, i.e., $\frac{\partial \bar{\theta}}{\partial c} > 0$ when $c \in (\frac{1}{8}, \infty)$. In particular, when the marginal cost of copyright protection is relatively high, i.e., $c \in (\frac{\sqrt{3}}{8}, \infty)$,\(^5\) the producer can benefit from dual channels only when the introduced online-direct channel is highly attractive such that it can charge a higher wholesale price than in the traditional channel, seeing examples in (c) and (d) of Figure 1. In short, different from the market without piracy, the reason why the producer in the pirated market benefits from dual-channel marketing can be that the resulting higher wholesale price offsets its increased copyright protection costs.

We also propose a new economic rationale for dual-channel marketing’s beneficial effect on the retailer’s profit. Unlike in the market without piracy, where the retailer benefits from the wholesale price reduction, in the pirated market with insufficient copyright protection, although introducing online-direct marketing is accompanied by wholesale price rising, it can also benefit the retailer, seeing examples in (c) and (d) of Figure 1. Its economic rationale is as follows: The introduced online-direct channel can segregate the competition between the retailer and piracy. This segregation protects the retailer’s profit margin from the harm of piracy. Although dual-channel marketing can lead to a higher wholesale price than in the traditional channel, its beneficial effect on the retailer’s profit maintains in the pirated market. Moreover, since the larger the copyright protection’s marginal cost is, the more

\(^5\)Note that when $c \in (\frac{1}{8}, \infty)$, $w^T = \frac{1}{16c}$. Substituting $\theta = 2c + \frac{1}{32c}$ in $w^D = \frac{\theta}{2}$, we get $w^D = c + \frac{1}{16c}$. Let $c + \frac{1}{16c} > \frac{1}{16c}$, we obtain $c > \frac{\sqrt{3}}{8}$. 

---

**Figure 2.** The win-win region by the online-direct channel’s introduction in the pirated market.
prominent the protective effect becomes, the retailer will be more willing to engage in dual-channel marketing, i.e., \( \frac{d\theta}{dc} > 0 \) when \( c \in (\frac{1}{\kappa}, \infty) \).

5. Model extension: Oligopolistic retailers. This section extends the basic model in section 4 to investigate the scenario that the producer sells digital content discs through \( n \) identical traditional retailers who directly compete with each other. The case of \( n = 1 \) is equal to the basic model. Here, the retailers engage in a two-stage oligopoly game where they first simultaneously announce public quantity preorder and then engage in Bertrand price competition with the proviso that one cannot satisfy more demand than the quantity preordered in the first stage. We intend to see if the main results in section 4 are still viable when retailers engage in quantity preorder and Bertrand competition. With this intention, the game is constructed with the following timing of events. In stage 0, the producer decides whether to introduce an online-direct channel alongside \( n \) traditional retailers. In stage 1, the producer ensures the copyright protection level \( e \). In stage 2, if the producer does not introduce online-direct marketing, the producer sets the wholesale price \( w \); otherwise, it sets both the wholesale price \( w \) and the online-direct price \( p_M \) with the constraint of \( p_M \geq w \). In stage 3, the retailers independently decide on a quantity \( Q_i \) and place a preorder for the product. In stage 4, the retailers engage in Bertrand-like price competition and set the retail price \( p_R \). Finally, consumers make their choices.

Kreps and Scheinkman [17] have shown that this type of quantity preorder and price competition will lead to the unique Cournot equilibrium where the retailers set the same price, and that price equates total supply and demand. Based on this Cournot equilibrium, we can solve the equilibrium outcomes in both channel structures regarding whether the producer in the pirated market introduces an online-direct channel, respectively. In the following analysis, we use the superscript \( n \) to denote the oligopolistic case, use the superscript \( D \) to denote the case when the producer introduces an online-direct channel and use the superscript \( T \) to denote the case when the producer does not introduce an online-direct channel.

**Theorem 3.** In the pirated market, (i) when the producer sells discs through \( n \) traditional retailers, the copyright protection level, wholesale and retail prices, retailer \( i \) and piracy demands, and producer and retailer \( i \) profits in equilibrium are detailed in Table 4;

(ii) when the producer sells discs through \( n \) traditional retailers and an online-direct channel, the copyright protection level, wholesale, retail, and online-direct prices, retailer \( i \) and online-direct channel demands, piracy demand, and producer and retailer \( i \) profits in equilibrium are detailed in Table 5.

Theorem 3 allows us to investigate dual-channel marketing optimality as a piracy-mitigating strategy when oligopolistic retailers engage in quantity preorder and Bertrand price competition. Recall that when the producer serves a single retailer, i.e., when \( n = 1 \), the online-direct channel’s introduction strategically mitigates the piracy level even with no copyright protection, and complements insufficient copyright protection. In the next proposition, we investigate whether these results are still viable when the producer sells discs through \( n \) traditional retailers.
Table 4. Equilibrium outcomes in the pirated market when the producer sells discs through traditional retailers.

| Copyright protection level, $e^{nT}$ | $c \in (0, \frac{n}{4(1+n)})$ | $c \in (\frac{n}{4(1+n)}, \infty)$ |
|--------------------------------------|-------------------------------|-------------------------------|
| **Price**                           |                               |                               |
| Wholesale price, $w^{nT}$            | $\frac{1}{7}$                 | $\frac{n}{8(1+n)c}$           |
| Retail price, $p^{nT}_R$             | $\frac{2+n}{2(1+n)}$         | $\frac{n^2+2n}{8(1+n)^2c}$    |
| **Demand**                           |                               |                               |
| Retail $i$’s demand, $Q^{nT}_i$      | $\frac{1}{2(1+n)}$           | $\frac{1}{2(1+n)}$           |
| Licensed demand, $Q^{nT}_L$          | $\frac{n}{2(1+n)}$           | $\frac{n}{2(1+n)}$           |
| Piracy demand, $Q^{nT}_P$            | $\frac{n+2}{2(1+n)}$         | $\frac{n+2}{2(1+n)}$         |
| **Profit**                           |                               |                               |
| Producer profit, $\pi^{nT}_M$        | $\frac{n-2(1+n)c}{4(1+n)}$   | $\frac{n^2}{32(1+n)^2c}$     |
| Retail profit, $\pi^{nT}_R$          | $\frac{1}{4(1+n)^2}$         | $\frac{1}{16(1+n)^2c}$       |

Table 5. Equilibrium outcomes in the pirated market when the producer sells discs through traditional retailers and an online-direct channel.

| Copyright protection level, $e^{nD}$ | $c \in (0, \frac{n}{(1+n)^2})$ | $c \in (\frac{n}{(1+n)^2}, \infty)$ |
|--------------------------------------|-------------------------------|-------------------------------|
| **Price**                           |                               |                               |
| Wholesale price, $w^{nD}$            | $\frac{\theta}{1+n}$         | $\frac{n-(1-\theta)(1+n)^2c}{(1+n)^2c}$ |
| Online-direct price, $p^{nD}_M$      | $\frac{\theta}{1+n}$         | $\frac{n-(1-\theta)(1+n)^2c}{(1+n)^2c}$ |
| Retail price, $p^{nD}_R$             | $\frac{1}{1+n}$              | $\frac{n}{(1+n)^2c}$          |
| **Demand**                           |                               |                               |
| Online-direct demand, $Q^{nD}_M$     | 0                             | 0                             |
| Retail $i$’s demand, $Q^{nD}_i$      | $\frac{1}{1+n}$              | $\frac{1}{1+n}$              |
| Licensed demand, $Q^{nD}_L$          | $\frac{n}{1+n}$              | $\frac{n}{1+n}$              |
| Piracy demand, $Q^{nD}_P$            | $\frac{1}{1+n}$              | $\frac{1}{1+n}$              |
| **Profit**                           |                               |                               |
| Producer profit, $\pi^{nD}_M$        | $\frac{2n\theta-(1+n)^2c}{2(1+n)^2}$ | $\frac{n^2-2(1-\theta)(1+n)^2cn}{2(1+n)^3c}$ |
| Retail profit, $\pi^{nD}_R$          | $\frac{1-\theta}{(1+n)^2}$   | $\frac{1-\theta}{(1+n)^2}$   |
Proposition 6. When the producer sells discs through \( n \) traditional retailers, (i) no matter what level the copyright protection is, the online-direct channel’s introduction will always mitigate the piracy level and increase the equal-size retail sales volume without generating any sales to the online-direct channel itself, i.e., \( \forall e \in [0,1] \), \( Q^n_D < Q^n_T \), \( Q^n_R > Q^n_R^T \), and \( Q^n_M = 0 \);

(ii) dual-channel marketing can act as either a complement to insufficient copyright protection, or a substitute for any copyright protection, i.e.,

\[
\begin{align*}
& e^{nD} > e^{nT} \text{ when } n < 3 \text{ and } c > \frac{n}{4(1+n)}; \\
& e^{nD} < e^{nT} \text{ when } n > 3 \text{ and } c > \frac{n}{(1+n)^2}.
\end{align*}
\]

Part (i) of Proposition 6 indicates that, as with the case of \( n = 1 \), when retailers engage in quantity preorder and Bertrand competition, the online-direct channel’s introduction can also strategically mitigate the piracy level even if no copyright protection is performed. However, part (ii) of Proposition 6 provides an additional effect of dual-channel marketing on copyright protection. We unexpectedly find that dual-channel marketing can sometimes substitute copyright protection. Specifically, when \( n < 3 \), dual-channel marketing complements insufficient copyright protection and \( n = 3 \) is a threshold under which dual-channel marketing does not influence the copyright protection level. However, when \( n \geq 4 \), dual-channel marketing as a substitute for copyright protection leads the producer to weaken the copyright protection level. This is because although dual-channel marketing always increases the sales volume of licensed discs, it can not necessarily improve the producer’s marginal return of copyright protection investments when the producer serves competing retailers.

Note that when the producer introduces an online-direct channel, the positive influences of copyright protection on the producer’s pricing power gradually disappears as the downstream competition approaches perfectly. When \( n > 1 \), the producer’s pricing power growth led by stricter copyright protection is smaller when it introduces an online-direct channel than when it does not. It turns out that when \( n \geq 4 \), the online-direct channel’s introduction will decrease the producer’s marginal return of copyright protection investments, and therefore, holding the marginal cost of copyright protection fixed, the producer will cut down copyright protection after introducing an online-direct channel. In this situation, dual-channel marketing acts as a substitute for copyright protection.

In section 4, we have shown that when \( n = 1 \), introducing an online-direct channel can simultaneously raise firms’ pricing power and sales volume. This is rooted in the complement effect of dual-channel marketing on copyright protection, mitigating the threat of piracy on firm pricing. However, the complement effect will decrease by degrees as the retailer quantity increases and even reverse into the substitute effect, which may not make firms set higher prices when the producer introduces an online-direct channel. In the next proposition, we examine the influences of dual-channel marketing on firm pricing in the pirated market when the producer serves competing retailers.

Proposition 7. In the pirated market, when the producer sells discs through \( n \) competing traditional retailers, the strategic use of dual-channel marketing will always decrease the wholesale price and the retail price, i.e.,

\[
\forall \theta \in (0,1), \text{ when } n > 1 \text{ and } c \in (0, +\infty), w^{nD} < w^{nT} \text{ and } p^{nD}_R < p^{nT}_R.
\]
Proposition 7 shows that, different from the case of \( n = 1 \) where dual-channel marketing can sometimes increase the sales volume and pricing power, when oligopolistic retailers engage in quantity preorder and Bertrand competition, dual-channel marketing can only increase the sales volume at the expense of all the firms’ pricing power. We explain it in different cases of \((n, c)\), respectively.

When \( n = 2 \) and \( c \in (\tfrac{2}{3}, \tfrac{2}{3}) \), stricter copyright protection caused by an online-direct channel’s introduction will result in a larger growth of the wholesale and retail prices, but the actual increase of the copyright protection level is not sufficiently large for both firms to set higher prices. When \( n = 2 \) and \( c \in (\tfrac{2}{3}, \infty) \), stricter copyright protection caused by an online-direct channel’s introduction will result in a smaller growth of the wholesale and retail prices, thus both firms will always charge lower prices once the online-direct channel is introduced. When \( n = 3 \), the online-direct channel’s introduction does not influence the copyright protection level and thus the negative influences of dual-channel marketing on firm pricing are as in a market without piracy. When \( n > 3 \), dual-channel marketing will induce the producer to cut down copyright protection, and weaker copyright protection caused by the online-direct channel’s introduction will result in a smaller growth of the wholesale and retail prices. Therefore, when \( n > 3 \), the online-direct channel’s introduction will always lead to a decrease of the wholesale and retail price.

Recall that under certain conditions, dual-channel marketing can reduce profit losses caused by piracy for the producer and its monopolistic retailer. In the final proposition, we investigate whether such beneficial effects are still viable when the producer sells discs through \( n \) retailers.

**Proposition 8.** When the producer sells discs through \( n \) traditional retailers, (i) the strategic use of dual-channel marketing can reduce the producer’s profit losses caused by piracy. Specifically, in the pirated market, when \( n = \{1, 2\} \), dual-channel marketing will increase (decrease) the producer’s profit, i.e., \( \theta > (\bar{\theta}) \bar{\theta}^n \), \( \pi^D_M > (\pi^T_M) \); but when \( n \geq 3 \), dual-channel marketing will always decrease the producer’s profit, i.e., \( \pi^D_M < \pi^T_M \). Here, we define

\[
\bar{\theta}^n = \begin{cases} 
\frac{1+n}{4} & \text{when } c \in (0, \frac{n}{4(1+n)}) \\
\frac{n}{32c} + \frac{(1+n)^2c}{2n} & \text{when } c \in \left(\frac{n}{4(1+n)}, \frac{n}{(1+n)^2}\right) \\
1 - n \frac{16-(1+n)^2}{32(1+n)^2}c & \text{when } c \in \left(\frac{n}{(1+n)^2}, \infty\right)
\end{cases}
\]

(ii) the strategic use of dual-channel marketing can reduce the retailer’s profit losses caused by piracy. Specifically, in the pirated market, dual-channel marketing will increase (decrease) the retailer’s profit, i.e., \( \pi^D_R > (\pi^T_R) \) when \( \theta < (\bar{\theta}) \bar{\theta}^n \). Here, we define

\[
\bar{\theta}^n = \begin{cases} 
\frac{3}{4} & \text{when } c \in (0, \frac{n}{4(1+n)}) \\
1 - \frac{n}{16(n+n)c} & \text{when } c \in \left(\frac{n}{4(1+n)}, \infty\right)
\end{cases}
\]

(iii) when \( n = \{1, 2\} \), there is always a non-empty interval of an online-direct channel’s attractiveness for consumers in which using dual-channel marketing can reduce all the firms’ profit losses caused by piracy. Specifically, in the pirated market, dual-channel marketing will increase all the firms’ profits when the introduced online-direct channel’s attractiveness for consumers is in a moderate range, i.e., \( \pi^D_M > \pi^T_M \) and \( \pi^D_R > \pi^T_R \) when \( \theta \in (\bar{\theta}_1, \bar{\theta}_2) \) and \( n = 1 \), or when \( \theta \in (\bar{\theta}_3, \bar{\theta}_4) \) and
$n = 2$, seeing Figure 3. Here, we define

$$\bar{\theta}^n_1 = \bar{\theta}, \ \bar{\theta}^n_2 = \bar{\theta},$$

$$\check{\theta}^n_2 = \begin{cases} \frac{3}{4} & \text{when } c \in (0, \frac{1}{6}] \\ \frac{1}{16c} + \frac{9c}{4} & \text{when } c \in \left(\frac{1}{6}, \frac{2}{9}\right) \\ 1 - \frac{7}{4c} & \text{when } c \in (\frac{2}{9}, \infty) \end{cases}$$

$$\check{\theta}^n_1 = \begin{cases} \frac{3}{4} & \text{when } c \in (0, \frac{1}{6}] \\ \frac{1}{16c} - \frac{1}{24} & \text{when } c \in \left(\frac{1}{6}, \infty\right) \end{cases}$$

\[\text{Figure 3. The win-win regions by the online-direct channel’s introduction in the pirated market when and } n = 1, n = 2, \text{ respectively.}\]

Proposition 8 shows that when the producer sells discs through more than one retailer, particularly only in the case of duopolistic retailers, the strategic use of dual-channel marketing can benefit all the firms and reduce their profit losses caused by piracy. This interesting result has inspired us to look deeply into part (i), (ii), and (iii) in this proposition from the perspectives of the producer, retailer(s), and win-win regions, respectively.

First, by comparing the thresholds above which the producer can benefit from dual-channel marketing in the cases of different quantities of retailers, we find that the producer who intends to benefit from dual-channel marketing always has a higher requirement for the introduced online-direct channel’s attractiveness when $n = 2$ than when $n = 1$, i.e., $\check{\theta}^n_2 > \check{\theta}^n_1$. To show its economic principle clearly, we first analyze how the retailer quantity $n$ influences the producer’s price-setting when it introduces online-direct marketing and when it does not, respectively. When the producer does not introduce online-direct marketing, since the producer always acts as the upstream of the retail channel, holding the copyright protection level fixed, the retailer quantity does not influence the wholesale price. However, when the producer introduces online-direct marketing, the producer also acts as a competitor of the retailers. The larger the retailer quantity is, the fiercer the competition between the producer and retailers is. Holding the copyright protection level fixed, both the
online-direct and wholesale prices will decrease with the retailer quantity. Therefore, when a producer selling discs through a single retailer adds another retailer, a more attractive online-direct channel may be needed to provide the producer with sufficient pricing power and increase its profit. Unfortunately, there is no evidence that the producer can benefit from dual-channel marketing when it adds two or more retailers. When $n \geq 3$, the downstream competition is so fierce that the producer can never gain enough pricing power from introducing an online-direct channel even when consumers regard the traditional retail channel and the online-direct channel to be equally attractive. This result also indicates a clear difference with Chiang [7], which shows that when $n \geq 1$ the producer can always benefit from dual-channel marketing in the market without piracy.

Next, we analyze when the oligopolistic retailers can benefit from the introduction of an online-direct channel in the pirated market. Since the online-direct channel can protect all the retailers’ profit margin from the harm of piracy, all of the retailers can benefit from dual-channel marketing no matter their quantity. However, we find that the protective effect weakens as the retailer quantity increases, and thus the threshold below which the retailers can benefit from dual-channel marketing will decrease with the retailer quantity, i.e, $\theta_n^a \leq \theta_{n-1}^a \leq \ldots \leq \theta_1^a$. The reason is intuitive. When the producer does not introduce an online-direct channel, a larger retailer quantity, which increases the producer’s sales volume, can raise the marginal return of copyright protection investments, thus leading to stricter copyright protection. As the retailer quantity increases, the protective effect of dual-channel marketing weakens, and hence the retailer can benefit from dual-channel marketing only when the online-direct channel is less attractive and competitive.

Finally, we analyze the win-win regions for the profits of the producer and the retailer(s) by the online-direct channel’s introduction in the pirated market. We find that, in the pirated market, only when $n = \{1, 2\}$, dual-channel marketing can benefit all of the parties in the sales channel. Note that in Proposition 6 we have shown that dual-channel marketing plays a complementary role on copyright protection only when $n = \{1, 2\}$. This means that the strategic use of dual-channel marketing can reduce profit losses caused by piracy for all the firms in the sales channel only when dual-channel marketing can complement copyright protection. From a more in-depth perspective, dual-channel marketing’s strategic value of mitigating piracy’s damage to firm profits is gradually weakened by perfect downstream competition. As illustrated in Figure 3, the win-win region when $n = 2$ is within the win-win region when $n = 1$. Proposition 8 also indicates the reason why a producer, who serves oligopolistic retailers, does not introduce an online-direct channel, is not merely based on the concern that retailers might be unwilling to accept another competitor. In the pirated market, to a large extent, introducing online-direct marketing may decrease the producer’s profit. In particular, when the retailer quantity is no less than three, it is in the producer’s self-interest to not design dual-channel marketing.

6. **Concluding remarks.** Digital content producers and their retailers have suffered from piracy problems for a long time. This paper explores dual-channel marketing optimality as a piracy-mitigating strategy for digital content sold in the physical disc format. We develop a pricing model in which a producer sells licensed digital content discs through its retailer(s) and invests in copyright protection to resist piracy. We study two channel structures regarding whether the producer in
a pirated market introduces an online-direct store alongside the brick-and-mortar retailer, i.e., the traditional-channel and the dual-channel structures. In the basic model, we study the case where the producer sells discs through a monopolistic retailer. In the model extension, we study the case where the producer sells discs through oligopolistic retailers engaging in quantity preorder and Bertrand competition. In each case, we examine how firms’ pricing, sales volumes, and profits are influenced by the interaction of endogenous copyright protection and channel structures in a pirated market. Our research reveals several significant findings.

First, dual-channel marketing can always strategically mitigate the piracy level by attracting some piracy users to buy licensed discs sold in the retail channel(s) no matter how much the producer invests in copyright protection and how many retailers the producer serves.

Second, dual-channel marketing can act as either a complementary role or substitutable role on conventional copyright protection, but which role it acts depends on the retailer quantity. When the producer introduces an online-direct channel, copyright protection’s positive influences on the producer’s pricing power gradually disappears as the downstream competition approaches perfectly. Although dual-channel marketing always increases the sales volume of licensed discs, when the producer serves more competing retailers, it does not necessarily improve the producer’s marginal return of copyright protection investments. Thus, only when the retail quantity is less than three, dual-channel marketing complements insufficient protection; otherwise, it substitutes copyright protection.

Third, counter-intuitively, in the pirated market with insufficient copyright protection, when the producer sells digital content discs through a monopolistic retailer, dual-channel marketing can simultaneously raise firms’ pricing power and retail sales volume. This is because the complement effect of dual-channel marketing can mitigate the threat of piracy on firm pricing. However, when the producer sells through competing retailers, dual-channel marketing can only increase the retail sales volume at the expense of firms’ pricing power. This is because as the retailer quantity increases, the complement effect of dual-channel marketing will decrease by degrees and even reverse into the substitute effect.

Fourth, the strategic use of dual-channel marketing can benefit the producer and reduce its profit losses caused by piracy when the producer sells discs through a monopolistic retailer or duopolistic retailers. In addition to attributing this beneficial effect to the mitigated double marginalization as in previous research, the economic principle can be that when the producer introduces an online-direct channel, the resulting higher wholesale price can afford the increased copyright protection costs. Besides, in the pirated market, the producer has a higher requirement for the introduced online-direct channel’s attractiveness when it sells through duopolistic retailers than when it sells through a monopolistic retailer. This is because when the producer introduces online-direct marketing, as the retailer quantity increases, the competition between the producer and retailers is fiercer, which as a result restrain the producer’s pricing. Therefore, a more attractive online-direct channel needs to be introduced to provide sufficient pricing power for the producer to benefit from dual-channel marketing. However, when the retailer quantity is no less than three, the downstream competition is so fierce that the producer can never gain enough pricing power by introducing any online-direct channel, and thus, the dual-channel marketing cannot improve its profit and mitigate the losses caused by
piracy. This result is different from previous research where dual-channel marketing in the market without piracy can benefit the producer no matter the retailer quantity.

Fifth, the strategic use of dual-channel marketing can benefit all the retailers and reduce their profit losses caused by piracy no matter their quantity. In addition to attributing this beneficial influence to the wholesale price reduction as in previous research, in the pirated market, the retailers can benefit from dual-channel marketing even with the wholesale price rising. This is because the online-direct channel segregates the competition between the retail channels and piracy, protecting the retailers’ profit margins from the harm of piracy. However, this protective effect weakens as the retailer quantity increases, and thus, the threshold below which dual-channel marketing can reduce the retailers’ profit losses caused by piracy decreases with the retailer quantity.

Finally, the strategic use of dual-channel marketing can benefit all the parties in the sales channels and reduce their profit losses caused by piracy only when it can complement conventional copyright protection, i.e., when the producer sells discs through a monopolistic retailer or duopolistic retailers. In each situation, as the marginal cost of copyright protection increases, the producer is more unwilling to design dual-channel marketing because it needs to introduce a more attractive online-direct channel that can provide it with enough pricing power to afford the increased copyright protection costs; however, the retailer will be more willing to accept dual-channel marketing because the protective effect becomes more prominent. However, the win-win region for the producer and its retailers by dual-channel marketing when the producer serves duopolistic retailers is within the win-win region when the producer serves a monopolistic retailer. This means that dual-channel marketing’s strategic value of mitigating piracy’s damage to firm profits is undermined as downstream competition becomes perfect.

The findings above have important managerial implications. First, in the pirated market, digital content producers can mitigate the piracy level and attract consumers to buy licensed discs by strategically introducing an online-direct channel alongside the traditional retail channels. Second, if the producer intends to add an online-direct channel, it should adjust the copyright protection investments according to the retailer quantity and the marginal cost of copyright protection. Specifically, if the retailer quantity is less (more) than three, the producers should strengthen (weaken) copyright protection. Third, if the producer introduces online-direct marketing, all the firms should reset their prices. Specifically, when the producer serves a single retailer, both firms can sometimes raise their prices; otherwise, all the firms should always decrease their prices. Fourth, the producer should introduce a highly attractive online-direct channel for reducing their profit losses caused by piracy. Moreover, as the retailer quantity increases, the producer should set a higher standard for the introduced online-direct channel’s attractiveness. In particular, when the producer in the pirated market sells discs through more than two retailers, it should not consider designing dual channels to improve its profit. Fifth, the retailers should not always oppose the upstream introducing an online-direct channel since it can protect their profits from the harm of piracy. However, as the retailer quantity increases, the protective effect is weakened, and thus, it is not in the retailers’ interests to accept a highly attractive online-direct channel. Finally, as piracy is becoming increasingly rampant nowadays, the retailers
can tolerate a more competitive online-direct channel because of its more substantial protective effect. However, the producer selling discs through a monopolistic retailer or duopolistic retailers should be more cautious about introducing online-direct marketing as copyright protection becoming increasingly costly. Fearing that the introduced online-direct channel may not provide enough pricing power to afford the higher copyright protection costs, the producer might give up introducing a low attractive online-direct channel.

There are several directions to extend the current research. First, one can explore possible piracy-mitigating strategies by considering the situation where the digital content producer simultaneously sells physical discs through traditional retailers and downloadable versions through digital retailers. Second, it would be interesting to investigate the role of information asymmetry between producers and retailers in dual-channel marketing. In particular, when the retailers do not know the specific copyright protection policy, researchers can examine if the main results are still viable under information asymmetry. Third, our model assumes a monopolistic digital content producer. Future research can relax this assumption to see if the main results are still viable with competing producers. Finally, in our model, all consumers know the digital content’s value. Future research can explore whether piracy always hurts firms’ profits when consumers do not know the value of digital content but can deduce it by piracy.

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