
Economic Implications of Variable Technology Standards for Movie Piracy in a Global Context

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ABSTRACT: Even if bandwidth on the Internet is limited, compression technologies have made online music piracy a foremost problem in intellectual copyright protection. However, due to significantly larger sizes of video files, movies are still largely pirated by duplicating DVDs, VCDs, and other physical media. In the case of DVDs, movie studios have historically maintained different technology codes or formats across various regions of the world, primarily to control the timings of theatrical releases in these parts of the world. This paper formulates an analytical model to study the implications of maintaining different or incompatible technology standards in DVD and other optical disc players on global pricing and piracy of movie discs. Our formulation develops two distinct piracy types, namely, regional and global piracy, signifying if consumers will pirate movies released for their own region or those meant for other regions. Our results find that maintaining separate technology standards is very critical when there is piracy as losses from global piracy can be higher than when only regional piracy exists. Further, we observe that piracy is not a victimless crime in that not only do producers suffer losses but consumers in regions with high willingness-to-pay for quality also stand to lose. In addition, we find that in-

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creasing homogeneity in consumer preferences for quality across regions may not be beneficial to digital product vendors unless there is also uniformity in copyright protection laws. We conclude with recommendations for research and practice for movie studios as well as producers for other goods that are dependent on copyright protection such as books and pharmaceuticals.

KEY WORDS AND PHRASES: contract theory, digital products, information goods, moral rent, movie piracy, pricing, technology standards, vertical segmentation.

Piracy is sometimes and mistakenly called a victimless crime. Jay Berman, IFPI Chairman (<http://www.ifpi.org/site-content/press/inthedia08.html>)

AS THE DEBATE ON ONLINE MUSIC PIRACY RAGES, piracy of movies continues in the offline world in the form of illegal copies of digital video (also called versatile) discs (DVDs) and video compact discs (VCDs), commonly referred to as optical disc piracy. The large size of video files of movies, combined with the lack of sufficient Internet bandwidth and consumer propensity to watch movies on television screens, has so far stemmed computer-based online movie piracy. Although Napster equivalents such as Morpheus, Grokster, and Kazaa have been fueling online movie sharing [13], piracy of information goods such as movies are closely related to the physical medium on which the good is sold. Statistics from the Motion Picture Association of America (MPAA; www.mpa.org) finds that more than 17 million pirated optical discs (predominantly VCDs and more recently DVDs) were seized in the Asia/Pacific region alone and concludes that optical and video piracy around the globe is the most significant threat to the future of the movie industry. Hence, an important goal of this paper is to understand the mechanics of movie piracy in the global context and particularly the role of piracy deterrence strategies.

Many consumers also consider piracy to be a victimless crime in that some believe that piracy affects only faceless corporations and not individuals. Generally, consumers may consider lying on insurance forms (such as providing false information) or not wearing a seat belt to be victimless crimes, that is, no other individual is a victim of the consumer's own actions, large corporations notwithstanding. Some have even argued for posting of DVD decryption codes as a part of their free speech rights (see www-2.cs.cmu.edu/~dst/DeCSS/ for further discussion). To thwart this notion, software and video game firms are involved in explicit efforts to point out that piracy does have its victims, for example, Microsoft has launched initiatives to warn companies buying illegal software that the firms themselves may become victims due to potential risks from viruses and missing files (www.microsoft.com/presspass/press/1999/Apr99/AtlantaEI.asp). Similarly, the video game industry points out that pirating games or buying illegal copies can hurt the small games writers rather than big corporations (news.bbc.co.uk/2/hi/business/1463157.stm). In our research, we ex-

plore this notion of piracy being a “victimless” crime and analyze if only the movie studio is hurt due to piracy or if the consumers themselves are also affected in some way.

Literature in economics, information systems (IS), and marketing informs us on the nature of software piracy [8, 12, 14, 23], and more recently on music piracy as well [7, 16, 18]. In particular, it has been argued that firms in the information goods industries such as the music recording labels are vulnerable to disintermediation, and piracy deterrence services are important mechanisms through which a studio can make itself attractive to recording artists [7]. However, there has been little analysis of such strategies for the movie industry and any discussion has been limited to the trade press. Our research builds on findings in the arena of software and music piracy to identify factors that contribute to movie piracy across the world. In the global context, unlike stereo players, audio cassettes, and CDs, for historical and marketing reasons, technologies for moving pictures such as televisions and VCRs have always employed different standards such as PAL, NTSC, VHS, and SECAM in various parts of the world. Along these lines, DVD players also use different Regional Management Information Codes (RMIC; www.unik.no/~robert/hifi/dvd/world.html) across different parts of the world, even if they are not technically different standards. In this paper we propose that employing incompatible technologies across the globe through different standards, formats, or some other technological mechanism can have significant implications on a movie studio’s marketing and pricing decisions amid the threat of piracy.

Compatibility from common technology standards and its role in creating positive externality benefits have been well documented in economics and IS literature [3, 19], for example, a producer of a component technology has access to a greater user base if he adopts a common technology standard rather than a proprietary one. In the context of piracy, it has been argued that although there is a direct loss of revenue to a producer, piracy might also be beneficial when it can create demand-side externalities [8, 12], that is, the potential legitimate user base might increase as more people pirate and experience a product. However, later work portrays this as wishful thinking and has argued that losses from piracy outweigh any such potential benefits [18]. More recently, it has been shown that any benefits from piracy are better abstracted through proactive sampling strategies rather than depending on unsure demand-side externalities [4].

Research on piracy should also incorporate economics and behavioral factors that influence a consumer to buy or pirate. In the context of piracy in other product industries, prior research has found that prices and a consumer’s expected cost from pirating are two most salient elements [8, 14] that control a consumer’s decision to pirate. The cost of pirating to a consumer is generally understood to be a combination of his or her likelihood of being caught and any punitive damage that may ensue. From a behavioral perspective, it has also been argued that consumers have varied ethical propensities toward illegal acts such as piracy [14]. Furthermore, research in the context of international software piracy [15] finds significant differences in deterrence and preventive factors across different parts of the world, implying that the overall

cost of pirating varies for consumers in these parts. We add to the current body of literature in economics of IS research by developing a contract-theoretic framework to model movie piracy by combining economic and behavioral elements that affect piracy with variability in technology standards.

We identify two distinct types of piracy, namely, global and regional (or local) piracy, and we show that by maintaining different technical standards for optical discs across regions, firms cannot only eliminate global piracy, but can also engage in quality segmentation and price discrimination. Our findings provide conditions when movie studios might find it optimal to ignore a region. Interestingly, our analysis reveals that piracy is not a victimless crime, and global piracy may lead to situations where the regions that have a higher marginal willingness-to-pay stand to lose. Thus, it is in the interest of both movie studios and customers from higher income regions such as the United States to prevent piracy. Finally, we also discuss our results in light of piracy in other digital products and intellectual copyright-based industries and show that our findings are applicable to these domains as well.

Model Development

RESEARCH IN SOFTWARE AND MUSIC PIRACY argues that there are economic, legal, and behavioral dimensions to piracy. Whereas price is a crucial element in a consumer's decision to pirate a product [8], research has also identified an individual's ethical propensity as being another important factor [4, 14]. Piracy is also dependent upon the prevalent legal infrastructure and such legal deterrents may differ significantly across countries; hence, we develop our model of global piracy by considering the varying emphasis on copyright enforcement laws, different ethical propensity to pirate, the varying customers' marginal willingness-to-pay for quality, and the variable technology standards across different regions of the world. For modeling purposes, we consider two regions, A and B, that are representative of the variations in customer segments, copyright laws, and technological standards, and we assume that the customer base in each region is given by N_A and N_B . We now develop the construct of vertically differentiated products in the context of optical movie discs. To construct our model, we rely upon literature on experience goods pricing and vertical segmentation from economics and marketing research [1, 9, 24, 25].

Enhancement In-Home Releases of Movies

Research in marketing suggests that movies are part of a consumer's hedonic consumption experience and it has been argued that movie markets can be segmented based on behavioral attributes including a consumer's individual preferences [11]. Movies also belong to the genre of economic goods, known as experience goods, and the pricing strategies for such goods are a function of consumers' preference for quality or any other valued attribute [27]. In addition to the basic set of valued attributes of a movie that is defined by its cast, director, and production house, movie DVDs also

provide value along two other dimensions, namely, through technical and content enhancements. Commonly a movie is offered on DVD after it has completed its first theatrical run and during this home-release movie studios strategically enhance the appeal of a movie by providing many additional technical features and new content.

Today, these extra features have come to signify an important part of a consumer's DVD purchase decisions that many online consumer sites such as DVDBreakdown.com (www.dvdbreakdown.com) have cropped up to provide reviews and ratings on both technical and extra features that were unavailable during theatrical release, but provided in the DVD versions. Consistent with prior abstractions of quality of experience goods [22, 27], in our model we define a movie DVD's quality to be defined by these sets of valued attributes. Movie studios can effectively use these attributes to vertically differentiate their DVD offerings. These enhanced items not only contain interviews with stars, bloopers, and cut footage (included to create a directors' cut) that could not be shown in theaters, but they also include technological enhancements such as wide-screen viewing, dubbing in a variety of languages, subtitles, and even special effects that are not possible in theaters. Thus on a quality or features scale, a simple copy of the theatrical release would be on one end of the scale, whereas a high-quality, more features (summarized in Table 1) enhanced DVD would represent the other end.

In producing the DVDs, the movie studio incurs three types of cost. First, there is the basic cost of producing and marketing the movie that may even include obtaining ownership of movie rights if the distributor and the production house are not the same. We denote such fixed costs by the parameter a . We then introduce another fixed-cost parameter that is convex in quality, representative of the initial infrastructure costs the firm will suffer in producing another DVD quality. Note that this is a fixed cost and is incurred only once when the initial platforms for the different technical enhancements are created. Finally, we have the marginal cost of DVD production that is also quality-dependent. It is widely assumed that all marginal costs of digital product production is zero. Arguably, this is true for the actual physical reproduction, for example, the actual price of copying a DVD is but a few cents. However, when a DVD enhanced for content includes additional materials such as games, cut footage, and tracks, the studio releasing the DVD has to pay a royalty to the various actors and other production crew a per-copy sold fee. In fact, recently the Screen Actors Guild has renegotiated royalty payments (called residuals) for actors (and similarly the writers' guild for script writers) that are to be paid for every copy of the DVD based on the actual content included. These payments are in the order of 4.5 percent to 5.4 percent of the gross revenue from any cassette/DVD sales and to around 3.6 percent of television broadcast revenue [28]. Thus, in our model, we assume that the cost of producing the DVDs is a function of its quality q (given by q_A and q_B in subsequent discussion), as given by

$$C(q, N) = a + \frac{q^2}{2} + cNq. \quad (1)$$

Table 1. Types of Enhancements for a High-Quality DVD

Technology enhancements	Content enhancements
<ul style="list-style-type: none"> • Can hold eight hours of high-quality video, or 30 hours of VHS quality video (with a double-sided, dual-layer disc). • Support for wide-screen movies on standard or wide-screen TVs (4:3 and 16:9 aspect ratios). • Up to eight tracks of digital audio, each with as many as eight channels (for multiple languages, DVS). • Up to 32 subtitle/karaoke tracks. • Automatic “seamless” branching of video (for multiple story lines or ratings on one disc). • Up to nine camera angles (different viewpoints can be selected during playback). • Menus and simple interactive features (for games and quizzes). • Multilingual identifying text for title name, album name, song name, cast, and crew. • Instant search to title, chapter, music track, and time-code. 	<ul style="list-style-type: none"> • Interviews with stars. • Cut footage (or director’s cut). • Bloopers. • Games related to the movie theme. • Full versions of songs and track from the movie. • Combine sequels (e.g., StarWars Trilogy). • Include mobile ring tones (e.g., Fox Media, Inc., allows “The Simpsons” tunes to be downloaded to cell phones).

Regional Differences in Customer Segments and Copyright Enforcements

In the context of software, Gopal and Sanders [15] find that not only does piracy vary across different regions of the world, but it is also related to the gross domestic product (GDP) of a country and these countries demonstrate variations in enactment and enforcement of copyright laws. Recent research specifically finds that high-income countries have lower software piracy rates and a higher emphasis on copyright protection and countries with individualist culture have lower piracy rates as compared to those with a collectivist culture [23].¹ As movie piracy also falls under threats to copyright protection, movie piracy also exhibits similar cross-regional and cross-cultural characteristics. Figure 1 shows the MPAA statistics for movie piracy in countries (grouped by region) that are being watched by the U.S. government and other intellectual property groups. Western countries such as the United States, the United Kingdom, and others who have very stringent copyright laws suffer from relatively low optical disc piracy and are not represented in this data set.

Therefore, in our model, customers in regions that include the United States and other developed countries (designated as Region A) can be assumed to possess a higher marginal willingness-to-pay compared to customers in China and other low-income countries (designated as Region B). We represent this value as θ_A and θ_B ($\theta_A > \theta_B$), respectively, and, further, we also assume that the combined willingness-to-pay of Region A is greater than Region B, that is, $N_A\theta_A > N_B\theta_B$. Consistent with prior research on quality segmentation [24], we also represent the utility derived by the

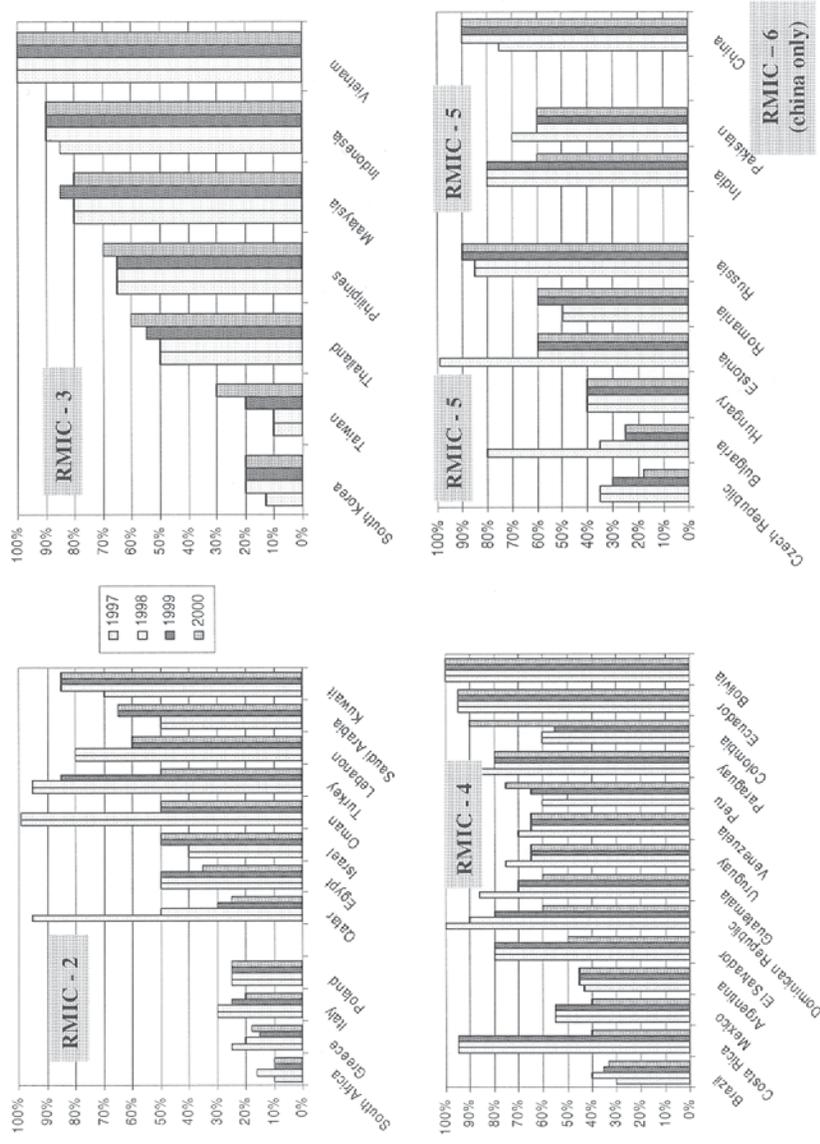


Figure 1. RMIC and MPAA Statistics on Movie Piracy in Selected Regions of the World

consumers in each region if they buy or pirate a DVD of quality q to be given by $\theta_A q$ and $\theta_B q$.² Prior research [14] also finds that piracy is related to an individual consumer's ethical propensity toward copyright laws, that is, a consumer with a low moral or ethical predisposition will suffer a smaller moral cost when he or she chooses to pirate or obtain an illegal copy of a movie. Such predisposition toward intellectual property rights have been shown to have cultural origins and is related to the prevalent individualist or collectivist culture [23].

For the purposes of modeling, we assume that the consumers in Regions A and B suffer moral costs that are given by β_A^h, β_A^l and β_B^h, β_B^l , where the superscripts h and l represent the high and low bounds of these costs. The proportion of consumers with high and low moral costs in each region is given by $(\gamma_A, 1 - \gamma_A)$ and $(\gamma_B, 1 - \gamma_B)$. We also assume that $\beta_A^l > \beta_B^l$ and $\beta_A^h > \beta_B^h$, that is, a consumer with the lowest moral cost in Region A still suffers a higher cost compared to the consumer with the lowest moral cost in Region B, and similarly, a consumer with the highest moral cost in Region B suffers a lower cost than the consumer with the highest moral cost in Region A. We call this the moral bands of Region A ($\beta_A^l \leftrightarrow \beta_A^h$) and Region B ($\beta_B^l \leftrightarrow \beta_B^h$). Note that we do not make any assumptions about the width of these bands, that is, there may be consumers who suffer similar costs in both regions. Consistent with the observations of Gopal and Sanders [15], we assume that Region A (representative of the United States, Western Europe, and other developed nations) has strong enforcement mechanisms as compared to Region B, such that the punitive costs (a combination of fines and expectations of getting caught) suffered by a consumer who pirates in the region is given by E_A and $E_B (E_A > E_B)$ [4]. Many other studies also find that intellectual property rights receive greater protection in developed economies and high-income countries [23].

Regional Differences in Technology Standards for DVDs

In order to segment our regions across the globe we adopt the division created by the use of RMIC for DVDs that is used by the MPAA member studios and all its allied organizations. Figure 2 and Table 2 show the six main regions used by DVDs, and in addition codes 7 (reserved) and 8 (special international venues—airplanes, cruise ships, etc.) are also used. The main reason movie studios have adopted these regional codes is so that they can control the home release and theater releases of their pictures in different countries (e.g., a movie already on DVD in the United States might just be released in theaters in China). Each DVD player is given a code for the region in which it is sold and it will not play discs that are not coded for its region.³ It is not an encryption system, but just one byte of information on the disc that the player checks. However, it is a permanent part of the disc, and will not “unlock” after a period of time. Although regional codes are entirely optional for the producer of a disc, so far almost all Hollywood releases play in only one region. Note that in this paper we do not focus on how technologically sophisticated or effective the regional code system is, rather we use this system as an example for creating separate formats or standards, thus causing incompatibility between products across regions. For the two regions

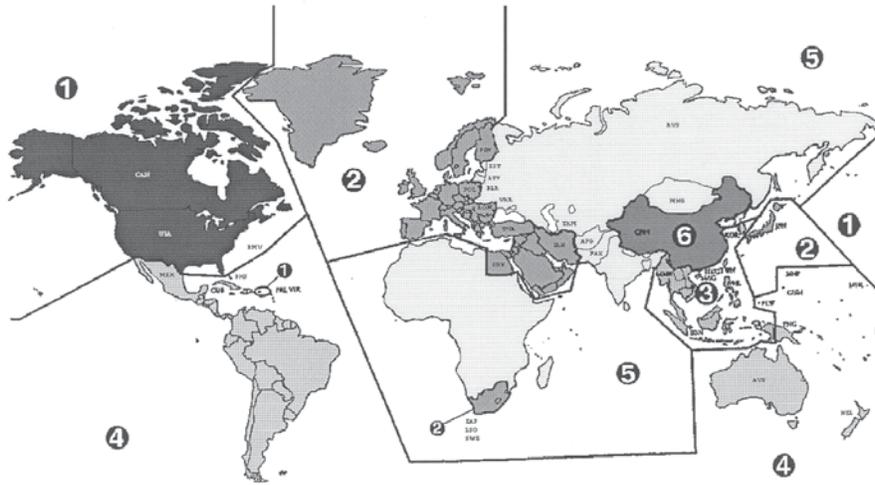


Figure 2. Regional Code Map for DVDs

Table 2. Countries and Their Regional Codes

Region	Areas
1	United States, Canada
2	Europe, Middle East, Japan, South Africa
3	South Korea, Taiwan, Hong Kong, ASEAN
4	Australia, New Zealand, Latin America
5	Ex-Soviets, Indian subcontinent, Africa
6	China
7	Reserved
8	International territory (airplanes, cruise ships, etc.)

we consider in our model, we assume that the standards for Regions A and B are given by S_A and S_B . A summary of the differences in the regions as abstracted in our model is given in Table 3.

Pricing in the Absence of Piracy

In order to understand the implications of piracy to pricing strategies and the role of regional differences, we first develop a model of pricing based on a contract-theoretic setting in the absence of piracy [4, 5]. We first find optimal prices and strategies of a movie studio with regard to its home releases of DVDs and optical discs in each region, in the absence of any piracy. If the movie studio produces two types of optical discs with variable quality, and if p_A and p_B represent the prices in Regions A and B, then the studio's profit-maximization problem can be set up as:

Table 3. Differences in Regions A and B

Factors	Region A (Western nations, e.g., United States, Western Europe)	Region B (developing regions, e.g., Latin America, China)
Marginal willingness-to-pay for quality	θ_A (High)	θ_B (Low)
Moral cost reflective of ethical propensity to pirate (proportion)	β_A^h, β_A^l $(\gamma_A, 1 - \gamma_A)$	β_B^h, β_B^l $(\gamma_B, 1 - \gamma_B)$
Emphasis on copyright enforcement	E_A	E_B
Standards adopted	S_A	S_B
Number of consumers	N_A	N_B

$$\max_{\{(q_A, p_A), (q_B, p_B)\}} \left[N_A p_A - \frac{q_A^2}{2} - c N_A q_A + N_B p_B - \frac{q_B^2}{2} - c N_B q_B - a \right] \quad (2)$$

subject to the individual rationality (IR) or the participation constraints, given by Equation (3).

$$\begin{aligned} \theta_A q_A - p_A &\geq 0 & \text{IR}_A \\ \theta_B q_B - p_B &\geq 0 & \text{IR}_B \end{aligned} \quad (3)$$

The participation constraints state that the prices are chosen such that the consumers in both regions derive a positive surplus in buying the DVD. Now we consider the optimal solution to this strategy under two distinct cases, when the standards are different across the two regions, implying that a DVD made for Region A will not work in Region B and vice versa ($S_A \neq S_B$), and when they are the same, that is, optical discs will work in either region irrespective of where they are made ($S_A = S_B$).

Lemma 1: When the DVD standards between two regions are incompatible ($S_A \neq S_B$), it is optimal for the movie studio to create a fully enhanced DVD for Region A, given by quality $Q_A^ = N_A(\theta_A - c)$ and price $P_A^* = N_A\theta_A(\theta_A - c)$, and a less-enhanced movie DVD for Region B given by quality $Q_B^* = N_B(\theta_B - c)$ and price $P_B^* = N_B\theta_B(\theta_B - c)$.*

When the standards between the two regions are different from each other it implies that one region's DVD will not function in the other. This allows the studio to create two vertically differentiated products, and price them differently. The nature of the incompatible technology standards automatically takes care of any cross-segment buying, and hence there are no separate incentive compatibility (IC) conditions to be fulfilled, that is, consumers will only buy DVDs meant for their region and the monopolist will extract full consumer surplus from each region.

Lemma 2: When the DVD standards between the two regions are the same ($S_A = S_B$), it is optimal for the movie studio to create an enhanced DVD for Region A with the same quality as given in Lemma 1, $Q_A = Q_A^ = N_A(\theta_A - c)$, and a lower price given by $P_A = N_A\theta_A(\theta_A - c) - (\theta_A - \theta_B)[N_B(\theta_B - c) - N_A(\theta_A - \theta_B)]$. For Region B, it is optimal for the vendor to offer a DVD of quality $Q_B = N_B(\theta_B - c) - N_A(\theta_A - q_B)$ and price $P_B = N_B\theta_B(\theta_B - c) - N_A\theta_B(\theta_A - \theta_B)$.*

When the technological standards are the same across the two regions and if the products were accessible across regions, then it is possible that some consumers in Region A may choose to buy a product meant for Region B as the price–quality combination of the lower-quality product may yield a positive surplus to the consumer in Region A. This is a real possibility today over the Internet where geographical boundaries are of no constraint and where a customer with a credit card can easily order a product from another country. Therefore customers from Region A (θ_A) will choose contract (Q_B^*, P_B^*) if it will provide a strictly positive utility, that is, $\theta_A q_B - p_B > \theta_B q_B - p_B$ as $\theta_B q_B - p_B = 0$ and $\theta_A > \theta_B$. Therefore the contracts (price, quality) that were optimal when the standards were incompatible, may not assure optimality when the standards across the two regions are the same. Therefore the studio has to reconsider the DVD quality and the number of features included and price such that the consumer's incentive compatibility constraints given by Equation (4) are satisfied:

$$\begin{aligned} \theta_A q_A - p_A &\geq \theta_A q_B - p_B & \text{IC}_A \\ \theta_B q_B - p_B &\geq \theta_B q_A - p_A & \text{IC}_B \end{aligned} \quad (4)$$

This ensures that even when the standards are the same across the two regions, the customers will buy only the DVDs meant for their own region. Long before the advent of CDs and DVDs, the publishing industry also faced such problems, and as a result, one finds largely hardcover editions of books in the U.S. market that are priced higher than their Eastern economic editions (paperback, low-quality paper) counterparts sold in countries such as India.

Proposition 1: It is optimal for the movie studio to maintain different technology standards for the DVDs.

Proposition 1 is fairly obvious when we compare the profits from Lemma 1 and Lemma 2. When standards are common, the DVD produced for Region B (at prices meant for Region B) will also yield a positive utility for consumers in Region A. Hence, to ensure that Region A will buy only the DVD meant for them, the movie studio has to lower the price in Region A as compared to the prices in Lemma 1. This is equivalent to the *information rent* paid in economic formulations of contracts under information asymmetry [20]. In addition, the quality and prices are both lowered for Region B when the standards are common. Whereas the profits to the movie studio are always greater when the regional standards are different, customers of Region A stand to gain when the standards are common and there is no piracy problem. Figure 3 shows the relative positions of prices and DVD qualities in both cases.

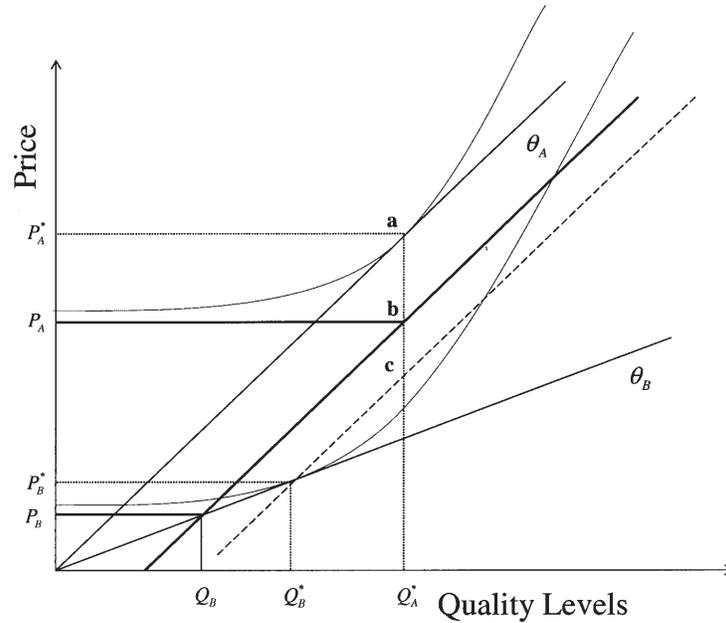


Figure 3. Optimal Contracts Under Common and Different DVD Standards in the Absence of Piracy

Proposition 2: When the two regions have the same standards and there is no threat of piracy, the movie studio will find it optimal to create only the enhanced DVD when $(N_B/N_A) \leq ((\theta_A - \theta_B)/(\theta_B - c))$ and $N_B - N_A(\theta_A - \theta_B) < 2(\theta_B - c)$.

Proposition 2 says that when the buying population is the same in both the Western and developing countries, then it may be best for the studio to create only the enhanced DVDs if the marginal willingness-to-pay of the customers in the Western countries is twice or more than that of customers in the developing world. This also implies that movie studios based in the West will find it optimal to create special products for the developing regions when the volume of potential buyers is sufficiently large. The intuition behind this proposition is that the information rent paid to the customers in Region A is increasing as the ratio of the marginal willingness-to-pay of Region A to B is increasing. Unless the volume of buyers in Region B can offset this information rent, the movie studio may find it optimal not to offer the low-quality product at all. Also, as we can see from Lemma 2, the quality provided to Region A is the same in both situations ($S_A = S_B$) and ($S_A \neq S_B$), but a lower quality is offered for Region B when the standards are the same.

From the movie studio's perspective, our analysis argues for the maintenance of incompatible standards. This result (maintaining a vertically segmented product line) is *not* surprising and is in fact consistent with findings in other physical product categories as well. There has been much work done on quality segmentation and pricing [9, 10, 24] and our purpose of re-deriving some of these results earlier is to compare

the profits when illegal copying comes into the picture. As opposed to their physical counterparts, digital products such as movie DVDs suffer from piracy problems and it is only recently that any understanding of vertical segmentation during piracy has been sought [2, 29].

In the next section, we reevaluate the movie studio's strategy under threats of piracy. We essentially model this as a repricing strategy when the vendor learns about the limited efficacy of the technological deterrents of piracy. Hence, we assume the qualities of the two movies to be fixed at the level determined by Lemma 2, that is, $q_A = N_A(\theta_A - c)$ and $q_B = N_B(\theta_B - c) - N_A(\theta_A - \theta_B)$, allowing the vendor to only manipulate his prices. Since our goal is to compare profits and cases that will involve eliminating a production line, fixing quality provides us both the analytical tractability and a base case against which we can compare pricing decisions. It would indeed be optimal for the vendor to both reprice and reconstruct the DVD quality; however, for reasons of tractability, it is common to exogenously fix the quality subproblem to analyze pricing strategies in isolation [27].

Standards and Strategic Pricing when Consumers Engage in Regional and Global Piracy

IN ORDER TO UNDERSTAND THE IMPLICATIONS OF PIRACY on DVD sales and optimal pricing, we first define two types of piracy, *regional* (or local) and *global* piracy. Regional piracy occurs when a consumer pirates or obtains illegal copies of the DVDs meant for his or her own region, that is, he or she is only evaluating buying versus pirating the same product. On the other hand, global piracy occurs when the consumer pirates or obtains illegal copies of the DVD meant for a region other than his or her own. To model piracy, we adopt a contract-theoretic setup as follows: a consumer's decision to pirate is modeled as the equivalent of a consumer being offered additional contracts by an external tempting agent, in addition to those offered by the legitimate vendor or the movie studio. We assume that the consumer does not incur any monetary cost in searching for pirated copies and we also assume that the pirated version does not suffer in quality or any other attribute compared to a legitimate copy. Hence, when a consumer pirates, the only price he or she pays is due to the cost he or she suffers as an individual in committing an illegal act and the expected cost from punitive actions if he or she is caught. Even though there is only a probability (and hence an expectation) that he or she would be caught and penalized for using a pirated DVD, we assume that the consumer is aware of this expected value given by E . Thus, we can represent the price paid by a consumer in pirating (or using a pirated) a copy as $(\beta + E)$. For example, a consumer in Region B who has a low moral cost would pay a price equivalent of $(\beta_B^l + E_B)$. A consumer will consider pirating a product if he or she derives a positive utility from the product, that is, $\theta q - (\beta + E) > 0$ and the price being charged for the product is greater than his or her combined punitive cost from pirating, that is, $p > (\beta + E)$. If the price were lesser than the combined punitive cost, that is, $p \leq (\beta + E)$, then he or she would have obviously purchased a legitimate copy

of the DVD. Therefore, we need to incorporate these consumer decisions into a vendor's pricing model.

Implications of Piracy when Standards are Common for Regions A and B

We first analyze the implications of piracy when both Regions A and B use the same standards ($S_A = S_B$), that is, what works on a DVD player in Region A would also work in Region B. Hence, the consumer in either region has two sets of options or evaluates four contracts before deciding what to do: (1) buy the DVD meant for Region A, (2) buy the DVD meant for Region B, (3) pirate the DVD for Region A, and (4) pirate the DVD for Region B. Therefore, a vendor's optimal strategy in this market needs to take into account all these possibilities.

Proposition 3: When standards are common, only the enhanced DVD meant for Region A will be pirated in both regions, that is, both regional and global piracy will involve only the enhanced DVD.

Whenever a consumer pirates, be it a product belonging to his or her own region or the other region, the combined moral and punitive costs he or she suffers during piracy is the same as can be seen from the construction provided in the "Enhancement in Home Releases of Movies" subsection. However, the utility that a consumer of either region gets from pirating is always higher for the enhanced DVD, and hence even Region B consumers will always pirate the product of Region A. The intuition behind this proposition is that if the cost of stealing for a thief is the same irrespective of the amount (e.g., same number of years in prison), then given an option between stealing a \$500 computer and a \$1,000 computer, he or she will always steal the \$1,000 computer, even if he or she had chosen to buy he or she could have afforded only the cheaper computer. However, the real extent of piracy and the corresponding vendor strategies will depend on the positions of the moral bands given in the "Enhancement in Home Releases of Movies" subsection (shown in Figure 4). Thus, we provide a case-by-case analysis of piracy, prices, and profits with varying positions of the moral bands. Note that in subsequent analysis of our model, price is deterministic as offered by the movie studio, whereas the price paid by the consumer when he or she pirates, is a discrete random variable that is determined by his or her region and his or her moral type.

Proposition 4: The price equivalent cutoff for Region B's consumers to engage in global piracy is given by $N_A(\theta_A - c)q_B$.

From Proposition 3, we can see that the decision to pirate for consumers in Region B is not based on a comparison of their moral costs and the price of the product meant for their own region P_B , rather they would trade off their moral costs against the potential utility $\theta_B N_A(\theta_A - c)$ they would derive from pirating the enhanced DVD from Region A (see Figure 4). This provides an interesting insight in that when a movie studio sets prices for Region B it also needs to take into consideration the

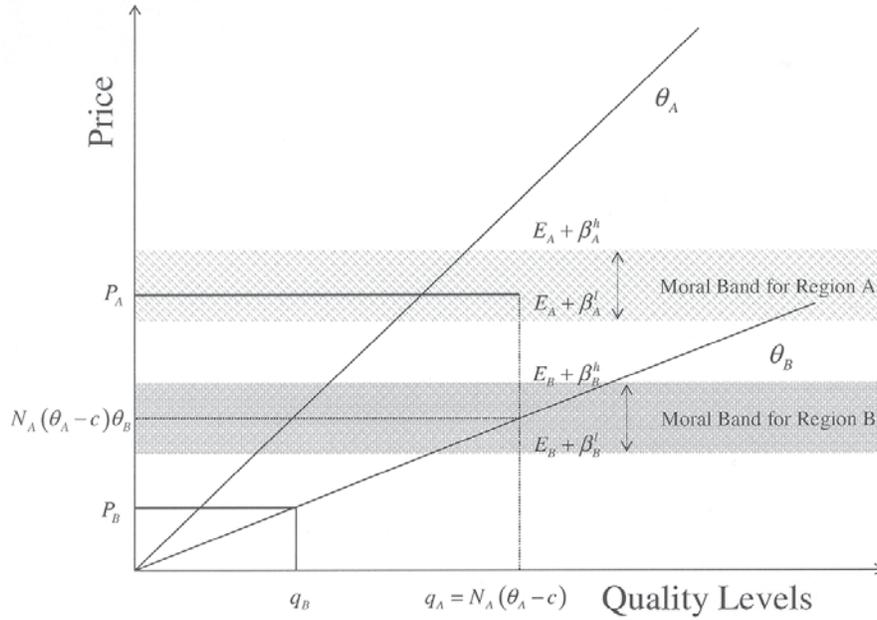


Figure 4. Relative Positions of Moral Bands

quality of the product in Region A (hence, the marginal willingness-to-pay of customers in Region A). This implies that when the standards are common and piracy is likely, pricing strategies in Region B cannot be independent of strategies for Region A. For the sake of illustration, we analyze the general cases when there is potential for a combination of global and regional piracy to exist, and the vendor can employ pricing as a strategy to lessen the loss in profits.⁴

Case 1: When Only Customers in Region B Engage in Piracy

Consider the case where the consumers in Region A will not engage in piracy as their cost from pirating is higher than the price charged by the studio, that is, $E_A + \beta_A^l \geq P_A$. Under this condition, we vary positions of Region B’s moral band to study the piracy implications. We first consider the situation where in Region B the proportion $(1 - \gamma_B)$ of consumers with low moral cost will engage in piracy, that is, their utility from pirating the enhanced DVD will be more than their moral cost of pirating. Although regional piracy appears to be protected by prices in Region B, the availability of enhanced DVDs due to common standards will allow for global piracy by some customers in Region B. In some cases, this problem may even require that the enhanced DVDs be not offered.

Lemma 3: The shutdown condition for Region A when $P_B \leq E_B + \beta_B^l < N_A(\theta_A - c)\theta_B$ and $E_A + \beta_A^l \geq P_A$ is given by $N_B(P_B - q_B c)(1 - \gamma_B) > N_A(P_A - P_B - q_A c + q_B c)$, where (q_A, P_A) and (q_B, P_B) are given by Lemma 2.

Corollary 1: When $E_B + \beta_B^l < P_B$ and $E_A + \beta_A^l \geq P_A$, then movie studio will not benefit from shutting down Region A.

Consumers of Region B defined in Lemma 3 include those who will engage in global piracy, but will not engage in regional piracy if the enhanced DVD is no more available, as the price of the regular DVD satisfies their utility requirements and pirating the same will yield a negative utility. Since consumers of Region A get a positive utility from buying DVD of Region B, not producing the enhanced DVD will force both customers of Regions A and B to buy the regular DVD. The shutdown condition itself is determined by comparing the profits when consumers from both regions buy the regular DVD with the profits when low moral value customers of Region B are allowed to pirate the enhanced DVD when it is offered. A special case of Lemma 3 is when even the high moral types in Region B will engage in global piracy and this is equivalent of taking $\gamma_B = 0$ in the expression. However, when the low moral types of Region B get a positive utility from regional piracy, shutting down Region A provides no relief, as given in Corollary 1. This is because the loss in surplus by shutting down Region A is not compensated by any change in pirating behavior of Region B's customers, as those who will pirate in Region B will continue to pirate Region B's own products. In other words, given an option, pirates in Region B will engage in global piracy, but when the enhanced product is not available, they will switch to regional piracy. Note that we assume that pirating only leads to a potential loss in revenue and no production cost is incurred for the pirated units.

Case 2: When Only Customers in Region A Engage in Piracy

In this situation, we assume that the moral costs of Region B's consumers are high, whereas those in Region A might be incentivized to pirate. Such a scenario implies that the prices charged are so high that even though moral and enforcement costs are relatively high in Region A some consumers may still find it optimal to pirate.

Lemma 4: When only the low moral-type customers in Region A will engage in piracy, that is, $E_B + \beta_B^l \geq \theta_A \theta_B$ and $E_A + \beta_A^l < P_A$, it is optimal for the movie studio to revise the prices of the enhanced DVD when $E_A + \beta_A^l > \gamma_A P_A + cq_A(1 - \gamma_A)$. The movie studio will need to pay a moral rent of $(P_A - (E_A + \beta_A^l))$ to the high moral types in Region A.

Lemma 4 informs us that in addition to any information rent paid to Region A to ensure that they only buy DVDs meant for their region (discussed in Proposition 1), due to variations in morality of customers in this region, the movie studio may have to lower its price further. This price incentive is the *moral rent* that is paid to ensure that customers continue to buy and not pirate. The construct of information rent in economics is introduced in problems with information asymmetry where the principal pays a high-type agent some rent (usually in the form of a price discount) so that the high-type agent is not enticed to buy the products designed for the low-types. This helps eliminate cannibalization of products when a firm adopts vertical segmentation strategies. Similarly, a moral rent prevents consumers with high moral cost from find-

ing piracy to be an attractive alternative and ensures legitimate buying behavior. Thus, if a moral rent of $(P_A - (E_A + \beta_A^l))$ is not paid, then consumers with β_A^h may be tempted to pirate.

Corollary 2: When all customers in Region A engage in piracy, that is, $E_B + \beta_B^l \geq N_A(\theta_A - c)\theta_B$ and $E_A + \beta_A^h < P_A$, the movie studio will be forced to revise its prices or stop offering enhanced DVDs. It is optimal for the movie studio to revise the prices of the enhanced DVD if $N_A(\gamma_A(E_A + \beta_A^h - cq_A) - (P_B - cq_B)) > ((q_A^2)/2)$, where q_A , q_B and P_B are given by Lemma 2. The movie studio will find it optimal to pay a moral rent to at least the high moral types in Region A.

Corollary 3: The movie studio will find it optimal to pay a moral rent to all customers in Region A if $(1 - \gamma_A)(E_A - cq_A) > \gamma_A\beta_A^h - \beta_A^l$.

If all consumers in Region A will pirate an enhanced DVD, if offered, then it may simply be best for the movie studio to only offer the regular DVD in which case sales from Region A will add to the sales from Region B. Corollary 2 reasons that some action is required on the part of the vendor and informs us that under some conditions it is actually optimal to revise the prices of the enhanced DVD, so that at least the high moral types in Region A might start buying. But if conditions described in Corollary 4 are also met, then the movie studio may actually be in a position to revise its prices so as to incentivize all customers in Region A to buy.

Case 3: When Consumers with Low Moral Cost in Both Regions Engage in Piracy

This is the most general situation when there are some customers in both regions who will engage in piracy. As discussed in Case 1, if the enhanced DVD is available, the customers in Region B who pirate will necessarily pirate only the enhanced DVD. Hence, it suffices to analyze the case when $E_B + \beta_B^l < N_A(\theta_A - c)\theta_B$ and $N_A(\theta_A - c)\theta_B < E_A + \beta_A^l < P_A$. The movie studio cannot provide price incentives in Region B to stop global piracy, and hence it has only three options: (1) persist with the global piracy in Region B and local piracy in Region A; (2) stop offering the enhanced DVD completely to stop global piracy; or (3) to revise prices of the enhanced DVD similar to Case 2 to stop local piracy in Region A.

Lemma 5: The movie studio will find it optimal to allow for global and regional piracy to exist, that is, does nothing if $N_A[\gamma_A(P_A - cq_A) - P_B + cq_B] - ((q_A^2)/2) > N_B(1 - \gamma_B)(P_B - cq_B)$ and $cq_A(1 - \gamma_A) > E_A - \gamma_A P_A$, where (q_A, P_A) and (q_B, P_B) are given by Lemma 2.

Corollary 4: The movie studio will find it optimal to stop offering the enhanced DVD and therefore stop global piracy if $N_A[\gamma_A(P_A - cq_A) - P_B + cq_B] - ((q_A^2)/2) < N_B(1 - \gamma_B)(P_B - cq_B)$ and $(1 - \gamma_B)N_B(P_B - cq_B) > N_A(E_A - \beta_A^l - P_B - c(q_A - q_B))$.

Corollary 5: The movie studio will find it optimal to revise the prices of the enhanced DVD and therefore stop regional piracy if $cq_A(1 - \gamma_A) < E_A - \gamma_A P_A$ and $(1 - \gamma_B)N_B(P_B - cq_B) < N_A(E_A - \beta_A^l - P_B - c(q_A - q_B))$.

Lemma 5 and Corollaries 4 and 5 are arrived at by comparing the profits depending upon the option exercised by the studio when consumers with low moral cost in both regions engage in piracy. The implications are that if the proportion of consumers pirating in Region A or Region B is sufficiently small then in all likelihood the studio will do nothing. However, in situations where these proportions are large enough (such that the first part of Corollary 4 is met), the studio's decision to completely stop offering the enhanced DVD or revise prices is contingent upon the nature of enforcement in Region A. If the combined punitive cost to the customers with low moral cost in Region A is sufficiently high, then the studio is likely to revise its prices. However, if this cost is low either due to low enforcement cost or low value of moral cost, then the studio may have no option but to shut down the production of enhanced DVDs and offer one DVD quality (given by Region B's quality) to both regions.

Cases 1, 2, and 3 provide us insights into the implications of piracy and the nature of the optimal vendor strategy in each of the cases. There are primarily two important themes here: First, people in Region B will always engage in global piracy and not regional piracy, and this piracy cannot be controlled by any price incentives. Thus, the movie studio can simply ignore global piracy, or completely shut down production of Region A's quality. However, shutting down the enhanced DVD offering does not imply that all piracy will stop as regional piracy by customers in both regions can still continue. Second, price incentives can be successfully employed in Region A to combat regional piracy. However, in order to persist with a vertical segmentation strategy (of offering two qualities) in the presence of piracy, the customer base in Region A should be sufficiently large or the pirates from Region B should be sufficiently small. Finally, the decision to shut down Region A versus revising prices is largely dependent on the nature of enforcement in the regions. This observation is intuitive and consistent with prior research on piracy and protection costs as well [8].

Implications of Global Piracy to Consumers and Producers of Intellectual Property

Our analysis of shutdown decisions faced by the vendor presents a very interesting and counterintuitive insight into the nature of global piracy. Note that although the movie studio considered shutting down (under some conditions) *Region B* when there was no piracy, in the presence of piracy threats it is *Region A* that would be considered for shutdown. This implies that when there is sufficient threat of global piracy, movie studios may not invest in creating enhanced DVDs, thus robbing the customers with high willingness-to-pay for quality of the opportunity to watch a superior quality DVD. Analysis of piracy in the music industry also finds that a large amount of piracy cannot only reduce industry profits but can also hurt consumers as it can eventually lead to fewer choices [7]. Similarly, our results also show that movie consumers themselves may become victims in the long run. So producers of intellectual properties should inform that it may not be optimal for consumers in high willingness-to-pay regions to turn a blind eye toward others engaging in piracy (even if they

themselves may not engage in piracy). It can clearly hurt their long-term interests as firms may have lesser incentive to produce high quality digital products.

Proposition 5: In case of global piracy, the information rent a movie studio pays to the consumers in the high marginal willingness-to-pay region decreases as the willingness-to-pay of the low region customers increases. However, the moral rent is increasing with the increasing willingness-to-pay of the low region customers.

Proposition 5 is again counterintuitive in that it argues that there may be cases where it may *not* be in a digital product vendor's interest when consumers from regions such as China (akin to Region B) begin to exhibit the same preference for quality as their counterparts in Western regions (akin to Region A). On the other hand, physical product vendors operating across the globe have strived to leverage commonality in consumer tastes for reasons of economies of scale in advertising costs, lower administrative complexity in managing a single global brand, lower costs of entry into new markets due to global reputation, and improved cross-border learning within organizations [26]. For example, companies such as PepsiCo market products developed initially for U.S. consumers to countries such as India, the United Kingdom, Russia, China, and Turkey and have been successful as well. Other global consumer brands such as McDonalds, Coca-Cola, Pizza Hut [21], and some financial services [30] are also known for such global, cross-regional promotions.

If there is no threat of piracy, commonality in tastes is beneficial to digital product vendors (such as the movie studio) as well as the information rent required to be paid to the Region A customers decreases with decreasing $(\theta_A - \theta_B)$. However, when there is piracy, vendors also need to pay a moral rent to consumers with high moral cost so that they are not tempted to pirate. We can provide two explanations to Proposition 5. First, as the willingness-to-pay of Region B's consumers increases, the enhanced quality DVD offered to Region A becomes more attractive to them (Region B). However, given that B types cannot afford to buy at Region A's prices and the combined punitive cost remains the same, the attractiveness of piracy increases with increasing θ_B . Hence, any moral rent to be paid is also increasing in θ_B . Similarly, research on music piracy has also argued that "star acts" are most vulnerable global music piracy as they are attractive to consumers across the globe [6]. Second, as θ_B increases the information rent to A types decreases and hence the price (P_A) that the studio can charge in Region A increases. Hence, the moral rent paid to the consumers with high moral cost in Region A increases (as the moral rent is given by the difference between P_A and the combined punitive cost). An important recommendation to the studio is that as it invests in making a Britney Spears video attractive to customers in China, it also needs to consider the possibility of increased global piracy and increasing moral rent it may need to pay and hence make efforts to increase legal and technological protection mechanisms in China as well.

We now analyze the implications to piracy when the movie studio is able to maintain two separate standards for the two regions.

Piracy When Separate Standards are Employed in Regions A and B

When the DVD standards are different in the two regions ($S_A \neq S_B$), then a DVD sold in one region cannot be operated by a DVD player in the other region, and thus it automatically obviates any global piracy. Hence, the pricing decision of the vendor has to only accommodate regional piracy in A and B. As discussed in the “Regional Differences in Technology Standards for DVDs” subsection, Lemma 1, separate standards also imply that no equivalent of an information rent needs to be paid to Region A. Hence, the movie studio will evaluate its losses in profit due to piracy with the prices set by Lemma 1, that is, P_A^* and P_B^* . We consider a general case where there are at least some customers (low moral types) in Region A and Region B who will prefer to pirate products available in their own region.

Lemma 6: The movie studio will find it optimal to revise the prices of its DVD offerings when $P_A^ < ((E_A + \beta_A^l - cq_A^*(1 - \gamma_A))/\gamma_A)$ and $P_B^* < ((E_B + \beta_B^l - cq_B^*(1 - \gamma_B))/\gamma_B)$, where P_A^* , P_B^* , q_A^* , and q_B^* are given by Lemma 1. The movie studio will provide a moral rent to the high moral types in both the regions. The moral rent for Regions A and B would be $P_A^* - (E_A + \beta_A^l)$ and $P_B^* - (E_B + \beta_B^l)$.*

Proposition 6: For all comparable cases of piracy (positions of the moral band), the profit to the studio when the standards are separate is always greater than the profit when the DVD technology standards are the same.

Table 4 compares the profits for all positions of the moral band under common and separate standards. We can observe that the profit when the standards are separate is always higher for any comparable case when the standards are common. There are two reasons for this increased profit: first, when standards are separate, there are no losses due to global piracy, and second, when the standards differ, the movie studio does not need to pay the equivalent of information rent to Region A. Note that the strategies involved and revenues earned in presence of regional piracy remain the same in common and separate standards situation. Also note that while information rent is fully eliminated when standards are separate, the studio may still have to pay a moral rent to combat regional piracy.

Discussion and Conclusion

RESEARCH IN ECONOMICS, IS, AND MARKETING has explored product differentiation through quality segmentation in the context of physical products [9] and versioning of information goods [3, 29]. Although it is well known that information goods can suffer from piracy, there is currently little research that has studied segmentation strategies in the presence of piracy. Our research extends IS research on software and music piracy to study movie piracy and segmentation strategies that can be employed in this industry. Similarly, the role of standards has primarily been explored from the perspective of positive externality benefits for producers and consumers from compatible technologies. We extend this notion to examine the impact of maintaining common and separate standards in DVD technology on global movie piracy.

Table 4. Comparison of Profits Under Common and Separate Standards

Nature of piracy	Profits when standards are common ($S_A = S_B$)	Profits when standards are separate ($S_A \neq S_B$)
<p>Case 1: When only customers in Region B engage in piracy (Lemma 3 and Corollary 1)</p> <p>Studio does NOT offer enhanced DVD</p>	$\pi_c = (N_A + N_B)(P_B - cq_B) - \frac{q_B^2}{2}$	$\pi_s = (N_A + N_B)(P_B^* - cq_B^*) - \frac{(q_B^*)^2}{2}$
<p>Studio continues to offer enhanced DVD</p>	$\pi_c = N_A(P_A - cq_A) - \frac{q_A^2}{2} + \gamma_B N_B(P_B - cq_B) - \frac{q_B^2}{2}$	$\pi_s = N_A(P_A^* - cq_A^*) - \frac{(q_A^*)^2}{2} + \gamma_B N_B(P_B^* - cq_B^*) - \frac{(q_B^*)^2}{2}$
<p>Case 2: When only customers in Region A engage in piracy (Lemma 4 and Corollaries 2 and 3)</p> <p>Studio takes no action</p>	$\pi_c = \gamma_A N_A(P_A - cq_A) - \frac{q_A^2}{2} + N_B(P_B - cq_B) - \frac{q_B^2}{2}$	$\pi_s = \gamma_A N_A(P_A^* - cq_A^*) - \frac{(q_A^*)^2}{2} + N_B(P_B^* - cq_B^*) - \frac{(q_B^*)^2}{2}$
<p>Studio does NOT offer enhanced DVD</p>	$\pi_c = (N_A + N_B)(P_B - cq_B) - \frac{q_B^2}{2}$	$\pi_s = (N_A + N_B)(P_B^* - cq_B^*) - \frac{(q_B^*)^2}{2}$
<p>Studio offers moral rent to only the customers with high moral cost in Region A</p>	$\pi_c = \gamma_A N_A(E_A + \beta_A^H - cq_A) - \frac{q_A^2}{2} + N_B(P_B - cq_B) - \frac{q_B^2}{2}$	$\pi_s = \gamma_A N_A(E_A + \beta_A^H - cq_A^*) - \frac{(q_A^*)^2}{2} + N_B(P_B^* - cq_B^*) - \frac{(q_B^*)^2}{2}$

(continues)

Table 4. (Continued)

Nature of piracy	Profits when standards are common ($S_A = S_B$)	Profits when standards are separate ($S_A \neq S_B$)
<i>Case 2: (Continued)</i>		
Studio offers moral rent to all customers in Region A	$\pi_c = N_A(E_A + \beta'_A - cq_A) - \frac{q_A^2}{2} + N_B(P_B - cq_B) - \frac{q_B^2}{2}$	$\pi_s = N_A(E_A + \beta'_A - cq_A) - \frac{(q_A^*)^2}{2} + N_B(P_B - cq_B) - \frac{(q_B^*)^2}{2}$
<i>Case 3: When customers in both regions engage in piracy (Lemma 5 and Corollaries 4 and 5)</i>		
Studio takes no action	$\pi_c = \gamma_A N_A(P_A - cq_A) - \frac{q_A^2}{2} + \gamma_B N_B(P_B - cq_B) - \frac{q_B^2}{2}$	$\pi_s = \gamma_A N_A(P_A - cq_A) - \frac{(q_A^*)^2}{2} + \gamma_B N_B(P_B - cq_B) - \frac{(q_B^*)^2}{2}$
Studio does NOT offer enhanced DVD	$\pi_c = (N_A + N_B)(P_B - cq_B) - \frac{q_B^2}{2}$	$\pi_s = (N_A + N_B)(P_B - cq_B) - \frac{(q_B^*)^2}{2}$
Studio offers moral rent to only the customers with high moral cost in Region A	$\pi_c = \gamma_A N_A(E_A + \beta'_A - cq_A) - \frac{q_A^2}{2} + N_B(P_B - cq_B) - \frac{q_B^2}{2}$	$\pi_s = \gamma_A N_A(E_A + \beta'_A + cq_A) - \frac{(q_A^*)^2}{2} + N_B(P_B - cq_B) - \frac{(q_B^*)^2}{2}$

The theoretical contributions of our research are twofold. First, it provides a simple contract-theoretic framework to study digital product pricing in the context of piracy. Our findings shed light on the role of maintaining common versus separate technology standards across two regions that differ in consumer and protection characteristics. As opposed to externality benefits identified in the economics literature, our findings argue against having common technology standards under threats of piracy. Second, our research adds to the literature on piracy and it develops the concept of global and regional piracy. Whereas prior research on piracy has primarily focused on the role of protection mechanisms, this paper sheds light on consumer behavior when both a high- and a low-quality product are available due to common standards. We point out that the loss in revenue from global piracy when a customer from Region B pirates a DVD meant for Region A (higher marginal willingness-to-pay), is still a loss in Region B's market and not Region A's market. This is unlike stealing a physical product where the loss is based on what is stolen rather than what may be potentially purchased.

From a managerial perspective, it offers important recommendations to movie studios. We discuss how quality segmentation can be employed for optical disc markets, and suggest that there can be implications to piracy in maintaining separate regional codes (or some other technology standard) in DVD players even if it was conceived only to time the theatrical and home release of movies. Our findings recommend the movie studios to always maintain separate standards across regions when the consumer and copyright enforcement characteristics differ. This implies that studios should work with technology manufacturers (including DVD and computer makers) to develop region-wise standards across the globe. Our results also find that in the case of piracy, producing high-quality products for consumers in developed regions (with higher marginal willingness-to-pay for quality) may not be profitable to studios. This suggests that producers should do a better job of educating how consumers in this region should not turn a blind eye toward piracy as it will eventually result in a loss of quality for their region. As a result, consumers in Western regions may be less inclined to create and propagate DVD cracking codes such as DeCSS. Our results would suggest aggressive advertisements and other campaigns that inform how the consumers themselves stand to suffer rather than focusing on the artists' loss alone.

Another important counterintuitive finding relates to vendor perceptions of uniformity in tastes across global markets. Common consumer brands such as Pepsi Cola and Coca-Cola have benefited from global recognition and preference for their originally U.S.-based brands. However, we point out that for digital products that can suffer from piracy problems homogenization of consumer tastes may not spell profits all the time. Such commonality in tastes without sufficient uniformity in copyright protection mechanisms can actually result in significant losses to the movie studio. Hence, our findings recommend that movie studios continue to work on the global equality in copyright laws for all digital products. Therefore, as a strategy, digital product firms should desist from engaging in advertising and other activities that lead to homogenization of tastes, until suitable efforts on copyright protection have been made across all regions.

Pricing Strategies for Other Intellectual Property Suffering from Threats of Imitation

Our findings are also applicable to other products that are based on intellectual property rights such as books and pharmaceuticals. The common theme among these products is that producers stand to lose from piracy or imitation of their high-quality products in regions where there is scant protection for copyright. In such situations, the producers may have little choice but to create a low-quality product available at a very low price for this segment. For example, the hardcover version of the textbook *Consumer Behavior*, by Schiffman and Kanuk, is priced at \$117.33 in the United States and in India (where the average income is \$460 per year), the publisher Prentice Hall provides an Eastern economy edition of this book (paperback, cheaper quality paper) for Rs 225 (approximately \$5). Given that photocopying the book costs only about \$3, the relatively poor enforcement in India could lead a majority of the consumers to pirate if the book was offered at the U.S. market price. Thus employing pricing techniques prescribed for physical product segmentation (with no threat of piracy) such as Desai's [9] may not be appropriate as they will result in much higher prices for the lower quality products. In this regard, anecdotal evidence (news.bbc.co.uk/2/hi/business/2012099.stm) also suggests that piracy rates fell drastically after Indian music firms reduced "haywire prices" set by multinationals.

In the pharmaceutical industry, many U.S. and Western drug companies face stiff competition in countries, such as India, where local companies thrive by imitating the drugs from the West. This is reflective of the prevalent copyright, for example, in India, only process patents and not product patents are recognized [17], hence allowing local companies to develop alternative processes of manufacturing the same product or drug.⁵ However, in the absence of additional tariffs, U.S. drug companies can successfully compete in these markets by producing a cheaper quality of the U.S. drug. In such situations, care must be taken that the cheaper product is not available to the U.S. customers (equal to common standards), or else the information rent that would need to be paid to the U.S. customers could become prohibitive. When these rules are lax, some customers who are from the high-quality region but whose utility is satisfied by the low-quality product will prefer to buy the low-quality product. This would explain why there are upward of 1,000 pharmacies in Tijuana, Mexico, in contrast to 125 pharmacies across the border in San Diego. In order for the U.S. pharmaceutical firms to operate profitably across both regions, say the United States and Mexico, our findings would argue that not only do they need to create a low-price/quality drug for Mexico, but also invest in strict customs regulation that prevents a Mexican drug from being brought into the United States.

Limitations and Future Research

Our research has fixed the quality levels exogenously as determined by the seller prior to any expectations of piracy. Whereas realistic in current day production of DVDs, it may be interesting to vary quality as well. This would allow strategies to be

formulated at the production stage itself, rather than relying only on pricing strategies during marketing. Further, our research has not explicitly considered potential positive externality benefits of pirating, that is, more piracy can imply greater buzz for the movie and hence potentially a larger legitimate user base. We should also note that the legality of RMIC is being challenged in the court of law as legitimate consumers who may buy in one region may not be able to watch their movies in another region.⁶ However, we would like to emphasize here that our research does not view RMIC itself as the final solution for segmentation, rather it explores the impact of maintaining separate standards across the globe just as NTSC and PAL standards do today for television. Further thought needs to be given to the development of standards as digital distribution of movies begins to unfold and global segmentation becomes infeasible through technology. In such an event, pricing for self-selection along with effective legal and technological piracy deterrents may play a much more important role in combating piracy. Other strategies such as product sampling may also be employed to incentivize consumers who may pirate just to evaluate [4].

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NOTES

1. This claim may be invalidated if indeed piracy of music is higher in the United States as compared to other countries, although this has not been studied and may be attributed to easier Internet access in the United States.
2. Note that our analysis does not include DVD renting. Our consumers derive utility from buying and owning a DVD. We thank one of the anonymous reviewers for bringing these two points to our attention.
3. A consumer could technically buy a DVD player from another region, for example, a U.S. consumer could purchase a Singapore DVD player that plays discs for the Singapore region. There are even multiregion disc players. We ignore these possibilities in our current research.
4. There are two trivial cases. First, when $E_B + \beta_B^l \geq N_A(\theta_A - c)\theta_B$ and $E_A + \beta_A^l \geq P_A$, which implies that no customer in either region will pirate. Second, when $E_A + \beta_A^h < P_A$ and $E_B + \beta_B^h < P_B$, which implies that consumers in both regions will pirate. We ignore these trivial cases.
5. With WTO rules taking root, this situation could be challenged even if the industry within India is in favor of the current model.
6. We would like to thank one of the anonymous reviewers for bringing this to our attention.

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Appendix

Proofs of Lemmas and Propositions

THE GENERAL PROFIT-MAXIMIZATION PROBLEM for the movie studio is

$$\max_{\{(q_A, p_A), (q_B, p_B)\}} \left[N_A p_A - \frac{q_A^2}{2} - c N_A q_A + N_B p_B - \frac{q_B^2}{2} - c N_B q_B - a \right] \quad (A1)$$

subject to individual rationality (IR) constraints given by

$$\begin{aligned} \theta_A q_A - p_A &\geq 0 & \text{IR}_A \\ \theta_B q_B - p_B &\geq 0 & \text{IR}_B \end{aligned} \quad (A2)$$

Proof of Lemma 1. The studio will set prices and quality such that both IRs are binding and maximizes the surplus extraction. Thus the studio will always set $p_A = \theta_A q_A$ and $p_B = \theta_B q_B$. Substituting P_A and P_B in Equation (A1) and setting FOCs to zero gives the optimal quality for each region as $Q_A^* = N_A(\theta_A - c)$ and $Q_B^* = N_B(\theta_B - c)$, and the price contracts will be given by $P_A^* = N_A \theta_A (\theta_A - c)$ and $P_B^* = N_B \theta_B (\theta_B - c)$. The profit can be written as $\Pi^* = ((N_A^2(\theta_A - c)^2 + N_B^2(\theta_B - c)^2)/2) - a$.

Proof of Lemma 2. In addition to Equations (A1) and (A2), incentive compatibility (IC) given by Equation (A3) need to be satisfied.

$$\begin{aligned} \theta_A q_A - p_A &\geq \theta_A q_B - p_B & \text{IC}_A \\ \theta_B q_B - p_B &\geq \theta_B q_A - p_A & \text{IC}_B \end{aligned} \quad (A3)$$

IR_B and IC_A immediately imply IR_A , therefore we ignore IR_A and IR_B is binding. Similarly, IC_A is binding (see Loffont and Martimort [20] for basic development of contracts under asymmetry). Therefore, both IR_B and IC_A must be binding at the optimum. This gives us $p_B = \theta_B q_B$ and $p_A = \theta_A q_A - (\theta_A - \theta_B) q_B$, and substituting them in Equation (A1), and setting FOCs to zero, we get the optimal contracts as

$$\begin{aligned} P_A &= N_A \theta_A (\theta_A - c) - (\theta_A - \theta_B) [N_B (\theta_B - c) - N_A (\theta_A - \theta_B)], \\ Q_A &= Q_A^* = N_A (\theta_A - c) \end{aligned}$$

and

$$\begin{aligned} P_B &= N_B \theta_B (\theta_B - c) - N_A \theta_B (\theta_A - \theta_B), \\ Q_B &= N_B (\theta_B - c) - N_A (\theta_A - \theta_B). \end{aligned}$$

Proof of Proposition 1. QED. ($\Pi^* > \Pi$)

Proof of Proposition 2. The vendor will not offer the low-quality product for Region B if the profits are less than or equal to zero, therefore, we need to have $N_B P_B - (q_B^2/2) - cN_B q_B > 0$. Since $P_B = \theta_B q_B$, we have $N_B q_B [\theta_B - (q_B/2) - c] > 0$. Hence, we need nonzero quality and the factor inside the square brackets to be nonzero, that is,

$$N_B (\theta_B - c) - N_A (\theta_A - \theta_B) > 0$$

and

$$\theta_B - \frac{N_B (\theta_B - c) - N_A (\theta_A - \theta_B)}{2} - c > 0.$$

Therefore,

$$\frac{N_B}{N_A} > \left(\frac{\theta_A - \theta_B}{\theta_B - c} \right)$$

and

$$N_B - N_A (\theta_A - \theta_B) < 2(\theta_B - c)$$

in order for Region B to remain profitable.

Proof of Proposition 3. The quality of enhanced DVD produced for Region A is always greater than the quality of DVD meant for Region B, $q_A > q_B$. Given that $\theta_B q_A - (\beta_B^i + E_B) > \theta_B q_B - (\beta_B^i + E_B)$, $i = \{l, h\}$, consumers will always pirate q_A .

Proof of Proposition 4. For enhanced quality DVD, $q_A = N_A(\theta_A - c)$. Hence, the utility to consumers in Region B in pirating/buying Region A's DVD is $\theta_B q_A = \theta_B N_A(\theta_A - c)$. Hence, no consumer in Region B will pirate if the combined cost of the low moral cost consumer, $\beta_B^l + E_B \geq N_A \theta_B (\theta_A - c)$.

Proof of Lemma 3. The profit, when no one in Region A pirates *and* only the low moral types in Region B pirate, is given by $[\gamma_B N_B (P_B - c q_B) - (q_B^2/2) + N_A (P_A - c q_A) - (q_A^2/2)]$, that is, all high moral types of Region B (proportion γ_B) are buying q_B at P_B , and everybody in Region A is buying q_A at P_A . Suppose the firm shuts down the enhanced DVD, then only quality q_B at price P_B is available for Region A customers as well. And since they derive a positive utility from q_B as well, they will buy. By the given condition ($P_B \leq E_B + \beta_B^l < N_A (\theta_A - c) \theta_B$ and $E_A + \beta_A^l \geq P_A$) when Region A is shut down, pirates in Region B who had previously pirated product A, will not pirate any product. Hence, the profit is given by $[N_A (P_B - q_B c) + N_B (P_B - q_B c) - (q_B^2/2)]$, and shutdown is optimal when this profit is greater than the profit without shutdown. Therefore, the shutdown condition can be derived when

$$\begin{aligned}
& \left[N_A (P_B - q_B c) + N_B (P_B - q_B c) - \frac{q_B^2}{2} \right] \\
& > \left[\gamma_B N_B (P_B - q_B c) - \frac{q_B^2}{2} + N_A (P_A - q_A c) - \frac{q_A^2}{2} \right] \\
\Rightarrow N_B (P_B - q_B c) (1 - \gamma_B) & > N_A (P_A - P_B - q_A c + q_B c) - \frac{q_A^2}{2}.
\end{aligned}$$

Substituting the values of (q_A, P_A) and (q_B, P_B) from Lemma 2, we get

$$N_B (P_B - q_B c) (1 - \gamma_B) > N_A (P_A - P_B - q_A c + q_B c).$$

Proof of Corollary 1. QED. If the combined costs of pirating to the consumers with low moral cost is less than the price charged for that region *and* there is no piracy in Region A, then even if the enhanced DVD offering is shut down, some consumers $(1 - \gamma_B)$ will continue to pirate. They will now pirate Region B's DVD.

Proof of Lemma 4. When no one pirates in Region B, and only consumers of Region A with low moral cost engage in piracy, then the profit is given by

$$\pi_1 = \text{Profit from Region B} + \left(\gamma_A N_A (P_A - c q_A) - \frac{q_A^2}{2} \right).$$

The profit when a moral rent is paid so as to bring down the price of the enhanced DVD to $(E_A + \beta_A^l)$ so that no customer from Region A pirates, is given by

$$\pi_2 = \text{Profit from Region B} + N_A (E_A + \beta_A^l - c q_A) - \frac{q_A^2}{2}.$$

Hence, the condition when paying a moral rent is optimal is when $\pi_2 > \pi_1$

$$\begin{aligned}
\Rightarrow N_A (E_A + \beta_A^l - c q_A) - \frac{q_A^2}{2} & > \gamma_A N_A (P_A - c q_A) - \frac{q_A^2}{2} \\
\Rightarrow E_A + \beta_A^l & > \gamma_A P_A + c q_A (1 - \gamma_A).
\end{aligned}$$

Proof of Corollaries 2 and 3. When everyone in Region A pirates (no one from Region B pirates), then the studio cannot extract any revenue from this region and hence the studio has **four** alternatives:

1. Do nothing. The profits are given by $\pi = N_B (P_B - c q_B) - (q_B^2/2)$.
2. The studio can shut down Region A so that at all consumers of Region A buy the lower-quality product. The profit in this case is given by $\pi_1 = (P_B - c q_B)(N_A + N_B) - (q_B^2/2)$.

3. Lower the enhanced DVD price to $E_A + \beta_A^h$ so that the consumers with high moral cost in Region A stop pirating and buy the product. The profit from this strategy is given by $\pi_2 = N_B(P_B - cq_B) - (q_B^2/2) + \gamma_A N_A(E_A + \beta_A^h - cq_A) - (q_A^2/2)$.
4. Lower the enhanced DVD price to $E_A + \beta_A^l$, so that all consumers in Region A stop pirating and buy the product. The profit from this strategy is given by $\pi_3 = N_B(P_B - cq_B) - (q_B^2/2) + N_A(E_A + \beta_A^l - cq_A) - (q_A^2/2)$. $\pi < \pi_1$, $\pi < \pi_2$, and $\pi < \pi_3$. Therefore its optimal for the studio to revise the prices.

Corollary 2 describes the case when $\pi_2 > \pi_1$, and Corollary 3 describes the case when $\pi_3 > \pi_2$.

Proof of Lemma 5 and Corollary 4 and 5. When consumers of low moral cost in both regions engage in piracy, that is, consumers with β_A^l in Region A engage in regional piracy and consumers with β_B^l in Region B engage in global piracy, the studio has three options:

1. Do nothing. The profits are given by $\pi_1 = \gamma_B N_B(P_B - cq_B) - (q_B^2/2) + \gamma_A N_A(P_A - cq_A) - (q_A^2/2)$.
2. The studio can shut down Region A so that at all consumers of Region A buy the lower-quality product. The profit in this case is given by $\pi_2 = (N_A + N_B)(P_B - cq_B) - (q_B^2/2)$.
3. Lower the enhanced DVD price to $E_A + \beta_A^l$, so that the consumers with low moral cost in Region A stop pirating and buy the product. The profit from this strategy is given by $\pi_3 = \gamma_B N_B(P_B - cq_B) - (q_B^2/2) + N_A(E_A + \beta_A^l - cq_A) - (q_A^2/2)$.

Lemma 5 describes the case when $\pi_1 > \pi_2$ and $\pi_1 > \pi_3$.

Corollary 4 describes the case when $\pi_2 > \pi_1$ and $\pi_2 > \pi_3$.

Corollary 5 describes the case when $\pi_3 > \pi_1$ and $\pi_3 > \pi_2$.

Proof of Lemma 6. In the case of separate standards, there is no global piracy. We are considering the case in which only the low moral types in both the regions engage in piracy. If the studio lowers the price to $E_A + \beta_A^l$ in Region A, then there will be no piracy in Region A. Similarly, if the studio lowers the price to $E_B + \beta_B^l$ in Region B, then there will be no piracy in Region B. We can analyze the profits in each region separately as the decision in one region will not affect the strategy in the other.

With piracy, the profits in Region A are $\pi_A^1 = \gamma_A N_A(P_A^* - cq_A) - (q_A^2/2)$, and when the prices are lowered to $E_A + \beta_A^l$, the profits in Region A are $\pi_A^2 = N_A(E_A + \beta_A^l - cq_A) - (q_A^2/2)$. Hence, the studio will lower prices in Region A when $\pi_A^1 < \pi_A^2$, that is, $\pi_A^* < ((E_A + \beta_A^l - cq_A)(1 - \gamma_A))/\gamma_A$.

Similarly, the profits in Region B with piracy are $\pi_B^1 = \gamma_B N_B(P_B^* - cq_B) - (q_B^2/2)$, and when the prices are lowered to $E_B + \beta_B^l$, the profits in Region B are $\pi_B^2 = N_B(E_B + \beta_B^l - cq_B) - (q_B^2/2)$. Hence, the studio will lower prices in Region A when $\pi_B^1 < \pi_B^2$, that is, $P_B^* < ((E_B + \beta_B^l - cq_B)(1 - \gamma_B))/\gamma_B$.

Proof of Proposition 5. In the case of global piracy, the *information rent* (IRENT) is given by $P_A^* - P_A$

$$\begin{aligned} \Rightarrow \text{IRENT} &= P_A^* - P_A = N_A \theta_A (\theta_A - c) - N_A \theta_A (\theta_A - c) - N_A \theta_A (\theta_A - c) \\ &\quad - (\theta_A - \theta_B) [N_B (\theta_B - c) - N_A (\theta_A - \theta_B)] \end{aligned}$$

and the *moral rent* (MRENT) is given by $P_A - (E_A + \beta_A^i)$, $i = \{l, h\}$. Therefore, the moral rent can be written as

$$\begin{aligned} \Rightarrow \text{MRENT} &= N_A \theta_A (\theta_A - c) - (\theta_A - \theta_B) [N_B (\theta_B - c) - N_A (\theta_A - \theta_B)] \\ &\quad - (E_A + \beta_A^i), i = \{l, h\}. \end{aligned}$$

Further, in order for the two regions to operate, from Proposition 2 we have $(N_B/N_A) > ((\theta_A - \theta_B)/(\theta_B - c))$. Assuming a fixed θ_A , we have $(\partial(\text{IRENT})/\partial\theta_B) = -\partial P_A/\partial\theta_B$, as P_A^* does not depend on θ_B . Similarly, $(\partial(\text{MRENT})/\partial\theta_B) = -\partial P_A/\partial\theta_B$. Further, in order for the two regions to operate, from the conditions given by Proposition 2, $\partial P_A/\partial\theta_B$ is always positive. Therefore, $\partial(\text{IRENT})/\partial\theta_B$ is always negative and $\partial(\text{MRENT})/\partial\theta_B$ is always positive. Hence, IRENT is decreasing and MRENT is increasing as the marginal willingness-to-pay of the low type is increasing.

Proof of Proposition 6. As we observed from Lemmas 1 and 2, $(P_A^* - cq_A^*) - ((q_A^*)^2/2) > (P_A - cq_Q) - (q_A^2/2)$ and $(P_B^* - cq_B^*) - ((q_B^*)^2/2) > (P_B - cq_B) - (q_B^2/2)$, hence in all the cases discussed in this proposition, we have $\pi_s > \pi_c$. QED