ECONOMICS OF MOVIE PIRACY:
THEATRE MOVIES AND DVDS

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Abstract

With the rapid advancement of technology, movie piracy has become a real concern to the movie industry. Many movie producers lament about how the existence of rampant movie piracy has greatly reduced their profits, and they take concerted efforts in fighting both online and hard goods piracy. In order to evaluate how movie piracy has affected both movie producers and consumers, we develop a simple theoretical model consisting of both the traditional theatrical movie market and the modern digital video discs (DVD) market. While prices, demand and profits of movie theatres and DVDs are adversely affected by movie piracy, consumers gain most with an early availability of pirated movies. However when taking into consideration the overall social welfare, it is best to protect the movie industry against piracy in the first period, and allow consumers to enjoy the availability of free pirated copies in the second period.

Keywords: Movie piracy, theatrical movies, digital video discs (DVDs), welfare

1. INTRODUCTION

1.1. Objective

According to the 2006 report[1] by the Motion Picture Association of America (MPAA), the film and television industry is one major private-sector employer responsible for over 1.3 million jobs and with a total payroll worth over US$30 billion in the United States. The movie industry is definitely one important driving force behind the American economy and this fact forces MPAA to invest millions every year in fighting piracy all around the world.[2] They track down the pirates, work with governments for the enactment and enforcement of adequate intellectual property right laws, educate the public about the dire consequences of piracy and also seek revolutionary ways to address the problem through new technology and complementary business practices.

The damage that piracy does to the movie industry must have been substantial to warrant such intense anti-piracy effort by MPAA. The Institute of Policy Innovation (IPI) report[3] of 2006 attempted to estimate the true cost of piracy to the American economy. It acknowledged that in 2005, the direct loss of major U.S. movie companies to piracy was about US$6.1 billion, but this amount did not include losses sustained indirectly by "downstream" industries like motion picture theatrical exhibitors or the video industry legitimately selling or renting U.S. motion pictures to consumers, or all other intermediate losses sustained by the many U.S. industries that would have supplied inputs for the motion picture industry. In reality, the true cost should be a total output loss of US$20.5 billion per year, loss of annual earnings for all U.S. workers amounting to US$5.5 billion, and 141,030 jobs that would otherwise have been created. In addition, the federal, state, and local governments are deprived of US$837 million in tax revenues each year.

The above estimates of the economic devastation that movie piracy can possibly do to the American economy are also highlighted in the recent report[4] by the Los Angeles County, where Hollywood is based in. One important point to note from the report is that movie piracy has evolved into a real threat with the advancement of digital technology, as faster computer processors and better internet connections has

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[1] For full report, please visit
http://www.mpaa.org/press_releases/mpa%20us%20economic%20impact%20report_final.pdf
[2] For more information, please visit http://www.mpaa.org.
[3] The full report is IPI Policy Report #186, please visit http://www.ipi.org/.
[4] For full report, please visit http://www.laedc.org/consulting/projects/2007_piracy-study.pdf

overturned the proposition that movies are protected from online piracy due to difficulties in transferring large digital files.

Interestingly, the same digital technology advancement is injecting new life into the movie business. As the MPAA chief, Dan Glickman, has described, viewers today not only go to the theatres to watch movies, there are also increasing demand for Digital Video Discs (DVDs) and legal online downloads, hence he encouraged the movie industry to embrace new digital technologies in order to capture the huge potential in DVDs and online markets.[5]

In view of these new developments in the movie industry, we aim to study the impact on piracy on the movie industry, hoping to contribute to the general study on movie piracy by including the more recent movie distribution channel- DVDs. A two-period model will be set up based on the utility of a consumer. Then we will consider the various scenarios of whether piracy exists, and in which period it begins. We have to structure such that DVDs only exist in the second period, as it follows theatre releases. From there, we derive the demand, prices and profits of theatrical movies and DVDs sales and proceed to analyze the impact of piracy on both markets by comparing profits across the various scenarios. Lastly, we aim to conduct a comprehensive social welfare analysis by taking into account consumer surpluses and balancing it with the earlier derived producers' profits.

1.2 The Movie Business

The *2006 U.S. Theatrical Market Statistics[6]* by MPAA shows that the average cost to make and market a major MPAA member company film was US$100.3 million in 2006. This consists of US$65.8 million in production costs and US$34.5 million in marketing costs. Unfortunately, six out of ten movies never recoup their original investment. This unfortunate phenomenon could be attributed to the complexity of the relationship between the theater and video markets and of course, the detrimental effect of piracy.

As described in *A Concise Handbook of Movie Industry Economics (2005)*, the movie industry today is extended beyond the local box-office, as other revenue sources such as foreign cinemas, retail merchandise sales and the DVD rental and

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[5] For full press release, please visit
http://www.hollywoodreporter.com/hr/content_display/news/e3if463a30783104b1044bbb6da4dec1f62

[6] Statistics from http://www.mpaa.org/2006-US-Theatrical-Market-Statistics-Report.pdf

sales markets are in fact contributing more than half of total revenue for each film. For example, Disney's *The Lion King* is released in the theatres in 1994, and what followed was an array of ancillary markets such as consumer products, theme-park attractions, videos (a year later in 1995) and even a live theatre show in 1997. Of Disney's US$1 billion revenue, U.S. box-office only contributed fifteen percent; in fact the dramatic growth in the DVD sales market has shifted the focus for movie producers from the theatres to the video markets.

The DVD market[7] can only become more significant in the future, especially with an 85% DVD penetration rate into American television households. Moreover, the sales of DVDs have increased from 600 million copies in 2002 to 1300 million copies in 2006 with an average price US$22 per DVD title. Even though it is undeniable that the DVD market looks promising for the movie industry, this same market also increases the complexity of the movie business as it is a market that is intricately linked to box-office performance.

The timing game between a movie's theatrical release and its DVD release is the most challenging in the movie industry today. DVD releases are usually arranged to follow theatrical movie releases, however it is hard to decide how long the time lag should be. If the DVD is introduced too early, it may dissipate away the profits from the box-office; but if the DVD is released too long after the movie is off the cinema screens, the hype and commercial value could be long gone. That is to say, because of the growing importance of the DVD market, the movie producers have to access the degree of complementary and substitutability between theatre movies and DVDs.

The difficulty of the timing game is increased by the existence of movie piracy. Illegal online downloads can appear as early as when the movie is first screened in the cinemas, or pirated DVDs can be available alongside original DVDs. It is not only difficult to gauge when pirated copies will be available, their varying level of quality also makes it hard to ascertain the effects of piracy on the movie industry. And of course, much financial resources would have to set aside for anti-piracy efforts.

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[7] Statistics from http://www.mpaa.org/USEntertainmentIndustryMarketStats.pdf

1.3 Nature of Movie Piracy

According to the MPAA website, piracy is "the unauthorized taking, copying or use of copyrighted materials without permission". [8] In an analysis prepared by L.E.K. Consulting for MPAA on The Cost of Movie Piracy[9], out of the US$6.1 billion loss of U.S. motion picture studios to piracy, $3.8 billion was lost to hard goods piracy, while US$2.3 billion was lost to Internet piracy. So what exactly are Internet piracy and hard goods piracy?

Internet piracy is "is the downloading or distribution of unauthorized copies of intellectual property such as movies, television, music, games and software programs via the Internet". [10] People often download free illegal copies of movies from sharing networks, pirate websites or servers such as "Topsites", and its immense speed and easy navigation allows for the explosion of global Internet movie piracy. The primary source of pirated movies comes from those who secretly record films in theaters and sell them to individuals who will then distribute them on peer-to-peer (P2P) file sharing networks such as eDonkey and Limewire.

Another major form of piracy is hard goods piracy. It is done when people make illegal copies of movies in digital disc formats including DVD, DVD-R, CD, CD-R and VCD. These illegal hard goods are sold on online auction sites, via e-mail solicitation and by street vendors. The source of these pirated versions could either be an original DVD, an illegally copied DVD or simply an online pirated version of the movie, and together with the low cost of disc burning devices and blank discs, the proliferation of hard goods piracy now spins out of control.

1.4 Consumer's Valuation of Theatrical Movies, DVDs and Pirated Copies

The wide variety of movie genres, ranging from action, thrillers, horror flicks to comedy, heart-warming and cartoon animations, already proven the fact that consumers have different tastes that the movie industry hopes to cater to. In other

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[8] Literal meaning taken from http://www.mpaa.org/piracy_internet.asp.
[9] For full report, please visit http://www.mpaa.org/2006_05_03leksumm.pdf
[10] Literal meaning taken from http://www.mpaa.org/piracy_internet.asp

words, a movie is a typical experience good that consumers have to watch and value it based on personal preferences. Here it is rational to expect consumers to be spread along a continuum ranging from high valuation to low valuation.

For consumers who choose to watch an original movie in the theatres, paying the movie ticket price will only allow them to watch the movie once. They are likely to be the ones with the highest valuation as they are so eager to watch the movie when it first releases and they do not mind paying more for one-time viewing in order to enjoy the full movie experience in the theatres.

As for consumers who choose to wait for the original DVDs in the second period, they will pay more for a DVD because DVDs are durable goods that allow them to view the movie repeatedly. When taking this repeated viewing into account, a one-time view of the movie from a DVD should cost less than a movie ticket.[11] This group of DVD purchasers is likely to follow behind the theatrical movie-goers in terms of valuation, as they do not mind waiting for three to six months or even longer for the DVD releases and they have to be compensated with enhanced features such as language selection that is unique to DVDs.

The group with the lowest valuation is those who choose to watch the pirated version of the movie. There is negligible tangible cost in getting a pirated copy, especially when Internet is easily available and disc burners are installed in almost all computer processors today. It is reasonable to discount the utility obtained from pirated version of a movie as most pirated motion pictures are of inferior video and audio quality. Hence, pirated copies can never be on par in terms of quality with either the original theatrical movie or the original DVDs.

In order to better understand the workings and impact of movie piracy, we shall review some current literatures on movie piracy in the next chapter. With that, we hope to gain more insights into the available theoretical and empirical studies on movie piracy in order to help us in the modeling of movie piracy in this paper.

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[11] Full price of DVD $= P_d^{full} = P_d^{per\ view} + \delta\ P_d^{per\ view} + \delta^2 P_d^{per\ view} + \ldots = \dfrac{1}{1-\delta} P_d^{per\ view}$ such that $P_d^{full} > P^{movie} > P_d^{per\ view}$. The one-time rental fee of a DVD can be a good proxy for the cost of sold DVD per view. As from *A Concise Handbook of Movie Industry Economics (2005),* the average retail price of a DVD in 2002 was US$20.78, while the average movie ticket price was US$5.81 while the average DVD rental price was US$3.20.

2. LITERATURE REVIEW

Much research has been dedicated to the piracy of various information goods, especially for software and music. Although these researches could provide us some basic concepts that are related to movie piracy, there still lie fundamental differences between the characteristics of movies and that of software and music. In other words, while digital products share similar features, the nature and effect of piracy could be specific to each industry. Hence here we would like to concentrate on reviewing literatures on movie piracy specifically in order to achieve a more appropriate application to our modelling of movie piracy in the next chapter.

2.1 Studies on Movie Piracy

Chellappa and Shivendu (2002) first focussed on understanding offline movie piracy in a global context. They observed that movies are largely pirated by duplicating DVDs, VCDs and other physical media, and identified two forms of movie piracy that consumers engaged in: global and regional piracy. By setting up an analytical model to study the implication of maintaining separate technological standards of DVD players across regions on the piracy of movies, they found that having varying technology standards across regions is indeed effective in bringing down global piracy. It also allows movie producers to create movies of variable qualities and fix discriminatory global prices. Although it is unable to restrict regional piracy, the overall profits to the movie firms under variable technology standards are shown to be higher than when there is a common technology standard for DVD players internationally.

Chellappa and Shivendu (2003) then went on to further include the regional differences in the willingness to pay for quality. They found that piracy is not a victimless crime, as not only do producers suffer losses, consumers in regions with high willingness to pay for quality is also on the losing end. Also, increasing 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.

Marc Fetscherin (2004) instead explored the online aspect of movie piracy, in response to claims by the movie industry that peer-to-peer (P2P) networks such as KaZaA, Morpheus or Audiogalaxy are causing their sales to decline. The paper empirically showed that there is a very low probability of getting high quality movies on KaZaA, and because of that, the majority of consumers prefer to download

movies legally when he conducted further simulation analyses. His second simulation showed that the most important factors determining consumers' behaviour are: the risk of being caught, the perceived value of the original, the availability of high quality copies and the price of the original.

Joel Waldfogel and Rafael Rob (2006) observed that new information technologies have allowed the proliferation of unpaid distribution and redistribution (also known as "file-sharing" and "piracy") and such phenomenon has become a major problem for producers of information products such as music and movies. In order to measure the displacement effect of unpaid consumption (consisting of burned and downloaded copies) on paid consumption (including theatrical, television, rental and DVD ownership), they used a survey data on movie consumption by 500 University of Pennsylvania college students and ran an empirical analysis, using both cross-sectional and longitudinal approaches. They found that unpaid first consumption reduced paid consumption by 1 unit, while unpaid second consumption had a smaller effect of 0.2 units. On the overall, it is estimated that unpaid consumption made up 5.2 percent of movie viewing in their sample and that led to the reduction of paid consumption by 3.5 percent. It thus confirmed that displacement effect was large and statistically significant and they attributed it to the fact that unpaid pirated versions could have quality as good as paid original versions. Though such displacement effect might cause producers to be unable to recoup their cost of production, they remained optimistic in their belief that unpaid copy of a movie i.e. home video viewing, cannot effectively replace the movie experience in the theatres, hence the threat of displacement is less for movie piracy.

Sougata Poddar (2006) studied the impact of movie piracy on box-office sales i.e. movie theatres by setting up a simple theoretical model. He found that the best outcome for movie producers is to have no piracy at all i.e. full protection; conversely, having no protection is the most optimal for consumers and the society. So in order to create a balance between the interests of movie producers and consumers, he proposed the strategy of partial protection, which is to delay piracy. With partial protection, he showed that consumer surplus and overall welfare is improved while movie producers enjoy profits and the incentives to invest in making new movies.

2.2 Evaluation and Application of Current Literature

The first three literatures highlight to us that the two major forms of movie piracy are hard goods piracy and online piracy. Chellappa and Shivendu (2002) suggested a way to fight hard goods piracy, which is to maintain variable technology standards for DVD players. However DVD players are usually mass-produced for international markets, hence it is no longer a viable strategy; rather now movie companies have arranged for simultaneous release of movies in all international markets, hoping to effectively fight global piracy.

As for online piracy, it appears that the harsh lawsuits that MPAA has imposed on individual pirates and online file-sharing sites like Grokster work well against copyright infringers as Marc Fetscherin (2004) suggested that consumers fear to risk being caught. Moreover, his empirical results show much optimism for the movie industry; that is consumers prefer legal downloads as pirated versions online are of inferior quality.

The last two literatures support the view that movie piracy hurts movie producers, as the empirical study shows that unpaid movie consumption displaces paid consumption, whereas the theoretical model shows how movie producers earn the most profit when there is no piracy. While the empirical paper considers both theatre movies and original DVDs market under "paid consumption", the theoretical paper only took into account of profit from the movie theatres. Now we shall combine the merits of the two papers to create a simple theoretical model of movie piracy which explores the impact of piracy on prices, demand and profits of movie theatres and original DVDs.

3. A TWO-PERIOD MODEL ON MOVIE PIRACY AND ITS IMPACT ON MOVIE THEATRES AND DIGITAL VIDEO DISCS (DVDs)

Movie watching is an experience good which is in today's world available in two main forms: theatre shows or DVDs. The main differences between movies from theatres and that from DVDs are as follows: firstly, an original movie is first launched in the theatres before the DVDs are released, and secondly, DVDs provide additional utility in terms of language selection and extra behind-the-scenes footages.

Upon taking the above differences into consideration, we can set up a two-period model similar to the model presented by Poddar (2006), which features a simplified market with one original movie producing company. This movie

monopolist will maximize profits across two periods and incur zero marginal cost.[12] The movie is distributed in the theatres only for the first period, and then released on DVDs in the second period. On the demand side, consumers are indexed by X, $X \in [\theta_L, \theta_H]$, where $\theta_H > \theta_L \geq 0$. The value of X, which is assumed to be uniformly distributed over $[\theta_L, \theta_H]$, measures the value of the movie to a consumer and his willingness to pay for it. Consumer's valuation is heterogeneous and the market size is normalized to 1.

Consumers live over two periods, denoted by t, where t= 1, 2. If a consumer watches the original movie in the theatre in the first period, he enjoys a utility of X and pays a price of P_m. In the second period, the movie will no longer be available in the theatres and thus a consumer would have to buy a DVD and enjoy a utility of δX, where $\delta \in (0, 1)$. δ is the discount factor to account for disutility of having to wait till the second period to view the movie, where disutility may come from the fact that the excitement over the movie is already over or that you have simply missed the real movie experience once the movie is no longer available in the second period.[13] Note that as compared to first period movie consumption in the theatres, second period DVD consumption has an additional positive utility of δA in order to capture the extra footages and language choices that are unique to DVDs. Since this is a two-period model, a consumer is assumed to view the DVD he bought once in the second period, although we know that a DVD is a durable good that allows a consumer to view the movie repeatedly in subsequent periods. Hence, for that one-time second period viewing of a DVD, he pays P_d, which measures the average cost of per movie viewing from an original DVD.

Piracy can enter in the first or second period, depending on how tight intellectual property rights protection is in a country. If a consumer watches a pirated version in the first period, he enjoys a utility of qX, and δqX if in the second period, where $q \in (0,1)$. It is usual to observe quality differences between original movies and pirated versions, and especially when we assume cost of piracy here to be zero, other non-tangible costs such as searching and downloading time is then captured by q. A low q could reflect inferior quality or more time-consuming searching for the

pirated version, and q can never take the value of 1 as it is unrealistic for pirated versions to be a perfect substitute for original movies in the theatres.

Here, we structure a consumer's one-period utility for as follows:

$$
U = \begin{cases}
X - P_m & \text{if he watches original movie in theatre (1}^{\text{st}}\text{ period)} \\
\delta(X+A) - P_d & \text{if he watches original DVD (2}^{\text{nd}}\text{ period)} \\
\delta^{t-1}qX & \text{if he watches pirated movie in period t} \\
0 & \text{if he does not watch at all}
\end{cases}
$$

With that, there are three scenarios which we have to consider: firstly, the extreme case when intellectual property rights are fully protected and there is no piracy at all; secondly, the alternative extreme case when there is no protection for original movies and thus piracy begins in the first period; lastly, the more realistic case when there is a limited form of protection and so piracy can only begins in the second period.

3.1 No Movie Piracy (Full Protection)

The extreme situation with no movie piracy is only possible with pervasive and successful implementation of intellectual property rights laws, making any attempt to copy intellectual content fruitless. This will mean that a consumer is left with only three choices: watch the original movie in the theatres in the first period, wait till the second period to buy the original DVD, or not watch at all. Thus his utility is as follows:

$$
U = \begin{cases}
X - P_{NP,m} & \text{if he watches original theatre movie (1}^{\text{st}}\text{ period)} \\
\delta(X + A) - P_{NP,d} & \text{if he watches original DVD (2}^{\text{nd}}\text{ period)} \\
0 & \text{if he watches nothing}
\end{cases}
$$

where the subscript NP denotes no piracy case.

With a fixed market size, consumers may choose between watching original theatre movie in the first period or watch the original movie on DVD in the second period. The marginal consumer X_1 who is indifferent between watching original theatre movie or original DVD is given by:

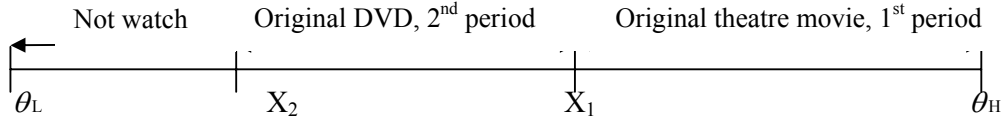$$X - P_{NP,m} = \delta X - P_{NP,d} + \delta A$$

$$X_1 = \frac{P_{NP,m} - P_{NP,d} + \delta A}{1 - \delta}$$

The marginal consumer X_2 who is indifferent between watching DVD in the second period and not watching at all is given by:

$$\delta X - P_{NP,d} + \delta A = 0$$

$$X_2 = \frac{P_{NP,d} - \delta A}{\delta}$$

Figure 3.1: DISTRIBUTION OF CONSUMERS (NO PIRACY)

Not watch   Original DVD, 2nd period   Original theatre movie, 1st period

θ_L X_2 X_1 θ_H

Demand for original theatre movie in the 1st period is:

$$D_{NP,m} = \int_{X_1}^{\theta_H} \frac{1}{\theta_H - \theta_L} dx = \frac{\theta_H(1-\delta) - P_{NP,m} + P_{NP,d} - \delta A}{(\theta_H - \theta_L)(1-\delta)}$$

Here we assume zero marginal cost and that makes the movie producer's profit from the theatres in the first period to be:

$$\pi_{NP,m} = P_{NP,m}.D_{NP,m} = P_{NP,m}.\frac{\theta_H(1-\delta) - P_{NP,m} + P_{NP,d} - \delta A}{(\theta_H - \theta_L)(1-\delta)}$$

Demand for original DVD in the 2nd period is:

$$D_{NP,d} = \int_{X_2}^{X_1} \frac{1}{\theta_H - \theta_L} dx = \frac{\delta P_{NP,m} - P_{NP,d} + \delta A}{(\theta_H - \theta_L)(1-\delta)\delta}$$

Movie producer's profit from DVDs in the second period is:

$$\pi_{NP,d} = P_{NP,d}.D_{NP,d} = P_{NP,d}.\frac{\delta P_{NP,m} - P_{NP,d} + \delta A}{(\theta_H - \theta_L)(1-\delta)\delta}$$

Thus total profit from movie theatres and DVDs for the movie producer is:

$$\pi_{NP,m+d} : \frac{2\delta P_{NP,m}P_{NP,d} - P_{NP,d}^2 + \delta A P_{NP,d} + \theta_H(1-\delta)\delta P_{NP,m} - \delta P_{NP,m}^2 - \delta^2 A P_{NP,m}}{(\theta_H - \theta_L)(1-\delta)\delta}$$

Using simultaneous optimizing, the movie producer will profit maximize total profit with respect to both prices:

$$\frac{\partial \pi_{NP,m+d}}{\partial P_{NP,m}} = \frac{2\delta P_{NP,d} + \delta(1-\delta)\theta_H - 2\delta P_{NP,m} - \delta^2 A}{(\theta_H - \theta_L)(1-\delta)\delta} = 0$$

$$P_{NP,m} = P_{NP,d} + \frac{(1-\delta)\theta_H}{2} - \frac{\delta A}{2}$$

$$\frac{\partial \pi_{NP,m+d}}{\partial P_{NP,d}} = \frac{2\delta P_{NP,m} - 2P_{NP,d} + \delta A}{(\theta_H - \theta_L)(1-\delta)\delta}$$

$$P_{NP,d} = \delta P_{NP,m} + \frac{\delta A}{2}$$

Substitute $P_{NP,d}$ into $P_{NP,m}$ to get profit-maximizing prices for theatre movies and DVDs:

$$P_{NP,m}{}^* = \frac{\theta_H}{2} \tag{1}$$

$$P_{NP,d}{}^* = \frac{\delta\theta_H + \delta A}{2} \tag{2}$$

The equilibrium demand for theatre movies and DVDs are:

$$D_{NP,m}{}^* = \frac{\theta_H(1-\delta) - \delta A}{2(\theta_H - \theta_L)(1-\delta)} \tag{3}$$

$$D_{NP,d}{}^* = \frac{A}{2(\theta_H - \theta_L)(1-\delta)} \tag{4}$$

Assumption 1: $A < \theta_H$ if $\delta < \frac{1}{2}$ and $A < \theta_H \frac{1-\delta}{\delta}$ if $\delta > \frac{1}{2}$

This restriction on the value of A is necessary for X_2 and $D_{NP,m}{}^*$, the equilibrium demand for theatre movies, both to be positive. If A is too large, everyone will want to enjoy this additional utility from DVDs. As a result, either there is no one who will not watch at all or the market for theatre movies will be totally eliminated. These two scenarios are both not realistic. Hence A must be below a certain upper bound. Thus, the profits from theatre movies and DVDs are:

$$\pi_{NP,m}{}^* = \frac{\theta_H{}^2(1-\delta) - \theta_H \delta A}{4(\theta_H - \theta_L)(1-\delta)} \tag{5}$$

$$\pi_{NP,d}{}^* = \frac{\theta_H \delta A + \delta A^2}{4(\theta_H - \theta_L)(1-\delta)} \tag{6}$$

And total profit for the movie producer is:

$$\pi_{NP,m+d}{}^* = \frac{\theta_H{}^2(1-\delta) + \delta A^2}{4(\theta_H - \theta_L)(1-\delta)} \tag{7}$$

With Assumption 1, $P_{NP,m}^* > P_{NP,d}^*$.[14] From equation (3) and (4), $D_{NP,d}^* > D_{NP,m}^*$

if $A > \dfrac{1-\delta}{1+\delta}\theta_H$. This is possible as long as $\dfrac{1-\delta}{1+\delta}\theta_H < A < \theta_H$ if $\delta < \dfrac{1}{2}$ or

$\dfrac{1-\delta}{1+\delta}\theta_H < A < \theta_H\dfrac{1-\delta}{\delta}$ if $\delta > \dfrac{1}{2}$. It is obvious that demand for DVDs will be higher

than that of theatre movies if the value of A is not too low i.e. above a certain lower

bound.

3.2 Piracy Begins in First Period (No Protection)

The other extreme situation occurs when piracy is prevalent from the first period as implementation of intellectual property rights law is very weak. This means that pirated copies are available at the same time when the movie is released in the theatres. A consumer who wants to watch the pirated version will definitely do it in the first period as he has no incentive to wait till the second period, especially when any utility will be discounted by δ. This will mean that a consumer has three choices: watch the original movie in the theatre in the first period, buy the original DVD in the second period, or watch the pirated copy in the first period. Thus his utility is as follows:

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[14] See Appendix A for proof

$$U= \begin{cases} X - P_{P1,m} & \text{if he watches original theatre movie (1}^{\text{st}}\text{ period)} \\ \delta(X+A) - P_{P1,d} & \text{if he watches original DVD (2}^{\text{nd}}\text{ period)} \\ qX & \text{if he watches pirated copy (1}^{\text{st}}\text{ period)} \end{cases}$$

where the subscript P1 denotes piracy begins in first period case.

Assumption 2: $\delta > q$

This condition is necessary for the existence of second period original DVD market. If not, everyone would prefer to get the free pirated copy that provides higher utility over the original DVD.

The marginal consumer X_1 is indifferent between watching original theatre movie in the first period and watching original DVD in the second period is given by:

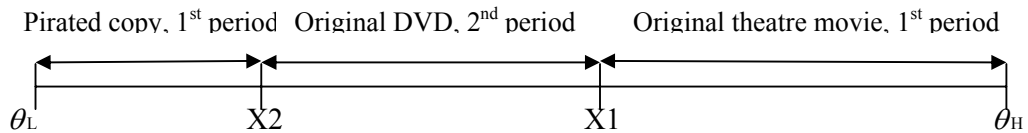$$X_1 - P_{P1,m} = \delta X_1 - P_{P1,d} + \delta A$$

$$X_1 = \frac{P_{P1,m} - P_{P1,d} + \delta A}{1 - \delta}$$

The marginal consumer X_2 is indifferent between watching original DVD in the second period and the pirated copy in the first period is given by:

$$\delta X_2 - P_{P1,d} + \delta A = qX_2$$

$$X_2 = \frac{P_{P1,d} - \delta A}{\delta - q}$$

Figure 3.2: DISTRIBUTION OF CONSUMERS (PIRACY AVAILABLE FROM FIRST PERIOD), $\delta > q$

Pirated copy, 1$^{\text{st}}$ period   Original DVD, 2$^{\text{nd}}$ period   Original theatre movie, 1$^{\text{st}}$ period

θ_L X2   X1 θ_H

Demand for original theatre movie in the 1$^{\text{st}}$ period is:

$$D_{P1,m} : \int_{X_1}^{\theta_H} \frac{1}{\theta_H - \theta_L} dx = \frac{\theta_H(1-\delta) - P_{P1,m} + P_{P1,d} - \delta A}{(\theta_H - \theta_L)(1-\delta)}$$

The profit from movie theatres is:

$$\pi_{P1,m} = P_{P1,m}.D_{P1,m} = P_{P1,m}.\frac{\theta_H(1-\delta) - P_{P1,m} + P_{P1,d} - \delta A}{(\theta_H - \theta_L)(1-\delta)}$$

Demand for original DVDs in the 2$^{\text{nd}}$ period is:

$$D_{P1,d} = \int_{X_2}^{X_1} \frac{1}{\theta_H - \theta_L} dx = \frac{(\delta-q)P_{P1,m} - (1-q)P_{P1,d} + \delta A(1-q)}{(\theta_H - \theta_L)(1-\delta)(\delta-q)}$$

The profit from DVDs is:

$$\pi_{P1,d} = P_{P1,d}.D_{P1,d} = P_{P1,d}.\frac{(\delta-q)P_{P1,m} - (1-q)P_{P1,d} + \delta A(1-q)}{(\theta_H - \theta_L)(1-\delta)(\delta-q)}$$

Thus total profit from movie theatres and DVDs for the movie producer is:

$$\pi_{P1,m+d} = \frac{2(\delta-q)P_{P1,m}P_{P1,d} - (1-q)P_{P1,d}^2 + SA(1-q)P_{P1,d} + (\delta-q)\theta_H(1-\delta)P_{P1,m} - \delta A(\delta-q)P_{P1,m} - (\delta-q)P_{P1,m}^2}{(\theta_H - \theta_L)(1-\delta)(\delta-q)}$$

Using simultaneous optimizing, the movie producer will profit maximize total profit with respect to both prices:

$$\frac{\partial \pi_{P1,m+d}}{\partial P_{P1,m}} = \frac{2(\delta-q)P_{P1,d} + (\delta-q)(1-\delta)\theta H - 2(\delta-q)P_{P1,m} - \delta A(\delta-q)}{(\theta_H - \theta_L)(1-\delta)(\delta-q)} = 0$$

$$P_{P1,m} = P_{P1,d} + \frac{\theta_H(1-\delta)}{2} - \frac{\delta A}{2}$$

$$\frac{\partial \pi_{P1,m+d}}{\partial P_{P1,d}} = \frac{2(\delta-q)P_{P1,m} - 2(1-q)P_{P1,d} + \delta A(1-q)}{(\theta_H - \theta_L)(1-\delta)(\delta-q)} = 0$$

$$P_{P1,d} = \frac{(\delta-q)P_{P1,m}}{(1-q)} + \frac{\delta A}{2}$$

Substitute $P_{P1,d}$ into $P_{P1,m}$ to get profit-maximizing prices for theatre movies and DVDs:

$$P_{P1,m}^* = \frac{\theta H(1-q)}{2} \tag{8}$$

$$P_{P1,d}^* = \frac{\theta_H(\delta-q) + \delta A}{2} \tag{9}$$

The equilibrium demand for theatre movies and DVDs are:

$$D_{P1,m}^* = \frac{\theta_H(1-\delta) - \delta A}{2(\theta_H - \theta_L)(1-\delta)} \tag{10}$$

$$D_{P1,d}^* = \frac{\delta A(1-q)}{2(\theta_H - \theta_L)(1-\delta)(\delta-q)} \tag{11}$$

Assumption 3: $\delta A < (\delta-q)\theta_H$ if $\delta < \frac{1+q}{2}$ and $\delta A < (1-\delta)\theta_H$ if $\delta > \frac{1+q}{2}$

This condition is again necessary for X_2 and $D_{P1,m}{}^*$, the equilibrium demand for theatre movies, both to be positive. This follows a similar reasoning as of the previous no piracy case.

Thus, profits from movie theatres and DVDs are:

$$\pi_{P1,m}{}^* = \frac{\theta_H(1-q)[\theta_H(1-\delta) - \delta A]}{4(\theta_H - \theta_L)(1-\delta)} \tag{12}$$

$$\pi_{P1,d}{}^* = \frac{\delta A(1-q)}{2(\theta_H - \theta_L)(1-\delta)(\delta - q)} \tag{13}$$

And total profit for the movie producer is:

$$\pi_{P1,m+d}{}^* = \frac{\theta_H{}^2(1-q)(\delta - q)(1-\delta) + (\delta A)^2(1-q)}{4(\theta_H - \theta_L)(1-\delta)(\delta - q)} \tag{14}$$

With Assumption 3, $P_{P1,m}{}^* > P_{P1,d}{}^*$.[15] From equation (10) and (11), $D_{P1,d}{}^* > D_{P1,m}{}^*$ if

$\delta A > \dfrac{(1-\delta)(\delta - q)}{1 + \delta - 2q}\theta_H$. This can be possible as long as

$\dfrac{(1-\delta)(\delta - q)}{1 + \delta - 2q}\theta_H < \delta A < (1-\delta)\theta_H$ for $\delta > \dfrac{1+q}{2}$ or

---

[15] See Appendix A for proof

$\frac{(1-\delta)(\delta-q)}{1+\delta-2q}\theta_H < \delta A < (1-\delta)\theta_H$ for $\delta > \frac{1+q}{2}$. The same reasoning follows as of the

previous no piracy case.

3.2.1 Case of $q > \delta$

We will now relax Assumption 2 and consider the case when $q > \delta$. This will mean

that consumers would get a higher utility (qX) from the pirated copy in the first

period than from the second period original DVD. As a result, a consumer has only

two choices: watch the original movie in the theatres in first period or watch the

pirated copy in first period. His utility is as follows:

$$
U = \begin{cases}
X - P_{P1,m}^{q>\delta} & \text{if he watches original theatre movie (1}^{st}\text{ period)} \\
\\
qX & \text{if he watches pirated copy (1}^{st}\text{ period)}
\end{cases}
$$

The marginal consumer X_1 is indifferent between watching original theatre movie

and the pirated copy is given by:

$$X_1 - P_{P1,m}^{q>\delta} = qX_1$$

$$X_1 = \frac{P_{P1,m}^{q>\delta}}{1-q}$$

Figure 3.2.1: DISTRIBUTION OF CONSUMERS (PIRACY AVAILABLE FROM
FIRST PERIOD), $q > \delta$
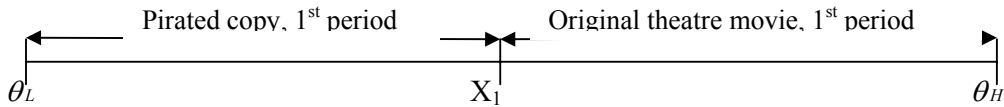
Demand for original theatre movie in first period is:

$$D_{P1,m}^{q>\delta} = \int_{X_1}^{\theta_H} \frac{1}{\theta_H - \theta_L} dx = \frac{\theta_H(1-q) - P_{P1,m}^{q>\delta}}{(\theta_H - \theta_L)(1-q)}$$

Since the movie producer only earns from movie theatres, his total profit is:

$$\pi_{P1,m}^{q>\delta} = P_{P1,m}^{q>\delta}.D_{P1,m}^{q>\delta} = P_{P1,m}^{q>\delta}.\frac{\theta_H(1-q) - P_{P1,m}^{q>\delta}}{(\theta_H - \theta_L)(1-q)}$$

And by maximizing his profit with respect to theatre movie price

$$\frac{\partial \pi_{P1,m}^{q>\delta}}{\partial P_{P1,m}^{q>\delta}} = \frac{(1-q)\theta_H - 2P_{P1,m}^{q>\delta}}{(\theta_H - \theta_L)(1-q)} = 0$$

The profit-maximizing theatre movie price is:

$$P_{P1,m}^{q>\delta*} = \frac{\theta_H(1-q)}{2} \tag{15}$$

The equilibrium demand for theatre movies is:

$$D_{P1,m}^{q>\delta*} = \frac{\theta_H}{2(\theta_H - \theta_L)} \tag{16}$$

Thus, the profit from theatre movies is:

$$\pi_{P1,m}^{q>\delta*} = \frac{\theta_H{}^2(1-q)}{4(\theta_H - \theta_L)} \tag{17}$$

3.3 Piracy Begins Only in Second Period (Partial Protection)

This is the most realistic case whereby there is some success in the implementation of intellectual property rights laws, making it impossible to obtain any pirated copy of the movie in the first period. However, due to today's extensive piracy networks, pirated versions of the movie can still find its way into the market, alongside the original DVD release in the second period. As a result, a consumer now has three choices: watch the original movie in the theatre in the first period, watch the original DVD in the second period or watch the pirated copy in the second period. His utility is as follows:

$$U = \begin{cases} X - P_{P2,m} & \text{if he watches original theatre movie (1}^{\text{st}}\text{ period)} \\ \delta X - P_{P2,d} + \delta A & \text{if he watches original DVD (2}^{\text{nd}}\text{ period)} \\ q\delta X & \text{if he watches pirated copy (2}^{\text{nd}}\text{ period)} \end{cases}$$

where the subscript P2 denotes piracy begins in second period case.

The marginal consumer X_1 who is indifferent between watching original theatre movie and original DVD is given by:

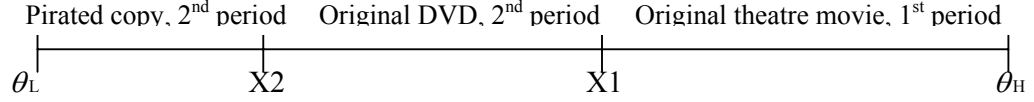$$X_1 - P_{P2,m} = \delta X_1 - P_{P2,d} + \delta A$$

$$X_1 = \frac{P_{P2,m} - P_{P2,d} + \delta A}{1 - \delta}$$

The marginal consumer X_2 who is indifferent between watching original DVD and the pirated copy is given by:

$$\delta X_2 - P_{P2,d} + \delta A = q\delta X_2$$

$$X_2 = \frac{P_{P2,d} - \delta A}{\delta(1-q)}$$

Pirated copy, 2nd period   Original DVD, 2nd period   Original theatre movie, 1st period

θ_L —————— X2 —————— X1 —————— θ_H

Demand for original theatre movie in the first period is:

$$D_{P2,m} = \int_{X_1}^{\theta_H} \frac{1}{\theta_H - \theta_L} dx = \frac{\theta_H(1-\delta) - P_{P2,m} + P_{P2,d} - \delta A}{(\theta_H - \theta_L)(1-\delta)}$$

The profit from movie theatres is:

$$\pi_{P2,m} = P_{P2,m}.D_{P2,m} = P_{P2,m}.\frac{\theta_H(1-\delta) - P_{P2,m} + P_{P2,d} - \delta A}{(\theta_H - \theta_L)(1-\delta)}$$

Demand for original DVD in the second period is:

$$\pi_{P2,d} = P_{P2,d}.D_{P2,d} = P_{P2,d}.\frac{\delta(1-q)P_{P2,m} - (1-\delta q)P_{P2,d} + \delta A(1-\delta q)}{(\theta_H - \theta_L)\delta(1-\delta)(1-q)}$$

The profit from original DVDs is:

$$\pi_{P2,d} = P_{P2,d}.D_{P2,d} = P_{P2,d}.\frac{\delta(1-q)P_{P2,m} - (1-\delta q)P_{P2,d} + \delta A(1-\delta q)}{(\theta_H - \theta_L)\delta(1-\delta)(1-q)}$$

So total profit from both movie theatres and DVDs for the movie producer is:

$$\pi_{P2,m+d} = \frac{2\delta(1-q)P_{P2,m}P_{P2,d} - (1-\delta q)P_{P2,d}^2 + \delta A(1-\delta q)P_{P2,d} + \delta(1-q)(1-\delta)\theta_H P_{P2,m} - \delta(1-q)P_{P2,m}^2 - \delta(1-q)\delta A P_{P2,m}}{(\theta_H - \theta_L)\delta(1-\delta)(1-q)}$$

Using simultaneous optimizing, the movie producer will profit maximize total profit with respect to both prices:

$$\frac{\partial \pi_{P2,m+d}}{\partial P_{P2,d}} = \frac{2\delta(1-q)P_{P2,m} - 2(1-\delta q)P_{P2,d} + \delta A(1-\delta q)}{(\theta_H - \theta_L)\delta(1-\delta)(1-q)} = 0$$

$$P_{P2,m} = P_{P2,d} + \frac{\theta_H(1-\delta) - \delta A}{2}$$

$$\frac{\partial \pi_{P2,m+d}}{\partial P_{P2,d}} = \frac{2\delta(1-q)P_{P2,m} - 2(1-\delta q)P_{P2,d} + \delta A(1-\delta q)}{(\theta_H - \theta_L)\delta(1-\delta)(1-q)} = 0$$

$$P_{P2,d} = \frac{\delta(1-q)}{1-\delta q} P_{P2,m} + \frac{\delta A}{2}$$

Substitute $P_{P2,d}$ into $P_{P2,m}$ to get profit-maximizing prices for theatre movies and DVDs:

$$P_{P2,m}{}^* = \frac{(1-\delta q)\theta_H}{2} \tag{18}$$

$$P_{P2,d}{}^* = \frac{\delta(1-q)\theta_H + \delta A}{2} \tag{19}$$

The equilibrium demand for theatre movies and DVDs are:

$$D_{P2,m}{}^* = \frac{\theta_H(1-\delta) - \delta A}{2(\theta_H - \theta_L)(1-\delta)} \tag{20}$$

$$D_{P2,d}{}^* = \frac{A(1-\delta q)}{2(\theta_H - \theta_L)(1-\delta)(1-q)} \tag{21}$$

Assumption 4: $\delta A < \delta(1-q)\theta_H$ if $\delta < \dfrac{1}{2-q}$ and $\delta A < (1-\delta)\theta_H$ if $\delta > \dfrac{1}{2-q}$

This assumption is necessary for X_2 and $D_{P2,m}{}^*$, the equilibrium demand for original theatre movies, both to be positive. This follows a similar reasoning as of the previous no piracy case.

Thus profits from movie theatres and DVDs are:

$$\pi_{P2,m}{}^* = \frac{\theta_H(1-\delta q)[\theta_H(1-\delta) - \delta A]}{4(\theta_H - \theta_L)(1-\delta)} \tag{22}$$

$$\pi_{P2,d}{}^* = \frac{(1-\delta q)[\theta_H \delta A(1-q) + \delta A^2]}{4(\theta_H - \theta_L)(1-\delta)(1-q)} \tag{23}$$

And the total profit for the movie producer is:

$$\pi_{P2,m+d}{}^* = \frac{(1-\delta q)[\delta A^2 + \theta_H(1-\delta)(1-q)]}{4(\theta_H - \theta_L)(1-\delta)(1-q)} \tag{24}$$

With Assumption 4, $P_{P2,m}{}^* > P_{P2,d}{}^*$.[16] From equation (20) and (21), $D_{P2,d}{}^* > D_{P2,m}{}^*$ if

$\delta A > \dfrac{\theta H(1-\delta)(1-q)\delta}{1-2\delta q + \delta}$. This is possible as long as

$\dfrac{\theta_H \delta(1-q)(1-\delta)}{1-2\delta q + \delta} < \delta A < \delta(1-q)\theta_H$ for $\delta < \dfrac{1}{2-q}$ or

---

[16] See Appendix A for proof

$$\frac{\theta_H\delta(1-q)(1-\delta)}{1-2\delta q+\delta} < \delta A < (1-\delta)\theta_H \text{ for } \delta > \frac{1}{2-q}.$$ The same reasoning follows as of

the previous no piracy case.

3.4. Result Analysis with Economic Rationale

The comparative statics is displayed in Table 1 and Table 2 below:

Table 1: Comparative Statics (Price and Demand)

Partial Derivatives with respect to →		δ	q	A
Theatre Movie Price	$(P_{NP,m}{}^*,\quad P_{P1,m}{}^*,\quad P_{P1,m}{}^{q>\delta},$ $P_{P2,m}{}^*)$	(0,0,0,-)	(0,-,-,-)	(0,0,0,0)
Theatre Movie Demand	$(D_{NP,m}{}^*,\quad D_{P1,m}{}^*,\quad D_{P1,m}{}^{q>\delta},$ $D_{P2,m}{}^*)$	(-,-,0,-)	(0,0,0,0)	(-,-,0,-)
DVD Price	$(P_{NP,d}{}^*, P_{P1,d}{}^*, P_{P2,d}{}^*)$	(+,+,+)	(0,-,-)	(+,+,+)
DVD Demand	$(D_{NP,d}{}^*, D_{P1,d}{}^*, D_{P2,d}{}^*)$	(+,+,+)	(0,-,-)	(+,+,+)

Table 2: Comparative Statics (Profit)

Partial Derivatives with respect to →		δ	q	A
Profit from movie theatres	$(\pi_{NP,m}{}^*, \pi_{P1,m}{}^*, \pi_{P1,m}{}^{q>\delta}, \pi_{P2,m}{}^*)$	(-,-,0,-)	(0,-,-,-)	(-,-,0,-)
Profit from DVDs	$(\pi_{NP,d}{}^*, \pi_{P1,d}{}^*, \pi_{P2,d}{}^*)$	(+,+,+)	(0,-,-)	(+,+,+)
Total profit	$(\pi_{NP,m+d}{}^*,\quad \pi_{P1,m+d}{}^*,\quad \pi_{P1,m}{}^{q>\delta*},$ $\pi_{P2,m+d}{}^*)$	(+,+,0,+)	(0,-,-,-)	(+,+,0,+)

Now we summarize and analysis the results from Table 1 and Table 2:

Lemma 1

The presence of piracy, from either first or second period, will cause the prices and demand of both theatrical movies and DVDs to be non-increasing in the quality of the pirated version.

Proof: Follow Table 1.

When consumers are able to get free pirated copies with better audio and visual quality or more efficient downloads, it will mean that the movie producer is facing a bigger threat from movie piracy and thus he will be forced to slash prices for both

theatre movies and DVDs in order to attract back the consumers. It is interesting to observe that in face of a higher quality pirated version, the lowering of prices help keep demand for theatre movies unchanged, but it is not able to prevent a fall in demand for DVDs. This could be due to the fact that theatre movies, as compared to DVDs, are able to differentiate themselves from the pirated version by providing the "full movie experience"; hence consumers find it more worthwhile to go back to the theatres when prices are lowered.

Lemma 2

The total profit for the movie producer and the respective profit from theatre movies and DVDs are decreasing in the quality of the pirated version
Proof: Follow Table 2.

In order to fight stiffer competition from piracy as quality of pirated version improves, the movie producer has to lower prices and suffer demand losses. Hence it is expected that profits will fall.

Lemma 3

For all situations, price and demand for theatrical movies are non-increasing in δ whereas price and demand for DVDs are increasing in δ.
Proof: Follow Table 1.

As consumers become more patient, they discount future less and δ increases. Since they are more patient, they will be willing to wait till the second period for the DVD

release in order to capture additional utility from extra footages or language selection that DVDs offer. As a result, price and demand for DVDs increase, causing demand for theatrical movies to fall. As a result, the price for theatre movies should fall. However this is only true for the case when piracy begins in the second period. This is because by using simultaneous profit-maximizing, the movie producer has already taken into account of the negative effect that a higher δ has on the price of theatre movies, hence in order to minimize the fall in profits from movie theatres, it has chosen a fixed optimal price for theatrical movies. However, the movie producer cannot effectively internalize the impact of δ on the price of theatre movies if piracy is only available in the second period, because a higher δ not only increases demand

for DVDs, it also increases demand for the pirated version.[17] The existence of piracy in the second period has removed the ability of the movie producer to set up carefully planned price equilibrium as there is a need to lower prices of theatre movies to fight second period piracy when consumers become more patient.

Lemma 4

For all situations, price and demand for theatrical movies are non-increasing in A whereas price and demand for DVDs are increasing in A.

Proof: Follow Table 1.

When DVDs offer more extra footages or language selection, more people will prefer DVDs to theatrical movies. As a result, demand and price of DVDs will increase, whereas demand for theatre movies fall. As explained before, price of theatre movies will be fixed at an optimal level when the movie producer maximizes profit simultaneously (having internalized the negative effect of a higher A on theatre movie prices).

Lemma 5

For all situations, total profit is increasing in δ and A.

Proof: Follow Table 2.

When consumers become more patient or enjoy more additional utility from extra footages or language selection, they will consume more DVDs. As a result, the movie producer will focus more on the DVD market, which in reality contributes more towards total revenue than movie theatres.[18] Hence in order to capture their higher valuation for DVDs, higher DVD prices will be set and profits will increase.

---

[17] δ does not affect utility from pirated copies if piracy exists in period 1.
[18] In 2005, U.S. box office receipts was worth US$8.99 billion (see data from http://www.mpaa.org/USEntertainmentIndustryMarketStats.pdf) while receipts from DVD market was US$23.32 billion (see data from http://www.entmerch.org/index.html).

4. PROFIT AND WELFARE ANALYSIS

In the previous chapter, we have seen how total profits is negatively affected by the presence of higher quality pirated movies; conversely, we expect consumers to benefit when better quality piracy drives down prices of both theatrical movies and DVDs. Since it is not a win-win situation, it will be interesting to see how producers' profits and consumers' benefit balance out with the existence of movie piracy. Hence, in this chapter, we will compare across the three different scenarios and evaluate how piracy affects the movie producer's profits, consumers' surplus and the overall social welfare.

Total profit for the movie producer is the respective equilibrium total profit derived in the previous chapter. Consumer surplus is measured by the excess of utility from movie viewing over the price paid for it. As for the overall social welfare, we assume that the movie producer and the consumers make up the entire population; hence total social welfare is obtained by adding up equilibrium producer's profits and consumers' surplus. To simplify our computation, we assume $\theta_H = 1$ and $\theta_L = 0$.

4.1 No Movie Piracy (Full Protection)

When $\theta_H = 1$ and $\theta_L = 0$, the equilibrium prices for theatre movies and DVDs and the equilibrium total profit are:

$$P_{NP,m}^* = \frac{1}{2}$$

$$P_{NP,d}^* = \frac{\delta(1+A)}{2}$$

$$\pi_{NP,m+d}^* = \frac{(1-\delta)+\delta A^2}{4(1-\delta)} \qquad (25)$$

We substitute the equilibrium prices to derive the marginal consumer X_1 and X_2:

$$X_1 = \frac{P_{NP,m}^* - P_{NP,d}^* + \delta A}{1-\delta} = \frac{1-\delta+\delta A}{2(1-\delta)} \; ; \; X_2 = \frac{P_{NP,d}^* - \delta A}{\delta} = \frac{1-A}{2}$$

Consumer surplus, CS_{NP}, is obtained by:

$$CS_{NP} = \int_{X_1}^{1} (X - P_{NP,m}^*)dx + \int_{X_2}^{X_1} [\delta(X+A) - P_{NP,d}]dx = \left[\frac{X^2}{2} - XP_{NP,m}^*\right]_{X_1}^{1} + \left[\delta(\frac{X^2}{2} + XA) - XP_{NP,d}^*\right]_{X_2}^{X_1}$$

Substituting the variables, we get:

$$CS_{NP}* = \frac{(1-\delta+\delta A)^2}{8(1-\delta)} \tag{26}$$

Thus total social welfare, W_{NP} is:

$$W_{NP}* = \pi_{NP,\,m+d}{}^* + CS_{NP}* = \frac{(1-\delta+\delta A)^2 + 2(1-\delta+\delta A^2)}{8(1-\delta)} \tag{27}$$

4.2 Piracy Begins in First Period (No Protection)

4.2.1 Case when δ>q

When $\theta_H = 1$ and $\theta_L = 0$, the equilibrium prices for theatre movies and DVDs and the equilibrium total profit are:

$$P_{P1,\,m}{}^* = \frac{(1-q)}{2}$$

$$P_{P1,\,d}{}^* = \frac{(\delta-q)+\delta A}{2}$$

$$\pi_{P1,\,m+d}{}^* = \frac{(1-q)\left[(\delta-q)(1-\delta)+(\delta A)^2\right]}{4(1-\delta)(\delta-q)} \tag{28}$$

We substitute the equilibrium prices to derive the marginal consumer X_1 and X_2:

$$X_1 = \frac{P_{P1,\,m}*-P_{P1,\,d}*+\delta A}{1-\delta} = \frac{1-\delta+\delta A}{2(1-\delta)} \;;\; X_2 = \frac{P_{P1,\,d}*-\delta A}{\delta-q} = \frac{(\delta-q)-\delta A}{2(\delta-q)}$$

Consumer surplus, CS_{P1} obtained by:

$$CS_{P1} = \int_{X_1}^{1}(X-P_{P1,\,m}*)dx + \int_{X_2}^{X_1}[\delta(X+A)-P_{P1,\,d}*]dx + \int_{0}^{X_2}(qX)dx$$

$$= \left[\frac{X^2}{2}-XP_{P1,\,m}*\right]_{X_1}^{1} + \left[\delta(\frac{X^2}{2}+XA)-XP_{P1,\,d}*\right]_{X_2}^{X_1} + \left[\frac{qX^2}{2}\right]_{0}^{X_2}$$

Substituting the variables, we get:

$$CS_{P1}* = \frac{2(1-\delta)^2[4q+(\delta-q-\delta A)^2(2+q-\delta)]+(1-\delta+\delta A)(1-\delta+\delta A+2\delta^2 A)}{8(1-\delta)^2} \tag{29}$$

Thus total social welfare, W_{P1} is:

$$W_{P1}* = \pi_{P1,\,m+d}{}^* + CS_{P1}*$$

$$= \frac{2(1-\delta)(1-q)\left[(\delta-q)(1-\delta)+(\delta A)^2\right]+(\delta-q)\{2(1-\delta)^2[4q+(\delta-q-\delta A)^2(2+q-\delta)]+(1-\delta+\delta A)(1-\delta+\delta A+2\delta^2 A)\}}{8(1-\delta)^2(\delta-q)} \tag{30}$$

4.2.2 Case when q > δ

When $\theta_H = 1$ and $\theta_L = 0$, the equilibrium prices for theatre movies and the equilibrium total profit are:

$$P_{P1,m}^{q>\delta*} = \frac{(1-q)}{2}$$

$$\pi_{P1,m}^{q>\delta*} = \frac{(1-q)}{4} \tag{31}$$

We substitute the equilibrium theatre movie price to derive the marginal consumer X_1:

$$X_1 = \frac{P_{P1,m}^{q>\delta}}{1-q} = \frac{1}{2}$$

Consumer surplus, $CS_{P1}^{q>\delta}$ is obtained by:

$$CS_{P1}^{q>\delta} = \int_{X_1}^{1}(X - P_{P1,m}^{q>\delta}*)dx + \int_{0}^{X_1}(qX)dx = \left[\frac{X^2}{2} - XP_{P1,m}^{q>\delta}*\right]_{X_1}^{1} + \left[\frac{qX^2}{2}\right]_{0}^{X_1}$$

Substituting the variables, we get:

$$CS_{P1}^{q>\delta}* = \frac{3q+1}{8} \tag{32}$$

Thus total social welfare, $W_{P1}^{q>\delta}$ is :

$$W_{P1}^{q>\delta}* = \pi_{P1,m}^{q>\delta*} + CS_{P1}^{q>\delta}* = \frac{q+3}{8} \tag{33}$$

4.3 Piracy Begins Only in Second Period (Partial Protection)

When $\theta_H = 1$ and $\theta_L = 0$, the equilibrium prices for theatre movies and DVDs and the equilibrium total profit are:

$$P_{P2,m}^{*} = \frac{(1-\delta q)}{2}$$

$$P_{P2,d}^{*} = \frac{\delta(1-q)+\delta A}{2}$$

$$\pi_{P2,m+d}^{*} = \frac{(1-\delta q)[\delta A^2 + (1-\delta)(1-q)]}{4(1-\delta)(1-q)} \tag{34}$$

We substitute the equilibrium prices to derive the marginal consumer X_1 and X_2:

$$X_1 = \frac{P_{P2,m}* - P_{P2,d}* + \delta A}{1-\delta} = \frac{1-\delta+\delta A}{2(1-\delta)} \ ; \ X_2 = \frac{P_{P2,d}* - \delta A}{\delta(1-q)} = \frac{1-q-A}{1-q}$$

Consumer surplus, CS_{P2} is obtained by:

$$CS_{P2}* = \int_{X_1}^{1}(X - P_{P2,m}*)dx + \int_{X_2}^{X_1}[\delta(X+A) - P_{P2,d}*]dx + \int_{0}^{X_2}(q\delta X)dx$$

$$= \left[\frac{X^2}{2} - XP_{P2,m}*\right]_{X_1}^{1} + \left[\delta(\frac{X^2}{2} + XA) - P_{P2,d}*\right]_{X_2}^{X_1} + \left[\frac{q\delta X^2}{2}\right]_{0}^{X_2}$$

Substituting the variables, we get:

$$CS_{P2}* = \frac{4\delta q(1-\delta) + [(1-\delta) + \delta A]^2}{8(1-\delta)} \qquad (35)$$

Thus total social welfare, W_{P2} is:

$$W_{P2}* = \pi_{P2,m+d}* + CS_{P2}* = \frac{2(1-\delta q)\delta A^2 + (1-q)\{2(1+\delta q)(1-\delta) + (1-\delta+\delta A)^2\}}{8(1-\delta)(1-q)} \qquad (36)$$

4.4 Result Analysis

Proposition 1

Total profit for the movie producer is the highest when there is no piracy and the lowest in the scenario when there piracy begins in the first period. The comparison of total profits across the three scenarios is as follows: $\pi_{NP}* > \pi_{P2}* > \pi_{P1}*$.

Proof: From equation (25) and (34), we can derive that $\pi_{NP}* - \pi_{P2}* = \frac{\delta q(1-q-A^{2)}}{4(1-q)}$.

This is always positive as Assumption 4 in Section 3.4 ensures that $A^2 < 1-q$ for all $\delta \in (0, 1)$ and $q \in (0, 1)$. Hence it must be that $\pi_{NP}* > \pi_{P2}*$.

From equation (31) and (34), we can derive that $\pi_{P2}* - \pi_{P1}* = \frac{(1-\delta q)\delta A^2 + q(1-q)(1-\delta)^2}{4(1-\delta)(1-q)}$. This expression is always positive for all $\delta \in (0, 1)$ and $q \in (0, 1)$. Hence it must be that $\pi_{P2}* > \pi_{P1}*$.

These results combined to confirm that $\pi_{NP}* > \pi_{P2}* > \pi_{P1}*$.[19]

Proposition 2

Consumer surplus is the highest when piracy begins in the first period (proven true only for the case of $\delta > q)$[20], and the lowest in the scenario when there is no piracy. The comparison of consumer surpluses across the three scenarios is as follows: $CS_{P1}* > CS_{P2}* > CS_{NP}*$.

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[19] We have used the case where $q > \delta$ for the scenario when piracy begins in the first period. However it can be checked that the proposition holds for the case of $\delta > q$.

[20] When piracy in first period totally eliminates the market for original DVDs, it becomes unclear if consumer surplus is higher than when there is no piracy or delayed piracy. It depends on the value of δA, which is the additional utility that consumers can get from original DVDs but not the pirated versions.

Proof: From equation (29) and (35), we can derive that

$$CS_{P1}* - CS_{P2}* = \frac{2(1-\delta)^2[2q(2-\delta)+(\delta-q-\delta A)^2(2+q-\delta)]+[(1-\delta)+\delta A][\delta+2\delta^2 A]}{8(1-\delta)^2}.$$

This expression is always positive for all $\delta \in (0, 1)$ and $q \in (0, 1)$. Hence it must be that

$$CS_{P1}* > CS_{P2}*.$$

From equation (26) and (35), we can derive that $CS_{P2}* - CS_{NP}* = \frac{\delta q}{2}$. This expression is positive for all $\delta \in (0, 1)$ and $q \in (0, 1)$. Hence it must be that $CS_{P2}* > CS_{NP}*$. These results combined to confirm that $CS_{P1}* > CS_{P2}* > CS_{NP}*$.

Proposition 3

Allowing for second period piracy results in a higher total social welfare as compared to the scenario when there is no piracy at all; that is to mean $W_{P2}* > W_{NP}*$.

Proof: From equation (27) and (36), we can derive that $W_{P2}* - W_{NP}* = \frac{2\delta q A^2 + 2\delta q(1-q)}{8(1-q)}$. This expression is positive for all $\delta \in (0, 1)$ and $q \in (0, 1)$. Hence it must be that $W_{P2}* > W_{NP}*$.

4.4 Economic Rationale

The above propositions resulting from the welfare analysis further justify our intuitions. From Proposition 1, we have proven all MPAA's claims on how movie piracy has hurt the movie industry by greatly reducing total profit for the movie producer. It certifies that the movie producer can earn the maximum amount of total profit when there is full protection against any movie piracy, and the later pirated versions are available, the more total profit the movie producer gets.

The opposite is true for consumer surplus, as proven by Proposition 2: the consumer gets the least benefits when there is no movie piracy, and the earlier pirated versions are available, the more the consumer surplus. This is expected as the presence of movie piracy will mean that consumers get to view the same movie for free and this puts a downward pressure of prices of original theatrical movies and DVDs. Such price competition always benefits consumers. There may even be more for consumers to gain when movie companies fight against piracy by improving

quality of films or by giving out free movie collectibles for those who value the original version.

In order to be fair to both the movie producer and consumers, the best situation is to enforce a certain level of intellectual property rights protection for the movie producer, but relaxing the surveillance against movie piracy in the second period. This strategy will not only protect the profit interest of movie producers; the presence of second period piracy will help consumers to check on the market power of the movie studios, preventing any unreasonably high movie tickets or DVD prices. This balance will definitely enhance the overall social welfare, as we have proven in Proposition 3.

5. CONCLUSION

In this paper, we set up a two-period model to find out the impact of movie piracy on both the movie theatres and DVD markets, where we considered three scenarios: no piracy case, piracy in first period and lastly, piracy only begins in the second period.

From Chapter 3, we found out that no matter when pirated version of the movie enters, a higher quality pirated copy will have an adverse effect on prices, demand and profits of both theatrical movies and original DVDs. Also from Chapter 4, we have proven that total profit for the movie producer is the highest when there is no piracy. Thus, it will be in the movie producer's best interest to eliminate piracy altogether.

As for consumers, we have found that consumer surplus is the lowest without piracy and increases with an earlier availability of the pirated version of a movie. It clearly highlights the fact the consumers and movie producers have a clash of interests. Since we need to balance the interests of both parties, the best strategy is to protect the movie producers in the first period, and then allowing consumers to enjoy the availability of free pirated copies in the second period. We have proven how allowing piracy in the second period creates a larger overall social welfare than not having piracy at all.

The model, despite considering both theatrical movie and DVDs market, still has its limitations. We have not considered the group of consumers who purchases

both the movie ticket and the original DVD. As movie piracy is a relatively new topic, there are certainly many other areas of research, such as how piracy affects the determination of the length of the "distribution window" between theatrical movies and original DVDs.

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Appendix A

<u>No Piracy Case: Comparing Prices of Theatre Movies and DVDs</u>

$$P_{NP,m}{}^{*} = \frac{\theta_H}{2} \qquad (1)$$

$$P_{NP,d}{}^{*} = \frac{\delta\theta_H + \delta A}{2} \qquad (2)$$

$$D_{NP,m}{}^{*} = \frac{\theta_H(1-\delta) - \delta A}{2(\theta_H - \theta_L)(1-\delta)} \qquad (3)$$

For $P_{NP,d}{}^{*} > P_{NP,m}{}^{*}$, then it must be that

$$\delta\theta_H + \delta A > \theta_H$$

$$\therefore A > \theta_H \frac{1-\delta}{\delta}$$

However for $D_{NP,m}{}^{*}$ to be positive (Assumption 1),

$$\delta A < \theta_H(1-\delta)$$

$$\therefore A < \theta_H \frac{1-\delta}{\delta}$$

Hence it is inconsistent for $P_{NP,d}{}^{*} > P_{NP,m}{}^{*}$ if we maintain a positive $D_{NP,m}{}^{*}$. For Assumption 1 to be binding, it must be that $P_{NP,m}{}^{*} > P_{NP,d}{}^{*}$.

<u>Piracy Begins in First Period Case: Comparing Prices of Theatre Movies and DVDs</u>

$$P_{P1,\,m}{}^* = \frac{\theta H(1-q)}{2} \qquad (8)$$

$$P_{P1,\,d}{}^* = \frac{\theta_H(\delta-q)+\delta A}{2} \qquad (9)$$

$$D_{P1,\,m}{}^* = \frac{\theta_H(1-\delta)-\delta A}{2(\theta_H-\theta_L)(1-\delta)} \qquad (10)$$

For $P_{P1,d}{}^* > P_{P1,m}{}^*$, then it must be that

$$\theta_H(\delta-q)+\delta A > \theta_H(1-q)$$
$$\therefore \delta A > \theta_H(1-\delta)$$

However for $D_{P1,m}{}^*$ to be positive (Assumption 3),

$$\delta A < \theta_H(1-\delta)$$

Hence it is inconsistent for $P_{P1,d}{}^* > P_{P1,m}{}^*$ if we maintain a positive $D_{P1,m}{}^*$. For Assumption 3 to be binding, it must be that $P_{P1,m}{}^* > P_{P1,d}{}^*$.

Piracy Begins in Second Period Case: Comparing Prices for Theatre Movies and DVDs

$$P_{P2,\,m}{}^* = \frac{(1-\delta q)\theta_H}{2} \qquad (18)$$

$$P_{P2,\,d}{}^* = \frac{\delta(1-q)\theta_H+\delta A}{2} \qquad (19)$$

$$D_{P2,\,m}{}^* = \frac{\theta_H(1-\delta)-\delta A}{2(\theta_H-\theta_L)(1-\delta)} \qquad (20)$$

For $P_{P2,d}{}^* > P_{P2,m}{}^*$, then it must be that

$$\theta_H\delta(1-q)+\delta A > \theta_H(1-\delta q)$$

$$\therefore \delta A > \theta_H(1-\delta)$$

However for $D_{P2,m}{}^*$ to be positive (Assumption 4),

$$\delta A < \theta_H(1-\delta)$$

Hence it is inconsistent that $P_{P2,d}^* > P_{P2,m}^*$ if we maintain a positive $D_{P2,m}^*$. For Assumption 4 to be binding, it must be that $P_{P2,m}^* > P_{P2,d}^*$.