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Motion pictures and piracy
- a theoretical investigation

Jørgen Rosenlund

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Working Paper No 20/13

Motion pictures and piracy - a theoretical investigation

by

Jørgen Rosenlund

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THE ECONOMICS OF MEDIA AND TELECOMMUNICATIONS

This report is one of a series of papers and reports published by the Institute for Research in Economics and Business Administration (SNF) as part of its telecommunications and media economics program. The main focus of the research program is to analyze the dynamics of the telecommunications and media sectors, and the connections between technology, products and business models. The project "Satsing i tele og media" is funded by Telenor AS, TV2 Gruppen AS and the Norwegian Broadcasting Corporation (NRK).

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Abstract

In recent years, copyright-protected markets have been challenged by the sharp rise in usage of peer-to-peer networks. Many of these networks participate in illegal sharing of copyrighted materials, such as books, music and movies. The illegal copying and sharing of intellectual property – also known as piracy – is depicted by firms and media as a terrible crime. But what are the actual consequences of the file-sharing activity?

While the music industry has progressed toward lower investment costs at the same time as piracy arose, motion pictures are as – or even more – expensive to produce than before. When reproduction costs are negligible, this makes the motion picture industry more vulnerable to piracy.

With the aim of gaining knowledge about motion picture piracy, this paper extensively reviews the motion picture industry and literature relevant to piracy in information good markets, motion pictures in particular. It then constructs two models of motion picture piracy with origins in different parts of the theory of industrial organization. Even though the models are not complete in any sense of the word, they nonetheless provide some interesting results.

It is shown that, under specific circumstances, piracy can both raise and lower legal demand for motion pictures. Effects upon profits cannot be unambiguously concluded with. It is also shown that an increase in a consumers cost of piracy can negatively affect demand in specific periods – due to fewer consumers being charged with a higher price. It is concluded that further research is much needed to fully understand the workings of piracy in the motion picture industry and its total welfare effects.

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Jørgen Rosenlund

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1. Introduction

Motion pictures have been a major part of the consumer's entertainment package ranging all the way back to the late 19th century. While the industry by age is an old one, technology driven changes still make the industry a highly interesting area of research.

From the start of the new millennium, industries protected by intellectual property rights have been challenged by a rise in so called file-sharing, wherein consumers that could have bought the products legally instead choose to download them from illegal file sharing sites. At the start of the Internet era, broadband speeds were so low that the music industry arguably had the biggest issue with illegal file sharing. As broadband speeds have become several times faster, however, the motion picture industry is also noticing the effects of the technological changes. Piracy in the form of file-sharing is interesting because, as Danaher & Waldfogel (2008) note, *"…it was not until the introduction of the BitTorrent protocol that movie piracy truly took off."*

While the illegal file sharing in the music industry has received wide-spread attention, both empirical and theoretical papers regarding the effect on the motion picture industry are few in number. Especially theoretical models for the effects on the motion picture industry are lacking. We are somewhat surprised by this, especially because the industry engages in very interesting inter-temporal pricing and quality issues – issues that are not as valid in the music industry.

The technological advance that allow for file sharing, also allow the industry to both save cost and raise consumption by exploiting the same technologies. While the motion picture industry was originally reluctant to offer digital copies of their products, new video-on-demand solutions like Hulu, Voddler and Netflix have emerged in the wake of the success of music streaming businesses like Spotify.

Motion pictures are released in both the cinema format and the DVD format, normally so that motion pictures are shown in the cinema for a limited period of time, and are sold in the DVD format or as video-on-demand for the rest of the motion picture's sales period. There is no reason to believe that all consumers agree upon which format is the best, and as such, cinema showings and DVD sales are horizontally differentiated goods. Applications from inter-temporal price discrimination of a uniform good are therefore lacking, as are applications from the classical "paperback vs. hardcover" literature on books – because consumers are homogenous in believing that hardcover versions have a higher quality.

We study the effects of motion picture piracy with a foundation in industrial organization. As Hotelling (1929) stated, *"between the perfect competition and monopoly of theory lie the actual cases."* We find it highly interesting to specify real life effects through the means of theoretical-mathematical models. The field has had significant interest in later years.

This paper will try to build on the existing theories of industrial organization to maximize profits with inter-temporal pricing in horizontally differentiated information goods – both with and without considering the effect of piracy. By doing this, we propose a possible way of modeling motion picture piracy. The models presented in this paper is supposed to help understand the effects of increasing piracy in the motion picture industry, and suggest some variables that are relevant when trying to maximize profits while at the same time accommodating piracy.

As such, we pose the research question

"Focusing on how to model piracy in the sequential distribution landscape that is motion pictures, how can it be modeled, and what are profit and welfare implications of the existence of piracy in the motion picture industry?"

The rest of the paper is arranged as follows. Section 2 provides an introduction to the motion picture industry. Section 3 reviews the relevant literature concerning piracy. Section 4 presents and discusses the model extended from Poddar (2005). Section 5 presents and discusses a model based on theories of horizontal differentiation. Section 6 discusses the models together and toward the general literature, and section 7 concludes.

2. Industry review

2.1 Prelude

The motion picture industry, while older than many other technology based industries, is still a highly dynamic one. Technological changes happen relatively often, and only in the last 20 years, the industry has seen a change in video sales going from VHS to DVD, and recently the possibility to buy and download a movie online. With the change from physical to digital reels, the movie theaters are also experiencing technological change. In Norway, 58% of auditoriums were digitalized by 2010 (Henriksen & Taule, 2012).

Even though this technological shift will save costs in the production process of motion pictures, it is not necessarily all good. While box office revenues have steadily risen during the 40 years from 1965-2005, the threat from motion picture copying and piracy has been significantly elevated with the introduction of high-speed internet (Vogel, 2011).

This section will focus on the history and current state of the motion picture industry, as well as a look into how the value chain of the motion picture industry works. Furthermore, a discussion of copyright will arise. The paper' main focus will be on piracy, and this section concludes with an introduction to the most important matters concerning internet piracy and copying.

2.2 A Little History

In the early 1890s Thomas Edison provided the world with a new invention – a camera able to photograph moving objects – the Kinetograph was created (Vogel, 2011, p.72). Soon after, consumers were offered the chance to buy a ticket to view short films played on a continuous reel, and the first "movie theatre" was born.

Fast forward to the 1920s, and several motion picture studios had already split the industry between them. Many of the studios controlled all parts of the value chain – from production to exhibition. In this decade, new technology introduced the possibility of having sound in the movies. The quote *"Who the hell wants to hear actors talk? They're silent the way they should be!"* famously credited to Warner Brothers founder H.M. Warner, gives an idea of how reluctant the industry has been to change since the very beginning (Eliashberg et al., 2006). This rigidity in the industry may also be seen in the tardiness of introducing legal online streaming possibilities in the Internet age.

Motion pictures quickly became a big part of leisure spending for U.S. consumers, and after the Great Depression, five big studios remained to control the industry – MGM, Paramount, Twentieth Century Fox, RKO and Warner Brothers. Some lesser companies - including Universal - also survived the Depression. The general consensus is that these survived mostly because they were vertically integrated firms (Vogel, 2011, p.74). After the Depression, the 'Code of Fair Conduct' was agreed upon to ensure stability for the major studios. This 'Code' was fairly quickly discontinued due to legal matters, but tacit collusion between the studios was not unheard of (McKenzie, 2012).

Controlling the entire chain had become a problem for the smaller studios, though, and by the 1940s, several lawsuits culminated in what is known as the Hollywood Antitrust Case of 1948. This case decreed that no studio could also own exhibition facilities. Thus, the vertically integrated firms were forced to split, and the major studios sold off their exhibition companies (Vogel, 2011, ch. 3). While the intent of the decree has later been slacked, exhibitors are still mostly independent from studios. How the value chain of the industry looks today will be further examined.

2.3 Defining characteristics

The literature on motion pictures is mostly based on the production and releases stemming from the world famous centre of Hollywood. Therefore, in this paper, whenever the "motion picture industry" is mentioned, what is thought of is the major group of producers and studios based in Hollywood. While motion pictures are produced in the entire world, Hollywood account for a large share of the motion pictures global consumers will see during a lifetime (Vogel, 2011, ch.4).

2.3.1 Information good

The motion picture industry produces what is known as *entertainment goods***,** a form of *information goods.*

Following the definition of Varian (1998) an information good is anything that can be digitized (but is not necessarily digitized.) Examples listed are books, music records, telephone conversations, newspapers – and of course *motion pictures*.

An information good has three main properties that are essential for its understanding. First, information goods are *experience goods.* There are *returns to scale* present in the production of them, and information goods may be *public goods.*

Being an experience good, to find out the exact nature of what the good is, you have to consume it. This means that consumption has taken place before the consumer knows the true value of the good. Comparing to the motion picture industry, you do not know the true quality of the movie until you have actually seen it. This means that there is a great amount of *uncertainty* in the consumption of information goods.

Considering that most consumers are risk averse, consumers of information goods would at the margin consume less of the information good than they would if they knew perfectly well the value of the good. Therefore, sellers of information goods try to decrease the amount of uncertainty connected to their good. In the motion picture industry, this is dealt with by offering previews of the movies that are in theaters. Reviews from both critics and consumer-driven sites like IMDb (the Internet Movie Database) also helps decrease uncertainty.

Varian (1998) writes that *"[i]nformation is costly to produce, but cheap to reproduce."* The inherent returns to scale in the production of information goods mean that producers take a big risk in producing them. High sunk costs in production will not be recovered if sales of the products are low. It should be noted as well that had the motion picture industry been close to

perfectly competitive, no expensive movies would likely be produced. This makes the industry interesting in the field of industrial organization. The fact that information goods are cheaply reproduced also means that they are highly vulnerable to piracy, as compared to producers of hard goods such as automobiles.

An information good may also be a public good. A public good means that the good is both non-rival and non-excludable. That the good is non-rival means that if consumer A consumes the good, consumer Bs consumption of the same good will not be affected or diminished in any way. With the low marginal cost nature of information goods, they are inherently non-rival (Varian, 1998). To be non-excludable, it is not possible to exclude any consumer from free consumption of the good. A classic example of a non-excludable good is street lights. It would be next to impossible to exclude some consumers from enjoying the positive effects of the street lights while allowing others to 'consume' them.

For motion pictures the non-rivalry of public goods seems to fit quite well. Paul will still have the same value of watching *Pirates of the Caribbean* even though John watched it the night before. (Unless John was to tell Paul every little detail about the script, of course.) It is very problematic to argue that a motion picture is non-excludable, however, considering that a consumer has to pay in order to watch the movie. A good that is non-rival, but excludable has been called a *club good* (Buchanan, 1965). Belleflamme (2002) calls them *public goods with exclusion.*

Of course, it is only a legal convention that a motion picture is excludable. If you were both able and willing to steal a movie, without caring about possible prosecution, it is by definition a pure public good (Varian, 1998). If laws were eliminated, the only thing keeping a non-rival good from being a public good would be anyone physically defending the product from being stolen.

The diffusion of online piracy makes this barrier easier to cross. With piracy, motion pictures are *legally*, but not technologically excludable (Varian, 1998). Gaustad (2009) points out that the negative effects arising from piracy stems from how they eliminate the excludability of the good – making it a public good instead of a club good.

2.3.2 The value chain

With this clarification of the nature of the information good that is motion pictures, we turn to a look at the value chain for the motion picture industry. Eliashberg et al. (2006) split the

sequence of making and selling a motion picture into three: *Production, distribution and exhibition.*

Production includes the various elements of producing the motion picture – usually starting with a story concept from a literary work, a real life event or an original idea. (Eliashberg et al., 2006) It is also possible that the concept is a sequel to an already successful franchise, or a re-creation of an already existing motion picture. Finally, a motion picture company can release an already existing movie in a better format for contemporary viewers, as for example "*Indiana Jones and the Raiders of the Lost Ark"* that was re-created in 2012 from a blockbuster originally released in 1981.

The writer of the story concept then tries to sell the idea to a producer, if it is not already. A producer will, if the motion picture is completed, be responsible for the actual production process – filming the scenes, and then putting them together to create what will eventually be seen on the big screen.

If the concept is picked up by a producer, the producer will seek financing to put together a filming crew and a cast for the movie. Quite few of the ideas originally pitched to producers make it to this stage (Eliashberg et al., 2006). Some producers have contracts with the major studios, meaning that the studios will help them with the financing – either by paying out of their own pockets, or by guaranteeing loans from external financers. The producers who have such deals, will often have to give up the rights to possible sequels and other ancillary revenue sources, but are in a much better position to actually finish production of their screenplay (Vogel, 2011, ch.4).

Producers who do not have access to such studio deals are much less likely to find financing; taking into consideration that the risks of these investments are much higher than it would be with a studio backing the production company. There is also the point that *distribution* is not guaranteed for these motion pictures (Eliashberg et al., 2006). According to Vogel, the most common ways to find external financing is from common-stock offerings, combination deals, limited partnerships, bank loans and private equity (Vogel, 2011, ch.4). Producers are highly creative in their way of trying to appeal to external financers, because receiving capital is "do-or-die" for any given screenplay.

With financing complete, the production company begins the process of actually producing the movie. This process is again split up into preproduction, principal photography and post-

production. Preproduction includes for example casting, crew selection, script development and choosing locations. In this process, the talent agencies providing production with actors are of utmost importance, helping producers to find the talent they need without high search costs or long delays. With all this in place, the principal photography takes place – scenes are shot and the "raw material" of the motion picture is produced. Finally, the production company edits, adds music and special effects in the post-production process (Vogel, 2011, ch. 4). After all this, the motion picture is ready for *distribution.*

The studios are typically responsible for the distribution of motion pictures. While some movies are produced without the help of a studio, ("independents" or indie movies) many of these are picked up by a studio after production has been completed (Eliashberg et al., 2006).

For this part of the process, it is important to understand a major characteristic of the motion picture industry. Motion pictures are released in several different formats – ranging from theatrical showings, DVD sales and rentals, Internet streaming and downloading, video-on-demand, pay-per-view, to showings at both pay- and free TV-channels (Vogel, 2011, ch.4).

Traditionally, the industry has used a special form of inter-temporal price discrimination to maximize their profits. The formats a motion picture is released in are distributed at different points in time, called "windows." To maximize their profits from this behavior, Vogel (2011) explains:

"Sequential distribution patterns are determined by the principle of the second-best alternative […] That is, films are normally first distributed to the market that generates the highest marginal revenue over the least amount of time."

Generally speaking, this means that the studio first releases the motion picture in theatres, then pay cable showings, DVDs and streaming, and finally open TV-channels (Vogel, 2011). The "video window" is regarded as the most important decision variable (Chiou, 2008).

The companies that carry these formats are generally known as exhibitors. Exhibitors include movie theatres, video shops and rental businesses, different types of TV-channels and online streaming sites, like Hulu and Voddler.

The distributors are responsible for the marketing efforts in the release of the motion picture, and are also making contracts with the exhibitors about both revenue-sharing and the length of the different windows (Mortimer, 2008).

In the simplest sense, a motion picture will be placed in one or more of the "four quadrants." For marketing purposes, the studios operate with the specifications young/old and male/female. Distributors then sell their motion picture to theatres situated in areas with desirable demographics. It is normal for the studio to negotiate terms with specific exhibitors instead of selling the motion picture with the same contract to the entire exhibition landscape (Vogel, 2011, ch. 4).

A contract with an exhibitor will normally include the number of *screens* the motion picture will run on. Furthermore, it will include a "staircase" of how much the distributor and the exhibitor gets of revenues. After accounting for the "house nut," the fixed cost of the movie theatre, the parts agree on a percentage share of the box office revenues for the first week, second week, and so on. Commonly, distributors receive most of the revenues in the first few weeks, and then their percentage share falls over time (Vogel, 2011, ch. 4). This form of sliding-scale agreement creates an incentive for the exhibitor to screen the motion picture for a longer period of time – which could create higher revenues for the distributor than if this sliding-scale arrangement was not in place.

Before the video window opens, the distributors' only revenue comes from the box office, while movie theaters also gain revenues from selling snacks and drinks, and from advertisements before the movies. Because of this, movie theaters have an interest in keeping the ticket prices low to attract higher admission. There is obviously a moral hazard problem in this case, yet it is not normal for distributors to make demands of a minimum admission price (Vogel, 2011, ch. 4).

The studios also have to make deals with the exhibitors of their other formats, with video retailers, TV channels and online video salesmen. While these formats are normally released at a later point in time, some of the contracts will also describe when the particular format will be released. Even though this contractual arrangement is made with ancillary exhibitors, and ultimately decided by the studio, the timing of the releases is of utmost importance to the movie theater exhibitors. Studios will consider the theater exhibitors' opinions when choosing when to open ancillary windows.

Traditionally, video stores acquired their inventory through linear-pricing contracts with distributors. But in 1998 revenue-sharing was adopted by a large part of the industry – even though most video stores were still allowed to choose between linear pricing and revenue-sharing (Mortimer, 2008). The main reason for this arrangement was that smaller video stores

did not have the technology or expertise to maximize their profits through a revenue-sharing contract. Larger video store chains like Blockbuster would adopt revenue-sharing, however.

According to Vogel (2011), revenues from pay-TV channels are facing a downward trend. The TV channels have found other viable options, for example making their own TV-shows, and consumers are increasingly watching motion pictures at home using other alternatives, such as video-on-demand, pay-per-view and, of course, through illegal downloading. There will still be a market for straight-to-TV movies, which are commonly bought from independent producers who did not get a theatre deal.

The future of the video retailers is also on the line. New methods of distribution, including online streaming sites like Voddler and online sites that sell and ship the physical product, for example Amazon, give the studios a bigger share of revenues than more traditional sales methods. Furthermore, some studios have seen it fit to sell their DVDs through their own online sites (Vogel, 2011). Walt Disney has already implemented such an arrangement for their motion pictures, although said motion pictures are also available through more traditional means. While sales through video retailers continue, this line of business is not only falling in revenues, but has also been solidified in the U.S. to include just a few major retailers like Blockbuster. This may be a further sign that this part of the industry is - speaking in the framework of business life cycles - maturing.

There is a current trend that all windows open earlier – and in some cases, studios have opted to release a motion picture "day-and-date", that is releasing the theatrical and home video at the same time (Calzada et al., 2012). There are both pros and cons associated with this trend. It is believed that this gradual change has been caused by studios who want to exploit the bandwagon effects of the theatrical release of the motion picture.

Bandwagon effects are positive network externalities where *"…a consumer wishes to possess a good in part because others do"* (Pindyck & Rubinfeld, 2005). If Paul told John that *The Avengers* is a great movie, John might have a bigger interest in buying the DVD than if he had not heard it from Paul. As time goes on, the positive buzz created from people talking about a motion picture they have seen will vanish.

Chiou (2008) explores an alternate explanation where a distributor times its theatrical and home video release to maximize profits when considering the yearly cycles of demand for both home video and theatrical viewings. The trend of shortening the video window might be

seen as a problem for the theatre exhibitors. Chiou (2008) notes that the possibility of harming long-term relationships between theatre owners and studios exerts pressure to keep the video window lengthy. The studios will have to decide how to balance the long-term effects of their relationship with theatre exhibitors and the short-term effect of generating higher revenues from the bandwagon effect of any single motion picture.

An important aspect in the discussion of this paper, piracy is likely to be a better substitute for DVD sales and rentals as compared to the theatre experience (Calzada & Valletti, 2012). There might be a push, therefore, to cluster the theatrical release in the U.S. and in foreign markets closer together to avoid potential foreign consumers downloading the movie illegally before it is released in the theatre. Gaps between U.S. and international release times are getting shorter (Eliashberg et al., 2006). Notably, while being a co-production between the U.K. and the U.S., the 32nd James Bond-movie *Skyfall* was released in European markets well over a month before it hit theaters in the U.S. (MI6-HQ).

Because piracy is much more likely to harm DVD sales and rentals than theatre attendance, future timing decisions will probably be affected by the surge of piracy (Bounie et al., 2006). In accordance with this thought, releasing theatre and DVD day-and-date should be a problem - because piracy has a bigger chance of cannibalizing theatre attendance when the waiting costs for obtaining a pirated copy are eliminated. Bounie et al.'s (2006) discussion of this substitutability is based on the existing timing principle, where DVDs are released after the theatre exhibition has run its course.

Mortimer (2008) underlines the fact that gross revenues from home video have exceeded theatrical revenues since as far back as 1986. From this understanding, the theatrical run might be seen as a loss leader (Weinberg, 2006). The fact that theaters no longer are the main source of income, and has not been for a long time may become a factor in future windowing decisions.

A rough take on the value chain for a studio-backed motion picture is recapped in Figure 2.1.

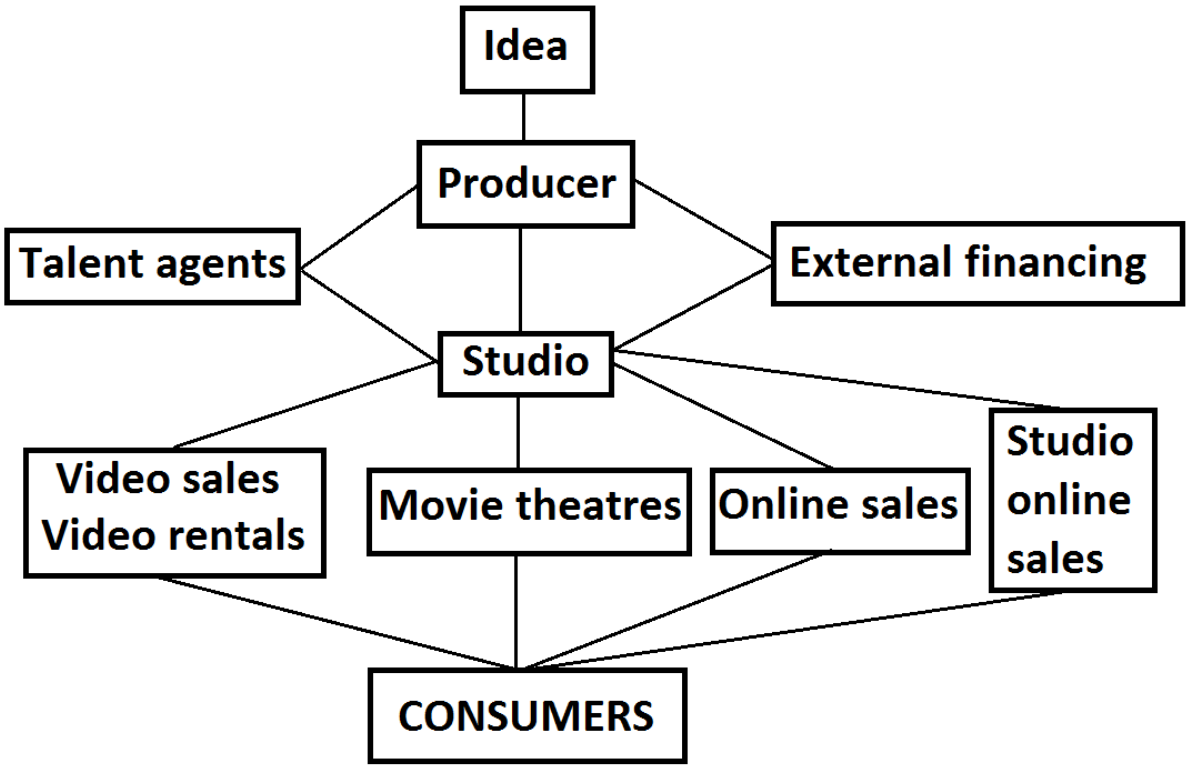

Figure 2.1. The value chain of the motion picture industry

Notably, the motion picture industry is one involving great risks. In practice, risk is the core of the motion picture industry. It is essential to understand that the major companies are involved in the industry not because they make small profits from each motion picture, but because they can earn considerably from a single blockbuster. As will be understood in greater detail, most motion pictures do not break even – the industry is kept afloat by a handful of great successes (Eliashberg et al., 2006).

As a footnote, the production process described here fits best to how a motion picture comes to life in the United States. Different processes can probably be found elsewhere, and Hollywood only accounts for about 700 of the approximately 4000 movies released worldwide every year. Still, Hollywood-produced movies account for a significant part of box office admissions worldwide (Eliashberg et al., 2006).

For the Norwegian part of the industry, the *basis* of business is of a completely different character. Not only are there a lot fewer potential customers, (limited by those knowing the Norwegian language) but financing is in the same manner more difficult to come by. Without the government subsidizing it, a significant share of the Norwegian film industry would fade away (Bertelsen, 2009).

The government has a goal that Norway as a whole should produce a minimum of 25 full length motion pictures per year, as well as other minor goals (Bertelsen, 2009). It is probable that this goal would not be met if it were not for the help of the government. Furthermore, the Norwegian industry also involves a lot fewer players – including producers, talent agents, actors, and financers.

In some ways, however, the Norwegian industry can be seen as a much smaller copy of the American one. The major players are split up into producers, distributors and exhibitors – all the while one company rarely has control over several parts of the value chain (Bertelsen, 2009). Producers are small, while both the distribution and exhibition part of the chain are dominated by bigger firms (Bertelsen, 2009). The main difference is probably that Norwegian motion pictures to a much larger degree are subsidized by the government.

A small remark about independent movies – "indies" - may be of use. While independent movies have had difficulty getting attention from a larger crowd – the emergence of the Internet may have positive effects on their reputation. Distribution through the Internet, while increasing the possibility of piracy, also increases the possibility of finding independent movies better suited for specific consumer groups. In a study about the effects of online music sharing for artists, Gopal et al. (2006) finds that unknown artists are more likely to become known during the Internet era than before it. This effect may be directly transferrable to independent films, but this claim should be examined further before drawing any conclusions.

The intricate value chain of the motion picture industry opens up unlimited research possibilities. The interaction between the different parts of the value chain would take a lot of time to fully understand, and the relative strength of the participants is ever-changing. After this introduction to how the business works, however, the paper will – unless otherwise stated - consider the motion picture industry as one single unit. This choice has been made to easier show the reader the point of the paper – to identify how the industry is affected by the current threat of online piracy.

2.3.3 Crunching the numbers (U.S. and Norway)

Another way of understanding the motion picture industry better is to look at the numbers. The Motion Picture Association of American (henceforth MPAA) regularly releases numbers for box office attendance and income, giving accurate numbers useful for empirical research. MPAA is made up of the six biggest studios of the U.S. – accounting for between 80 and 90%

of yearly revenues from distribution of theatrical films in the industry. For this reason the motion picture industry is the basis of quite an extensive chunk empirical literature.

In 2009, the box office revenue from the U.S. alone generated more than $10 billion; globally the numbers were up to $26 billion, for 7.2 billion admissions (Vogel, 2011, ch. 3). Considering that there is an established fact that most motion pictures generate bigger revenues from video rentals and sales than from the box office, this gives an indication about the size of the industry (Calzada & Valletti, 2012). One of the latest blockbusters, *The Avengers,* generated $207 million in box revenue during its first week at the screens (Box Office Mojo).

Revenues are only one part of the picture, though. While the marginal cost of producing a copy of a motion picture is practically zero, huge sums are spent on creating the motion picture in the first place. In 2007, the average MPAA-film had a production cost (including marketing) of approximately $60 million (Vogel, 2011, ch. 4). Considering the fact that any single consumer will pay a relatively low price for consuming a motion picture, it is of utmost essence to the motion picture industry that consumers pay for their consumption. While the average U.S. box office admission price is $6 (Vogel, 2011, ch.3), an "average" MPAA-film would need 10 million admissions just to break even! Ancillary revenue sources account for the biggest part of revenues; nonetheless, the comparison shows how important it for the industry to avoid piracy from consumers who otherwise would have purchased a ticket.

To say that ancillary revenue sources account for the biggest part of revenues may seem contradictory. Ancillary revenue sources are in practice not ancillary at all. A better way to describe the revenue model of the industry is to call the theatrical run a "loss leader." And domestic cinema has been a loss leader for as far back as 1986.

With the high risk and huge volatility involved in the motion picture industry, studios often have to rely on earning their profits from a few big hits. According to Vogel (2011), this is one of the most important aspects of the industry, stating:

"…this leads to an estimate that perhaps 5% of movies earn about 80% of the industry's total profits and that exhibition on a large number of screens can as easily lead to rapid failure as to quick and great success."

In reality, there is no such thing as the average movie. It is accepted that most movies do not even break even – the major hits are what drives profit in the motion picture industry (Vogel,

2011, ch. 4). Essentially, major studios are playing the lottery again and again, hoping to at least once hit the jackpot. One major hit may generate a profit for the entire year for a studio – shown by the huge box office of for example *The Avengers* or *Avatar*.

There are no clear numbers for total revenues in the industry – considering the many sources of revenue. Furthermore, the studios are becoming more reluctant to share their revenue levels (Vogel, 2011).

Statistics Norway (SSB, Statistisk Sentralbyrå), on the other hand, regularly releases numbers for how motion pictures fare in Norway. A short presentation of said numbers is of relevance.

Borrowing from Henriksen & Taule (2012), Norwegian movie theaters had a total of 11 million admissions during 2010. This corresponds to a decline in attendance of 13% from 2009, and to about 2.3 admissions per inhabitant – down from a maximum of 2.9 in 2003.

Admissions for Norwegian made motion pictures account for 23.3% of total admissions, and it is reasonable to believe that most of the remaining admissions come from Hollywood movies. Norwegian made motion pictures experience a smaller fall in admissions than non-Norwegian.

Furthermore, fewer motion pictures are being shown – 207 as compared to 223 in 2009. 68% of the Norwegian population attended a motion picture in 2011 (Vaage, 2012). In the age group 16-24 90% had visited a movie theatre at least once during 2010.

Vaage's (2012) statistics suggest that one out of five visit a movie theater in a given month. He also observes a trend towards falling admissions – and that there are fewer visits per person in rural districts than in bigger towns.

There were an estimated 18.3 million DVD and Blu-ray sales in 2010. This number has not been lower since 2006. Vaage (2012) finds that 14% watches some form of motion picture daily. If a consumer watches a motion picture on a particular day, he finds that 46% buys or rents a DVD, while 29% views so-called "video-files" on their computers. It is likely that many of these "video-files" are illegally downloaded. Respondents were able to tick for watching both bought or rented, "video-files" and other alternatives at the same time – such that there may be overlapping.

2.3.4 Copyright

What is inherently wrong with piracy? It all depends on the framework. From an economist's point of view, piracy might not be a problem – even though producers lose, consumer surplus is raised, and the deadweight loss is minimized. In the long run this could be different, of course, because some motion pictures that would otherwise be produced might not be, and this effect would decrease the total surplus. Although this is an interesting discussion, the fact of the matter is that under the legal framework, piracy is prohibited.

While motion pictures are information goods – where copying them will not deplenish the source, motion pictures are protected from copying by so-called *copyright laws*. To understand why the motion picture industry fights piracy, it is fitting to also understand the origins and effects of copyright legislature.

Copyright has a history spanning over the last 300 years, but it wasn't until Plant's (1934) seminal paper that economists systematically analyzed its effects.

Copyright is a grant given to the original inventor or producer of a specific idea, such that he has the main rights to produce, sell or use the idea. In effect, copyright grants the inventor a right to exploit the idea as a monopoly for the duration of the copyright period (Towse et al., 2008).

Towse et al. (2008) surveys the existing research in copyright economics. The field is vast, but is only required to give background understanding of the motion picture market for the purposes of this paper.

The original usage for copyright was in the market for books, but has later been introduced into a great number of markets (Towse et. al, 2008). Copyright for intellectual property includes music, art, software, architecture, and of course motion pictures.

Books are relatively easily copied and sold by third parties, and without copyright profit-seeking authors would have no incentive to create if they knew that a third party could compete with them in selling their own work. Copyright was therefore introduced to make sure authors were reimbursed with the profits from their own works, thus creating an incentive to continue producing intellectual goods.

Modern research on copyright includes assessing the effects on *social surplus* and the *optimal duration* of the copyright period. Furthermore, economists have tried to find *alternative solutions* to incentivizing the creation of intellectual goods, since the monopoly a copyright

grants is seen by some as a "necessary evil." Hadfield (1992) quotes from the Patent Debates in the 19th century that:

> *"Copyright is a monopoly and produces all the effects which the general voice of mankind attributes to monopoly….the effect of a monopoly is to make articles scarce, to make them dear, and to make them bad…. It is good that authors are remunerated; and the least exceptional way of remunerating them is by a monopoly. Yet monopoly is an evil; for the sake of good, we must submit to evil; but the evil ought not to last a day longer than is necessary for the purpose of securing the good."*

The quote highlights that many economists are wary of monopolies as entities, for example because they create an unnecessary deadweight loss that yields lower social welfare than under free competition. Copyright is tolerated, though, because the dynamic effects are such that there would be a decline in the supply of intellectual goods if it were to be abolished. Towse et al. (2008) claim that *"[c]opyright is a second best solution."*

Some economists take the discussion further, and claim that intellectual goods would in fact be supplied even without copyright. Boldrin and Levine (2004) make this case. They argue that intellectual monopoly could lead to lower rather than higher innovation, and that no copyright can lead to more efficient innovations. Their arguments includes showing that innovation in steam engines only just accelerated after the patent of the original engine ran out, suggesting that the industrial revolution could be accelerated by not allowing a patent to James Watts steam engine. Whether these findings are relevant also in the case of information goods, such as motion pictures, is not necessarily likely, since "innovation" in that case could be an entirely different movie or song.

Still, it is fruitful to understand some of the aspects of copyright before venturing into the domain of the motion picture industry. While this paper will not have focus on the legal aspects of copyright violations, copyright in many ways explain the way the industry is set up ex-ante.

The copyright laws protecting motion pictures grant the owner of a motion picture what is in practice "infinite" copyright of the product. In the Europen Union, motion picture copyright lasts for 50 years after publication, while it currently lasts for 95 years in the United States (Belleflamme and Peitz, 2010). Though aforementioned economists might have a problem with this arrangement – it could be argued that infinite copyright protects new motion pictures

from being cannibalized by old ones who have just become public goods. This argument is not necessarily strong, but alas, motion pictures are still protected in this fashion.

Because of the way copyright is granted in the motion picture industry, the interested parties of the industry have the legal framework behind them when they want to fight piracy. Waterman et al. (2007) describes various ways the motion picture industry has dealt with pirates – and split their paper into hard goods commercial piracy, consumer theft of pay television signals, consumer copying and sharing of pay TV and home video movies, and *Internet file sharing.* The newly arisen point of Internet file sharing has been deemed as one of the biggest threats to the motion picture industry (THR Staff, 2011).

To pull consumers away from piracy, the industry has two options – either using a cost-raising strategy or a product quality reducing one. A cost-raising strategy could include raising punishments for infringements, while a product quality reducing one could be set in place by installing technology that degrades the value of copies.

The MPAA has been the leading agent for enforcing copyright laws in the motion picture industry. They report illegal activity they uncover to the authorities, and lobby for stronger punishments for copyright infringements. Furthermore, they have a hand in the licensing of technical standards that tries to limit the pirating activities – such as copying locks on DVDs or DRM systems.

In the past, the MPAA and others have succeeded in persuading the government to introduce legislature for specific types of piracy, especially in the encoding of pay-TV signals. With Internet file sharing, however, strict punishments have not yet been implemented – often due to there being a discussion about the possible limitations on fair use of the copyrighted products.

The MPAA have combated Internet file sharing mainly by attempting to raise the cost of piracy – but also by trying to reduce the quality of the files. There have been attempts to raise search costs, for example by adding corrupt files to the file sharing network or by paying search sites on the Internet to present results for BitTorrents lower down on searches (Dvorak, 2012).

By raising the number of security guards at the movie theaters, they have also tried to limit the number of camrecordings that are available online. Further, they have launched campaigns in the media to inform of the illegality of file sharing, and filed lawsuits against consumers.

Several attempts to limit the consumer file sharing of motion pictures have already been put in place, and more are bound to follow. With more specific legislature in hand, it might be easier to deter the pirates, without having to lower prices too much.

2.3.5 Legal inter-industry competition

The main focus of the paper is the effect piracy has on a motion picture as a whole. While there are several interested parties in the motion picture industry – producers, studios, cinemas, home video outlets, and online streaming sites – that all to some extent compete with each other, there can be of no doubt that the industry also experience competition from inter-industry substitutes. A short look to these substitutes might be of use.

As an entertainment good, motion pictures are competing with other entertainment products. Consumers will consume entertainment goods during their leisure time – which is limited, and most consumers will also have a cap on the spending they can have on these activities. Since consumers have no chance to consume everything, we experience competition between different entertainment products.

While all entertainment goods compete for the same leisure time – some are likely to be better substitutes for a motion picture than others. A single consumer has specific preferences about the nature of the entertainment goods he consumes. For example, some consumers will prefer to sit at home and consume an entertainment alternative, while other consumers might prefer to go out and consume. In the same manner, some consumers might want to actively take part in their entertainment experience, and some prefer to passively consume an entertainment good.

Some entertainment goods have an advantage in that they can be consumed while doing other things – motion pictures are excluded from this advantage. When watching a motion picture, it is likely that the consumer will be completely focused on the consumption of it.

Since there are nearly infinite possibilities as to how the consumer mass chooses to allocate their leisure time, it seems fitting to split up the entertainment alternatives into groups after how well they compare to different types of consumption of motion pictures.

Passively at home alternatives include watching TV-shows, sports on TV, or other TV-programs. They could also be reading a book, or listening to music or to the radio.

Actively at home entertainment goods include - but are not limited to - video games, board games and surfing the Web.

Passively outside entertainment goods would be alternatives such as being a spectator at a sports event, attending an art exhibition or, also fitting here, listening to music or the radio.

Actively outside entertainment goods would be such 'consumption' as doing sports, exercising, dancing or using newly introduced smart phones.

Motion pictures can be consumed passively at home – with alternatives such as the DVD, VOD, TV alternatives and internet streaming. Motion pictures can also be consumed actively outside of the home – most prominently at the movie theater.

Logically, it seems that motion pictures compete mostly with other passive at home or passive outside alternatives, but also with active at home entertainment alternatives. We would expect active outside alternatives to compete the least with motion pictures. Empiric research about the nature of consumers entertainment bundle would of course be needed to specify this section further.

A rise in inter-industry competition has been put forth as one of the reasons that the motion picture industry is noticing a decline in spending. As Waterman et al. (2007) notes:

"U.S. movie spending has flattened since 2004, but that has been widely attributed to a spate of poor movies and a defection of movie consumers to video games and other electronic media."

Several hundred million dollars is used in marketing efforts by the motion picture industry every year. Such marketing will in most cases be about a single motion picture, but the total effect of the marketing effort can be both informing and market stealing. If a consumer chooses to watch the motion picture, his time and money available for other entertainment goods diminishes.

Silver & McDonnell (2007) propose that there are many reasons for why we see diminishing revenues in the motion picture industry. Amongst them are many intra-industry competitors. Any research on piracy should bear in mind that piracy is not the only threat to the industry.

2.4 Piracy

2.4.1 What is piracy?

So what is piracy, anyway? The industry review as yet has assumed that this is common knowledge, but a specification of what piracy is and how it affects the motion picture industry is in order. Piracy doesn't only affect motion pictures – there have been widespread media attention towards piracy of for example music, computer software, e-books, and other copy-able information goods. See for example "Nordmann siktet for fildeling etter internasjonal storaksjon" (Heyerdahl and Akerhaug, 2010) and "Pirate Bay blokkeres i Storbritannia" (Færaas, 2012). A search for "file-sharing" at BBCs website provided 865 results.

Piracy is the *"unauthorized reproduction, use or diffusion of a copyrighted work"* (Belleflamme and Peitz, 2010).

Why piracy? For consumers, piracy offers a way of consuming a specific information good without having to pay the full price of the legitimate good. Several limiting factors weigh in, of course, including having to accept lower quality, the potential hassle of obtaining it, and of course the implicit cost of breaking the law.

The illegality of the matter raises further questions - if a consumer is willing to break the law by knowingly acquiring an illicit copy of an information good, why not go a step further and steal, say, a car? Behavioral studies are required in order to better understand this, but a preliminary idea is that buying or downloading pirated goods is seen as "okay" partly because of the "digital mindset" of the contemporary time period (Mayer-Schönberger, 2008).

For the pirates who sell their goods at a price, the incentive is clear. These pirates are able to sell a good that's already been developed – remember that an information good typically has a very high fixed cost and a very low marginal cost – and therefore sell it at a lower price than the original developer.

It may be more difficult to understand why pirates in the digital era are sharing pirated material. With today's P2P technology, it is common to see "ripping groups" offer their pirated copies at no cost, and at Internet sites other than their own (VCDQ).

Hennig-Thurau et al. (2007) put forth possible reasons for obtaining and sharing illegal copies of motion pictures in the digital era. They list concepts such as transaction utility, mobility utility, social utility and collection utility. The utility most likely to be high in members of "ripping groups" should be the *anti-industry utility.* Having a negative attitude towards the

system and/or the copyright holders provides an incentive to share illegal copies even without financial gain. Social utility might also be of relevance, but the perpetrators need for secrecy about who they are might mitigate this effect.

It is important to note that piracy has taken many forms through its history. Piracy tends to blossom when new technology and distribution channels are introduced (Gaustad, 2009). As already mentioned under the context of copyright, *hard goods piracy* was the main focus for the motion picture industry up until the digital era. After the Internet emerged, the motion picture industry faces the possibly even greater threat of piracy through file-sharing.

When technology advances, pirates find new ways of making and distributing illegal copies. Waterman et al. (2007) describes how boxes that circumvented the encrypting of pay-TV signals were widely distributed before legislature banned them. When the VHS entered the market, retail pirates were copying motion pictures onto blank discs for distribution, while consumers shared their movies with friends through the use of a dual-slot VHS recorder.

The advent of the Internet provides the biggest technological boost as of yet. The global nature of the Internet provides pirates with a unique ability to share copyrighted material illegally. Early in the digital age, however, researchers insisted that the possible threat may be limited. It was argued that low broadband speeds and a high share of corrupt files on file-sharing networks made Internet file sharing a less viable alternative for consumers (Mayer-Schönberger, 2008).

2.4.2 Why file-sharing?

Internet file sharing will be the main focus of this paper. Henceforth, unless otherwise stated, piracy should be understood as illicit Internet file sharing of copyrighted materials.

There are several reasons for this limitation. First of all, Internet file sharing has been stated as “the biggest threat to the motion picture industry” by major Hollywood executives (THR Staff, 2011). This means that the study of it has real-life implications.

Secondly, since Internet file sharing mainly is free-of-charge – or at least accessible to some degree for all consumers with an Internet connection – the focus on profit from the file sharers should be limited. This ensures that the motivation behind file sharing simply is that the net utility from consuming them is higher than consuming the legitimate product – which makes for more interesting implications for the motion picture industry itself.

Furthermore, diffusion of high-speed Internet broadband in several industrial countries means that early researchers' downplaying of the threat because of high download times may be obsolete. As broadband speeds continue to rise, the amount of time needed to successfully download an illegal copy of a motion picture will tend toward negligible. Indeed, Martikainen (2010) postulates that *"increases in internet bandwidth as well as developments in the so-called torrent file-sharing, the sharing of movie files has become increasingly easy and common during the last few years."*

Finally, Internet file sharing seems to be the form of piracy that receives the most media attention. A paper about a relevant topic seems much more in place than analyzing an outdated threat to the industry.

2.4.3 Mediums, stakeholders, types of piracy

File sharing has already taken several different forms in its short life. At its current stage, motion pictures are successfully shared through the means of P2P (peer-to-peer) technology. So-called 'torrent' trackers are a prominent type of P2P networks.

Peer-to-peer networks differ from traditional client-server setups of file-sharing. Peer-to-peer offers a possibility to share files between consumers without having to store aforementioned files on a central server. P2P resources are stored on the computers of the users of the P2P networks, and shared through this storage arrangement (Krishnan et al., 2006).

There have already been several popular designs of P2P networks, including software such as the pioneering Napster, Kazaa and LimeWire. The U.S. government has in several cases taken action against the file sharing networks. Napster was shut down permanently. LimeWire was also shut down, albeit temporarily (Halliday, 2010).

Currently, the use of 'BitTorrents' is a popular design for peer-to-peer activity. According to Schulze and Mochalski (2009) the use of P2P networks, including BitTorrents, accounted for in excess of 50% of all Internet traffic. At the same time, BitTorrent.com reported that their main services BitTorrent and µTorrent had over 150 million unique users (BitTorrent.com press release, 2012).

Using the size of the file-sharing networks in empiric works is a problem even with published numbers. Some of the files shared are legal, and it is also highly questionable whether one download equals one sale. What the sizes do tell, is that piracy is a very real problem for owners of information goods.

Illegal file-sharing through torrents is a free endeavor for consumers of them. While consumers have no financial expense from it, however, the owners of the illegal sites may have economic incentives behind providing the service. Most torrent sites online, notably The Pirate Bay, are ridden with commercial advertisements for a wide range of consumption goods.

As a site reaches higher popularity, the use of advertisements in many cases surpasses the need to cover server costs, and the owners can pocket a relatively large sum of money. This was one of the arguments the music and motion picture industries had for taking down well-known online piracy site Megaupload in January 2012.

On the 19th of January, 2012, U.S. government seized Megauploads domain names, assets worth several million dollars, and taking four of the owners and employees of the site under arrest. Prosecutors claimed that Megaupload had earned more than $175 million during their 7 years of operation (Anderson, 2012). The amount suggests that while the file-sharing may be free, sites can earn considerably from companies willing to advertise their goods through file-sharing sites. The Megaupload case also shows how relevant piracy is in a world news setting. A horde of news outlets around the world wrote about the case, including Norwegian newspapers – see for example "Fildelingsgigant ble stoppet" (Beyer-Olsen, 2012).

There has been a focus on the fact that both hard goods piracy and Internet file sharing rates is highly volatile between different countries. Understanding the differences in piracy between countries is of importance to the motion picture industry since non-U.S. piracy rates are at substantial levels. As Waterman et al. (2007) puts it

"The MPAA attributes the effects of Internet file sharing to be in about the same proportion in U.S. and foreign markets"

Further empirical papers about these effects are needed for the motion picture industry. Walls (2008), for example, examines a data set containing piracy rates for 26 different countries, and finds that for all types of piracy, it is *"increasing in the level of social coordination and the cost of enforcing property rights, unrelated to income and decreasing in internet usage."*

When shared online, motion pictures come in different formats, describing their technical quality. Pirated movies come in many formats – but are commonly either CAM releases or DVD-rips. CAM releases are movies that have been pirated by filming it while in a movie theater. The quality is correlated to this crude method of copying. DVD-rips are copied

directly from a retail DVD, and is expected to have a very high quality. Other formats include TV-rips, workprints and screeners (VCDQ).

As is expected, considering the nature of the video window – if a motion picture has been copied in a CAM release, it will be online long before the DVD has been released. The CAM rip therefore poses a threat to the sequential distribution strategy of the motion picture industry, because consumers can enjoy a motion picture illegally at home, before distribution has even begun for home access. When the DVD is released, pirates soon release a DVD-rip, a high quality copy of the retail DVD.

Before the video window opens, this DVD-rip will not be available, and as such probably poses a smaller threat to the theaters, because there are waiting costs. However, at times there is a misalignment in the distribution of both the theater and DVD version in the global market – and the Internet works such that if a DVD is released in the U.S. while the theaters are still open around the globe, a DVD-rip can harm global theater admissions. The leaking of company DVDs before the actual DVD release can also be a problem for the industry.

Under the assumption that DVD-rips and CAM releases are the most common piracy threats, one can see that piracy is likely to be a bigger problem for the sequential parts of the motion picture industry's windowing decisions – and a lesser problem for movie theaters. This effect is mostly based on the perceived quality differences between CAM releases and DVD-rips.

2.4.5 Some news articles

Disregarding legal measures in the analysis can be said to be reasonable, considering the fact that Norwegian file-sharers are essentially under no risk of being prosecuted. In April 2012, Aftenposten published a story about how only one single legal practitioner monitored Norwegian file sharers. (Eggesvik, 2012) Later in the same year, pirate friendly news site TorrentFreak broke the news that file-sharing was de facto 'legal' in Norway, because Simonsen, the group that monitored the Norwegian file-sharing activity, had lost their license to do so. (enigmax, 2012)

In Sweden a political party – Piratpartiet - has been formed with the sole goal of legalizing copyright infringement. Piratpartiet gained almost 50 000 members in Sweden, and got several spots in the European Parliament in 2009. (Raaum, 2009) Piratpartiet shows how the public opinion is in favor of free use of formerly copyrighted material, without necessarily knowing the long-term effects of such a grant. This case can also be related to the "digital mindset" already introduced by Mayer-Schönberger.

3. Literature Review

Much has been written about motion pictures, especially since the early 1980s – and writing an exhaustive literature review about motion pictures would be a great undertaking. Nevertheless, such an undertaking would require more time than is available for the completion of the paper. Neither is it necessary. The industry review already introduces key phenomena and the value chain of the motion picture industry. This review focuses on describing theories that will help getting to the essence of this paper – namely *understanding piracy in the motion picture industry.*

The literature review is split in three. The first part presents research on piracy or copying. Some of the papers are seminal literature in the field, while some are reviewed because they can be related to how piracy works in the motion picture industry. The review is not exhaustive for piracy on information goods in general.

Sadly, the search for literature yielded but one technical paper concerning *piracy in motion pictures* in particular. While there is a vast literature on many areas that are relevant for the file sharing challenge, theoretical models to build empirical research upon are scarce. This proves that there is a hole in the literature, and an important one at that.

The theoretical review mainly focuses on how fit the models presented are to describe piracy in the motion picture industry. While some specifications seem to fit rather poorly, others can be used for motion picture piracy without much effort or change.

In the second part, several papers concerning horizontal differentiation are presented. These papers open up possibilities for a new direction in analyzing motion picture piracy, and will culminate in model II.

At this point the literature review turns to the third part, *empirics*. A few papers concerning piracy in other industries are shortly reviewed, before the focus is turned towards empirics about motion picture piracy. These papers are essential to the review, because they aim to confirm whether piracy is in fact a threat to the motion picture industry.

3.1 The Economics of Piracy

The surge of papers on economics of piracy in the 21st century stems from the original economics of copying, which bloomed in the late 1970s and early 1980s. Johnson (1985) and Liebowitz (1985) are seminal papers from this era. Furthermore, the economics of piracy has been highly affected by Mussa & Rosen's (1978) analysis of product quality under monopoly.

Johnson (1985) presents a model of copying in a multi-firm setting. Applying a framework a la Salop (1979), the firms are placed along a circle. However, Johnson assumes that the products are not in any manner substitutes – a consumer located at *x* will therefore consume any and all goods that offer him a positive net utility. A consumer's location along the circle is thought to represent his tastes – such that he is more likely to consume works close to him on the circle than far away. The consumer will consume a work *j* if and only if

$$\mu_i \geq p_j + \psi_{ij}$$

where μ_i represents willingness-to-pay, p_j represents the price of good j, and ψ_{ij} represents the distance between the consumer and the good. He reasons that the simplification to no competition between producers is for analytic convenience. Any analysis would be highly tedious without it.

Johnson (1985) models copying in two extreme settings. First, consumers have a zero fixed cost and positive marginal cost of copying. This copying cost is assumed to be different across consumers. The model is called the "household production model." Second, he considers a scenario where consumers can invest in a copying technology at a fixed price, albeit at zero marginal cost. This is referred to as the "fixed cost model." It is important to note that in Johnson's setting, copies are perfect substitutes of the original. This differs from the general notion in the motion picture industry, where consumers continue to buy originals in part because the copies are not perfect substitutes for the original good.

In the household production model, consumers are thought to have positive marginal cost of copying, while acquiring the copying technology is free. This has the effect that there is absolutely no interdependence between the different producers. Therefore, in the household production model, an analysis of a single firm is sufficient. Consumers are thought to have a cost of *w* of making a copy – equivalent to their wage rate per time unit, where a time unit is the time it takes to make a copy. The effect of this assumption is that – for those who choose

to consume – high wage consumers choose to purchase, while low wage consumers choose to copy.

Considering a specific example where both wages and willingness-to-pay are bounded by 0 and a number $a \leq \frac{1}{2}$, Johnson (1985) notes that with this type of copying technology, copying reduces price, consumption *and* revenue of originals compared to the benchmark case. Consumer surplus rises, because more consumers enjoy the work, and the prices are lower for both the consumers of originals and the consumers of copies. In the example, consumer surplus rises by 64%, while social surplus rises by 8% from the benchmark case.

Johnson also offers an examination of long run effects – in the setting of entrance and exit of the number of producers. He argues that if the elasticity of supply is large enough – both social surplus *and* consumer surplus might fall in the long run. However, this result stems from the assumption that there is no substitutability between the goods offered. Still, if this was not the case, consumer surplus could still fall if consumers place a high value on product diversity, a likely case for many information goods.

In the fixed cost model, the marginal cost for copying is zero – but a consumer has to invest in possibly costly technology to be able to copy. This cost is denoted by *F*. In this model, there is interdependence between producers, because a consumer who has invested in copying technology can copy all the goods at zero marginal cost. A consumer with a copying technology will now copy all works until a distance of μ_i from him. For N firms located evenly around the circle, it can be shown that a consumer copies if and only if

$$\mu > \frac{F + Np^2}{2pN}$$

The consumer is more likely to copy if the price of the original is high, if there are many firms, or if the copying technology is cheap. Under specific assumptions, a symmetric Nash equilibrium can be reached for the N firms located on the circle. The existence of a fixed cost copying technology works as an entry barrier to new firms – because a higher number of firms give a higher number of copiers. This lowers demand for originals, and by extension, total profits.

The welfare effects in the short run are such that lower prices and more consumers give a higher consumer surplus per good. The revenue per work is decreased, because prices fall and fewer consumers choose to purchase the original. In this model, it is conceivable that the total social surplus is falling with copying. This effect comes into place if the fixed cost of the copying technology is large enough, and there are enough consumers with a high valuation who become copiers. As in the household production model, the long run effects of copying can also be detrimental to social surplus because producers might exit the market.

Johnson's (1985) analysis shows that copying can be detrimental to welfare both in the short- and long run. However, the conclusions are not unambiguous. Johnson (1985) offered an important framework for the analysis of copying, and as we will see, this framework has been used in extensions considering the effect of modern digital piracy.

Liebowitz (1985) is motivated by the emergence of cheap photocopying technology. He studies how these photocopiers affect illegitimate copying of academic journals. In contrast to contemporary works, he introduces the now widely used effect known as *indirect appropriation* to describe how copying can actually raise the profits of intellectual works owners. The evidence offered in Liebowitz (1985) is mainly argumentational and partly empirical, but is seminal because it offered a new direction for researchers to look at possible *positive* producer effects of copying.

In later works, Liebowitz has denounced other researchers for focusing too much on positive effects when they are arguably small compared to the losses caused by copyright breaches. In digital media, Alvisi et al. (2002) also argue that indirect appropriability cannot apply because *"copies can be made out of copies without a progressive decline in their quality."* Their argumentation can be misleading, however, because some profits can still be appropriated through sales of ancillary products. In motion pictures, this could for example be action figures of the hero in a major blockbuster.

Another important paper regarding the economics of piracy is Mussa & Rosen (1978). While Mussa & Rosen originally set out to explain monopolies offering several partly substitutable goods, their analysis have proved to be applicable to monopolists competing with (partly substitutable) copies of their own good.

The setting of Mussa & Rosen (1978) is that of a monopolist that can offer consumers a product line of goods – several goods of the same generic type, that are differentiated over

quality. The goods are therefore non-perfect substitutes. The monopolist cannot distinguish between consumers, so no price discrimination is possible. Consumers self-select the product they wish to consume.

Consumers are limited to purchasing one unit of good, and there are constant marginal costs of production of a certain variety, with higher marginal costs for goods of higher quality. Product quality is given by q – a larger q corresponds to a higher quality. Market equilibrium is denoted by a price for every variety offered *P(q)*, the number of varieties *N(q)*, and the breadth of the varieties offered $[\underline{q}, \bar{q}]$. The cost for a specific quality *C(q)* is constant, and is an increasing function of quality so that $C'(q) > 0, C''(q) > 0$.

Consumers have a utility function given by their utilization of the monopolist's good and a composite good, *x*. Ignoring income effects by assuming the product is cheap compared to total income, the utility is approximated by

$$U = x + \theta q$$

Where $\theta > 0$ measures intensity of the consumer's taste for quality. θ is defined on the interval $[\underline{\theta}, \overline{\theta}]$ – where $f(\theta)\, d\theta$ is the density function that describes the share of consumers whose net utility is positive for this specific θ.

The analysis then continues to find optimal solutions for a monopoly, and comparing it to a case of perfect competition. Although Mussa & Rosen (1978) find interesting results, it is the framework that is important for the literature describing piracy. The general framework has been used in several papers regarding piracy, including Belleflamme (2002).

While the economics of piracy offer research outcomes for a larger number of information good markets, we are concerned with the effects of piracy in motion pictures. The literature on piracy of software, video games, music and e-books is related and interesting – but these papers usually focus on specific applications that cannot be directly related to motion pictures. Examples are the aforementioned indirect appropriation (although possible, not necessarily relevant for the specific analysis of one single movie) and the consumer sampling effect. Moreover, many papers concern network effects – and while we see that these should be relevant also for the motion picture industry, we will not consider them in our models. Research on the size of these effects is important because they describe whether piracy can

return extra profits to producers, and not only add to consumer surplus. For a description of the literature on piracy in other information good markets, the reader is directed toward Belleflamme and Peitz (2010). The literature reviewed in this section is reviewed because it can be made relevant to the motion picture industry.

Bae & Choi (2006) develops a theoretical framework for analyzing both short-term and long-term effects of copying on usage and development incentives of software. Their results can be made applicable to the motion picture industry.

To analyze the incentives to copy, Bae & Choi (2006) introduce two different types of costs related to the act of pirating – the degradation cost, that is proportional to a consumer's valuation of the software, and the reproduction cost, thought to be equal across all users. Their framework is modeled such that consumers themselves select which "version" of the product to consume, if any.

In the basic model, they assume a monopolist has already developed a software. The population of consumers is normalized to one – and they are heterogeneous in their valuations of the software. v is the consumer's valuation of the software, and F(v) is the proportion of consumers that has a value of software higher than v. Marginal production cost is zero, such that the producer's profit maximizes with respect to the price, p.

The benchmark case assumes that no piracy is possible – a consumer's utility of the software is therefore

$$U_B(v;p) = v - p$$

No consumption induces zero utility. In the benchmark case, consumers with valuations higher than p will consume, and those with v lower than p will not consume. Profit maximization is given by

$$\max(v)\ R(v) = v \cdot F(v)$$

The marginal consumers and optimal price is only dependent on the distribution of consumer types. Since the socially optimal price is equal to marginal cost, zero, there is a deadweight loss in this case.

In the case with piracy, consumers can choose between authorized consumption, unauthorized consumption and no consumption. Their valuation of the unauthorized copy is dependent on both the degradation cost α and the reproduction cost c such that

$$U_{UC}(v) = (1-\alpha)\, v - c$$

The analysis is only carried out when the piracy constraint is binding, such that

$$\frac{c}{1-\alpha} < p^* = v^*$$

Where *v** is corresponding to the optimal price in the benchmark case. The monopolist can choose between accommodating and deterring piracy. To deter piracy, the monopolist chooses a *limit price* such that $U_B = U_{UC}$ for $v = \frac{c}{1-\alpha}$.

The optimal limit price and corresponding revenue is given by

$$p^L = \frac{c}{1-\alpha}$$

$$R = p^L F(p^L) = \frac{c}{1-\alpha} \cdot F\left(\frac{c}{1-\alpha}\right)$$

Accomodating piracy, some consumers choose to pirate and some choose to buy an authorized copy. Consumers choose the alternative that yields the highest net utility, and their optimal choices are given by:

$\frac{p-c}{\alpha} \le v$	purchasing an authorized copy
$\frac{c}{1-\alpha} \le v \le \frac{p-c}{\alpha}$	acquire a pirated copy
$v < \frac{c}{1-\alpha}$	do not use

The monopolist maximizes profits from consumption of the authorized copy,

$$Max\,(\alpha v + c)\, F(v)$$

The consumer indifferent between purchasing an authorized copy and acquiring a pirated copy, $\tilde{v}$, is given by the first order condition

$$(\alpha v + c) F'(v) + \alpha F(v) = 0$$

The distribution of consumers is thus given by figure 3.1:

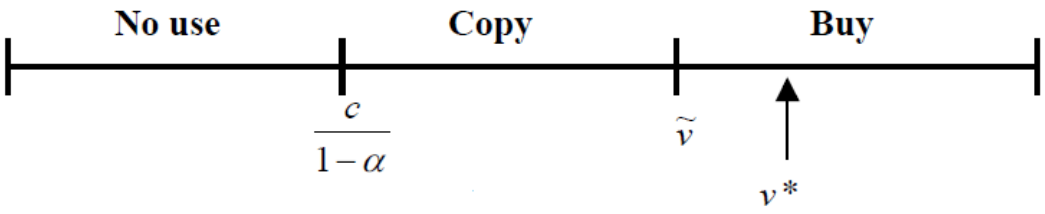

Figure 3.1 From Bae & Choi (2006)

This distribution corresponds well to the distribution we will see in Poddar's case of piracy from the first period. However, Bae & Choi (2006) differs from Poddar (2005) in both the intertemporal aspect of Poddar's (2005) model, and because Bae & Choi (2006) assumes a positive reproduction cost of piracy.

Bae & Choi (2006) propose that in the presence of piracy, demand for the *authorized version* is bigger than would be the case under no piracy. Pirated copies thus act as a *complementary* to the authorized version. The substitution effect towards the copy is more than erased by the effect of the price fall on the authorized version. Because there is also a positive demand for the pirated version, total usage is unambiguously higher with piracy.

Demand for the legal version is now given by the gross copy cost ($w = \alpha v + c$) instead of the consumers valuation, because they have the option to pirate. Furthermore, social welfare is increased under piracy because the users who pirated are a pure addition to the welfare calculation.

Testing the effects of marginal increases in the two types of costs associated with piracy – the degradation rate and reproduction cost – Bae & Choi (2006) finds that

$$\frac{\partial p^L}{\partial c} > 0 \quad \frac{\partial F(p^L)}{\partial c} < 0$$

$$\frac{\partial p^L}{\partial \alpha} > 0 \quad \frac{\partial F(p^L)}{\partial \alpha} < 0$$

Under the limit pricing regime, increases in any of the costs associated with piracy leads to a higher software price and a lower authorized demand.

In the copying regime, a higher degradation rate α leads to a higher software price and a lower authorized demand. Higher reproduction cost *c* leads to a higher software price, but *more*

authorized demand. A higher reproduction cost represents a parallel shift in demand, while a higher degradation rate causes a pivot in demand that makes the monopolist more interested in serving high value customers at a higher price.

An increase in both reproduction costs and degradation rate causes a decline in social welfare under the limit pricing regime. When accommodating piracy, a higher degradation rate causes a decline in social welfare, while a higher reproduction cost causes ambiguous results.

The propositions are illustrated with the use of a simple uniform distribution.

Extending from short-run analysis to considering the long-run effects of development incentives, the quality of the software is endogenized. Before selling the software, the monopolist can choose the quality of the software with a cost $C(\theta)$ with the properties $C'(\theta) > 0, C''(\theta) > 0$.

The consumer's valuation of the software rises proportionally with the quality of it, his gross utility is $\theta \cdot v$. While the long-term incentives to invest in high quality motion pictures might be relevant for the industry, the "nobody-knows" principle in motion pictures point out that a motion picture's quality is not necessarily correlated strongly with its budget. Neither will it be analyzed thoroughly in the models presented. Therefore, Bae & Choi's (2006) long-term results are quickly presented.

Bae & Choi (2006) finds that the software quality is sub-optimally low for social welfare without piracy. Under limit pricing, a lower level of quality is chosen than if it were not possible to pirate. Under the copying regime, the quality is further lowered, but authorized demand is raised. The results support the hypothesis that piracy reduces development incentives.

An increase in either reproduction cost or degradation rate causes higher software quality and lower authorized demand under the limit pricing regime. In the copying regime, a higher degradation rate causes higher quality and lower authorized demand. A higher reproduction cost causes lower quality and higher authorized demand.

Bae & Choi (2006) offer relevance for the analysis of piracy in motion pictures because the structure of the costs is closely related to what we expect to see from motion picture piracy. Furthermore, there is only one acquisition of the product. The analysis is also relevant because they do not consider network effects, sampling effects or effects stemming from

indirect appropriation. The analysis should be extended for motion pictures, however, because there are no inter-temporal effects in play. Motion picture profits are highly related to the sequential distribution pattern and needs to be analyzed with this in mind.

Alvisi et al. (2002) introduce a model where a monopolist would only offer one quality if it were not for the threat of piracy. Seeing as the motion picture industry has offered a broad range of products for a long period of time, it is unlikely that the model proposed by Alvisi et al. (2002) offers useful insights into the motion picture industry. Alvisi et al. uses a Mussa & Rosen (1978) framework, and is related to Bae & Choi (2006) in that they both consider effects when the quality choice of the products is endogenized. This offers implications for the long run. Their main contribution is the insight that offering a lower quality product may positively affect the revenue gained from the high quality good under the threat of piracy. For motion pictures, this could include selling DVDs with no extra material, or offering movie theaters with bad chairs. The insights are insufficient, however, to hugely alter the analysis of this paper.

Belleflamme (2002) builds upon the framework of Mussa & Rosen (1978). In their model, a monopolist offers a single information good. A continuum of consumers is characterized by their valuation, $\theta \in [0, 1]$. The consumers can either buy the good at price *p*, or copy it at a cost $c \geq 0$. There is vertical differentiation between the original and the copy, quality s_i is defined such that $s_o > 0$ is the quality of the original and $0 < s_c < s_o$, the quality of the copy is lower than the original's.

User θ has a utility function defined by

$$U_\theta = \begin{cases} \theta s_o - p & buys\ an\ original \\ \theta s_c - p & makes\ a\ copy \\ 0 & does\ not\ use \end{cases}$$

The indifferent consumers θ_1 and θ_2, who are indifferent between consuming the authorized version and the pirated one, and indifferent between pirating and not using, respectively, are given by:

$$\theta_1 = \frac{p - c}{s_o - s_c}$$

$$\theta_2 = \frac{c}{s_c}$$

Two demand patterns might emerge for the profit maximizing monopolist; One where piracy is accommodated, and one where piracy is deterred. For intermediate prices, demand for the authorized version is

$$L(p) = 1 - \frac{p - c}{s_o - s_c}$$

For the copy, demand is

$$I(p) = \frac{p - c}{s_o - s_c} - \frac{c}{s_c}$$

Total demand is therefore given by

$$N(p) = 1 - \frac{c}{s_c}$$

As seen, total demand is only dependent on the cost and quality of the copy – the price and quality of the original product only determines the split between authorized and unauthorized usage. For real world applications, however, it is likely that the quality of the copy is a function of the quality of the original.

For low prices, piracy is deterred, and total demand is equal to the demand for the original

$$L_0(p) = N_0(p) = 1 - \frac{p}{s_o}$$

The monopolist seeks to maximize his profits from the legitimate product. If he chooses to deter piracy, his profit maximization is given by

$$\max_{(p)} \pi(p) = p \cdot L_0(p) = p\left(1 - \frac{p}{s_o}\right)$$

$$\text{subject to } p < \frac{cs_o}{s_c}$$

If the monopolist accommodates piracy, his profit maximization is defined as

$$\max_{(p)} \pi(p) = p \cdot L(p) = p\left(1 - \frac{p - c}{s_o - s_c}\right)$$

$$\text{subject to } \frac{cs_o}{s_c} \leq p \leq s_o - s_c + c$$

When the deterrence condition is not binding, we can say that piracy is blockaded. The monopolist sets his price as if piracy did not exist. The profit maximizing prices for blockading, deterrence and accommodation is given

$$p_b = \frac{s_o}{2} \quad \textbf{for} \ \frac{s_c}{2} \leq c \leq s_c$$

$$p_d = \frac{cs_o}{s_c} \quad \textbf{for} \ \frac{s_c(s_o - s_c)}{2s_o - s_c} \leq c \leq \frac{s_c}{2}$$

$$p_a = \frac{s_o - s_c + c}{2} \quad \textbf{for} \ 0 \leq c \leq \frac{s_c(s_o - s_c)}{2s_o - s_c}$$

Testing welfare effects, Belleflamme (2002) proposes that piracy improves social welfare in the short run, given that it cannot be blockaded.

In the latter part of the working paper, Belleflamme (2002) considers long-run effects of piracy, while adopting a framework highly similar to that of Johnson (1985). Consumers can choose from a broad set of products, S, and have the budget to consume all goods if they yield a positive net utility from them. As in Johnson, the analysis is carried out with two different set-ups of the copying costs. One, where the cost of copying has no fixed part and a positive marginal part, and the second where there is no marginal part and a positive fixed cost.

Reporting the results, Belleflamme (2002) sees that copying with no fixed cost and a positive unit cost causes a welfare loss in the long-run, as long as copies are good enough substitutes or not too costly to produce. For the fixed-cost setting, he explores Nash-equilibria for competition between the producers. This is not relevant for our analysis. Belleflamme & Picard (2004) offers an extension of the fixed cost model in Belleflamme (2002). This working paper produces the Nash equilibria not provided in the original paper.

Belleflamme (2002) also report results when assuming network effects, and an interesting part of this considers a peer-to-peer technology. Consumers can utilize lower costs of piracy the more users there are of the P2P network, indexed by *I*. This is highly interesting for internet piracy of motion pictures.

In a P2P network setting, consumer θ's utility is given by

$$U_\theta = \begin{cases} \theta s_o - p & buying\ the\ original \\ \theta s_c - (c - \beta I) & making\ a\ copy \\ 0 & no\ use \end{cases}$$

Assuming that $s_o = 1$, the indifferent consumers is found at

$$\theta_1 = \frac{p - c + \beta I}{1 - s_c} \text{ and}$$

$$\theta_2 = \frac{c - \beta I}{s_c}$$

If the producer's optimal strategy is to accommodate piracy, and prices are such that $0 < \theta_2 < \theta_1 < 1$, demands are given by

$$L(p) = \frac{\left(s_c\left(1 - s_c\right) - \beta + cs_c - \left(s_c - \beta\right)p\right.}{s_c\left(1 - s_c\right) - \beta}$$

$$I(p) = \frac{s_c p - c}{s_c\left(1 - s_c\right) - \beta}$$

$$N(p) = \frac{\left(1 - s_c\right)\left(s_c - c\right) - \beta(1 - p)}{s_c\left(1 - s_c\right) - \beta}$$

The statics of this peer effect is such that a) P2P technology increases demand for copies compared to the benchmark case, b) the P2P technology makes demand for originals more elastic, and c) total demand is an increasing function of β. With this peer effect, total demand is now indirectly a function of the original's price. This price affects how many users pirate, which in turn has a direct effect on total demand. It is further shown that with a P2P technology, the market is *never fully covered.*

Testing the peer effect β, Belleflamme (2002) finds that equilibrium price *decreases* in the peer effect β, because copies become closer substitutes to the original. Furthermore, the number of *legitimate users* increases in the peer effect. However, for specific values of *c*, demand for the pirated copy and total demand can both increase and decrease with the peer effect.

Social welfare effects of the peer effect are unambiguously positive in the short-run, and increase further with a stronger peer effect. The effect on long-term social welfare is less

obvious, as the peer effect apparently limits the degree to which accommodation is enhancing social welfare.

Early research on unauthorized copying mainly considers the effects of copying in a static one-period setting. While some papers include how piracy affects development incentives, no papers discussed the inter-temporal consequences for durable goods before Takeyama (1997). Her findings include a possibility that static models of piracy may in fact significantly underestimate the ill-effects of the piracy. However, under her framework, one may also find a *positive* effect of piracy – if the producer can more easily commit to a set of prices that are time consistent.

The model consists of two periods, 1 and 2. The good is produced at a marginal cost, *c*, and is durable for both periods. There are two classes of consumers – high and low valuation, denoted by V^H and V^L. There are N^H and N^L consumers in the classes, respectively. Consumers are rational, and there is full information. In the basic model, consumers choose to consume one unit of the good only.

Consumers maximize their total net utility over both periods. In the base model, consumers can choose to purchase in the first period, purchase in the second period, or not purchase at all. To induce a first-period sale from consumers of the class V^i, the first period price must be

$$V^i + \beta V^i - P_1 > \beta\left(V^i - P_2\right)$$

That is

$$P_1 \leq V^i + \beta P_2$$

It is straightforward to show the profits achieved by inter-temporally price discriminating such that only high-value consumers will purchase in period 1, while low-value consumers will purchase in period 2. The profit gained by selling to both classes in the first period and when it is profitable to inter-temporally price discriminate is also fairly easy to compute.

$$\Pi^1 = \left(V^H + \beta V^L - c\right)N^H + \beta\left(V^L - c\right)N^L$$

$$\Pi^2 = \left(V^L + \beta V^L - c\right)\left(N^H + N^L\right)$$

$$N^H\left(V^H - V^L\right) > N^L\left[V^L - (1-\beta)c\right]$$

Extending her model, Takeyama (1997) explores the possibility for consumers to copy the durable good at a cost P_c. This cost is exogenously given. Copies are imperfect substitutes, and the consumers utility from the copy is indexed by V_c^i, such that $0 \le V_c^i \le V^i$. The consumer's per-period surplus of originals over copies is given by $D^i = \left(V^i - V_c^i \right)$.

In the analysis, Takeyama (1997) assumes that high-valuation consumers *do not copy*, that is $V_c^H + \beta V_c^H - P_c < 0$. Compared to analysis of continuously distributed consumers, this would correspond to that of both Bae & Choi (2006), and, as we will see, Poddar (2005). Consumers with the highest valuation of the good does indeed purchase it.

Without inter-temporal price discrimination, Takeyama (1997) finds that consumers are unambiguously worse off. With inter-temporal price discrimination, the monopolist has to set a second-period price lower than the low valuation group's consumer surplus of originals over copies to sell to the lower valuation group. In the first period, prices must be so low as to keep high valuation consumers from purchasing in period 2.

Inter-temporal profits with piracy is given by

$$\Pi^3 = \left(V^H + \beta D^L - c \right) N^H + \beta \left(D^L - c \right) N^L$$

Compared to Π^1, it can be seen that copying reduces firm profits in both periods. This is partly because unauthorized copying from some consumers reduces the profits from *all* consumers.

For $D^L < c$, however, the monopolist can credibly commit to a price such that he can extract the maximum profit from the high-valuation group

$$\Pi^4 = \left(V^H + \beta V^H - c \right) N^H$$

In this case, it is actually possible that profits with copying are higher than without it, under the assumption that intertemporal price discrimination maximizes no-copy profits. Takeyama (1997) thus finds that copying can both harm and help the monopolist.

Takeyama's (1997) analysis may not fit well in the motion picture industry for several reasons. First, consumers have positive utility of the good in the second period when it was bought in the first period. This does not compare well to the motion picture industry's

experience good setting. Furthermore, purchasing an authorized version in the second period may cause positive utility for a consumer even though he has already copied in the first period. Finally, there are only two types of consumers – low and high valuation. For motion pictures, it seems that a big difference in consumer tastes can best be analyzed using a continuous distribution of consumers. A big plus with Takeyama's (1997) analysis is that she considers inter-temporal aspects. This is very important for the motion picture industry, as proved by the sequential distribution pattern. With some tweaks, the analysis undertaken by Takeyama should be quite useful for describing motion picture piracy.

There have been other theoretical attempts to explain the nature of piracy. Balestrino (2008) present a model in which he tries to explain why engaging in piracy is not seen as a breach of a social norm. He combines general piracy theory with a game-theoretic model of social norm formation.

An interesting methodological aspect of Balestrino's (2008) model is that piracy can come from any of two sources. High quality piracy, expected to be extracted from copying from originals among social groups, and low quality piracy – expected to be extracted from online file-sharing sites. While the assumptions of Balestrino (2008) are not exactly similar – in a motion picture context, it can be said that the high quality piracy comes from DVD-rips, while low quality comes from CAM-releases.

The consumer's utility of consuming the information good is given by $u(x)$ where

$$x = \gamma + \theta e(y) + \omega$$

γ is high quality copies, θ is low quality copies, and ω is the original version. e ϵ (0,1) is the factor by which low quality copies are translated from high quality copies. e is dependent upon income, such that lower income consumers sees the low quality good as a better substitute than high income consumers.

Similarly to Takeyama (1997), Cremer & Pestieau (2009) consider an economy where a monopolist sells an information good to two consumer groups – one with a high valuation of the good, and one with a low valuation. Instead of considering inter-temporal choices, however, Cremer & Pestieau (2009) test the effects of piracy for a monopolist who chooses the quality of his goods, and balances possible revenues compared to a changing cost function. The type of versioning discussed in their paper translates poorly to the setup of the

motion picture industry. As Poddar (2005) states, versioning is in practice impossible in the motion picture industry – and the effects of it would probably be highly limited.

Cho & Ahn (2010) also suggest how to choose versioning under a threat of piracy. The framework is similar to that of Mussa & Rosen (1978). They assume that the pirated copy contains the same quality as the original version, an unlikely assumption for the motion picture industry.

Minniti & Vergari (2010) is, to our knowledge, the only model of piracy that uses a spatial duopoly model á la Hotelling (1929). They consider a framework where there are two producers, *A* and *B*, each producing one information good, *A* and *B*, respectively. The firms are located at an endpoint each on the interval [0,1]. p_A and p_B denotes the prices of the information goods, and production is costless.

Consumers can consume either or both of the goods. While there exists a file-sharing network, consumers can only join it by purchasing one of the information goods and sharing it on the network. The only reason to join the file-sharing network will then be to also consume the second good.

Each consumer will have three options in this framework: To buy one good, to buy one good and download the other, or not to consume. The setup of the model thus eliminates the possibility that the consumer can legitimately purchase both goods.

The model provides insights as to why firms in *expanding markets* do not care as much about the threat of piracy. While the setting of Hotelling is interesting, there are few direct applications to motion pictures. However, using this setting in the competition between two simultaneously released movies with for example genre differences may be useful.

After conducting the literature search, there is to our knowledge only *one* theoretical paper concerning *piracy in motion pictures* in particular. This article is a working paper by Poddar (2005). Because it is the only paper that specifically works with the sequential distribution pattern of movies, it serves as a good starting point for the analysis in the next part of the paper. In the literature review, it is thoroughly examined for the sake of understanding.

In the spirit of Mussa & Rosen (1978) there is a continuum of consumers described by $X \in \left[\theta_L, \theta_H\right]$ where $\theta_H > \theta_L \geq 0$. *X* is uniformly distributed over the interval, and measures the consumers valuation of a ticket to the movie theater. A motion picture is released in the movie

theater over two periods, 1 and 2. Piracy may be possible, and may be available in both or just one of the periods.

Consumers have three basic choices – consuming the motion picture in the theater in period 1 or 2, consuming the pirated version in period 1 or 2, or not consuming at all. It is assumed that the movie is a one-time ordeal – so that consumers who watched the movie in period 1 leave the market before period 2.

There is a positive depreciation factor $\delta \in (0, 1)$ describing impatient consumers. If a consumer X watches a movie in the first period, he receives a gross utility of X, while his gross utility from consuming in period 2 is δX.

There is vertical differentiation between the original and the pirated version, such that consumer X will only receive a gross utility of qX from consuming the pirated version, $q \in (0, 1)$.

The consumer's utility is therefore described like the following function:

$$U_t = \begin{cases} \delta^{t-1}X - P_t & watches\ in\ theatre \\ \delta^{t-1}qX & watches\ pirated\ copy \\ 0 & does\ not\ watch \end{cases}$$

The model is analyzed under three different set-ups: One, where no piracy exists. Two, where a pirated version is available in both periods. Three, where the pirated version is only available in the second period.

In the first model, the benchmark, piracy is non-existent. A consumer can therefore choose between watching the movie in the theatre in period 1, watching it in the theatre in period 2, or not watch it at all. His utility is given by

$$\mathrm{U} = \begin{cases} X - P_{NP,1} & watches\ in\ theatre\ in\ period\ 1 \\ \delta X - P_{NP,2} & watches\ in\ theatre\ in\ period\ 2 \\ 0 & does\ not\ watch \end{cases}$$

The consumer indifferent between consuming in period 1 and in period 2 is given by

$$X_1 = \frac{P_{NP,1} - P_{NP,2}}{1 - \delta}$$

The consumer indifferent between consuming in period 2 and not consuming at all is

$$X_2 = \frac{P_{NP,2}}{\delta}$$

Demand in the first period is given by the integral of total consumers limited by θ_H and X_1, such that

$$D_{NP,1} = \frac{\theta_H(1-\delta) - (P_{NP,1} - P_{NP,2})}{(\theta_H - \theta_L)(1-\delta)}$$

In the same manner, demand in period 2 is the integral limited by X_1 and X_2:

$$D_{NP,2} = \frac{\delta(P_{NP,1} - P_{NP,2}) - P_{NP,2}(1-\delta)}{(\theta_H - \theta_L)(1-\delta)(\delta)}$$

And period profits are given by period price times period demand. The marginal cost of production is assumed to be zero.

Using backward induction, and maximizing profits in period 2 with respect to the price in period 2, he derives price, demand and profit functions as functions of the first period price. Differentiating total profits with respect to the first period price yields the following equilibrium set of prices, demand and profit:

$$P^*_{NP,1} = \frac{2\theta_H(1-\delta)}{4-3\delta}$$

$$P^*_{NP,2} = \frac{\delta\theta_H(1-\delta)}{4-3\delta}$$

$$D^*_{NP,1} = \frac{2\theta_H(1-\delta)}{(\theta_H - \theta_L)(4-3\delta)}$$

$$D^*_{NP,2} = \frac{\theta_H}{(\theta_H - \theta_L)(4-3\delta)}$$

$$\pi^*_{NP} = \frac{\theta_H^2(1-\delta)}{(\theta_H - \theta_L)(4-3\delta)}$$

Prices in period 1 are always higher than prices in period 2, and demand in period 1 exceeds period 2 demand for $\delta < 0.5$.

In the second model, a pirated version is available from the first period on. Because there is no cost of piracy, the market will be covered. Also, because there is no reason to postpone

piracy – all pirated copies consumed will be consumed in the first period. Three choices emerge for the consumer: Watch the movie in the theatre in period 1 or 2, or watch a pirated version in period 1. The utility function in this case is given as

$$U = \begin{cases} X - P_{P^1,1} & watches\ in\ theatre\ in\ period\ 1 \\ \delta X - P_{P^1,2} & watches\ in\ theatre\ in\ period\ 2 \\ qX & pirate\ in\ period\ 1 \end{cases}$$

Once again, we have two indifferent consumers. The consumer who is indifferent between watching in the theatre in period 1 and watching in the theatre in period 2 is

$$X_1 = \frac{P_{P^1,1} - P_{P^1,2}}{1-\delta}$$

The consumer who is indifferent between watching in the theatre in period 2 and consuming the pirated version is

$$X_2 = \frac{P_{P^1,2}}{\delta - q}$$

Demand is derived as in the benchmark case, and backward induction is once more used to find the set of price, profit and demand functions as expressions of the first period price. The equilibrium set of prices, demand and profit under the case of no protection from piracy is given by:

$$P^*_{P^1,1} = \frac{2\theta_H(1-q)(1-\delta)}{4-q-3\delta}$$

$$P^*_{P^1,2} = \frac{\theta_H(\delta-q)(1-\delta)}{4-q-3\delta}$$

$$D^*_{P^1,1} = \frac{2\theta_H(1-\delta)}{(\theta_H-\theta_L)(4-q-3\delta)}$$

$$D^*_{P^1,2} = \frac{\theta_H(1-q)}{(\theta_H-\theta_L)(4-q-3\delta)}$$

$$\pi^*_{P^1} = \frac{\theta_H^2(1-q)(1-\delta)}{(\theta_H-\theta_L)(4-q-3\delta)}$$

Prices in period 1 are still higher than period 2 for all values of δ. Demand in period 1 is higher than in period 2 for $\delta < 0.5(1-q)$. This is under the assumption that $\delta > q$. If this is not the case, authorized demand in period 2 is less than or equal to zero. For this instance, we need to renew the profit maximization.

If $\delta > q$, the utility function is given as

$$U = \begin{cases} X - P_{P^1, q>\delta} & watches\ in\ theatre\ in\ period\ 1 \\ qX & watches\ pirated\ copy\ in\ period\ 1 \end{cases}$$

There is now only one marginal consumer, given by

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

Equilibrium producer profit in this case is

$$\pi^*_{P^1,\, q>\delta} = \frac{\theta_H^2(1-q)}{4\left(\theta_H - \theta_L\right)}$$

In the last model, piracy can be prevented in the first period, but a pirated version is available to the consumers in period 2. Since piracy is still costless, the market will be fully served also in this model. Consumers thus maximize profits by choosing between the following three alternatives: purchase a theatre ticket in period 1, purchase a theatre ticket in period 2, or consume the pirated version in period 2. The utility function is given by

$$U = \begin{cases} X - P_{P^2,1} & \text{watches in theatre in period 1} \\ \delta X - P_{P^2,2} & \text{watches in theatre in period 2} \\ \delta qX & \text{pirate in period 2} \end{cases}$$

There are two indifferent consumers – the one indifferent between watching in the theatre in period 1 and 2, and the one indifferent between watching in the theatre in period 2 and watching a pirated version in period 2.

$$X_1 = \frac{P_{P^2,\,1} - P_{P^2,\,2}}{1-\delta}$$

$$X_2 = \frac{P_{P^2,\,2}}{\delta - \delta q}$$

Using the exact same procedure as in the other models, the set of equilibrium prices, demands and profit is found to be

$$P^{*}_{P^2,\,1} = \frac{2\,\theta_H(1-\delta q)(1-\delta)}{4-\delta q-3\,\delta}$$

$$P^{*}_{P^2,\,2} = \frac{\theta_H(\delta-\delta q)(1-\delta)}{4-\delta q-3\,\delta}$$

$$\mathrm{D}^{*}_{P^2,\,1} = \frac{2\,\theta_H(1-\delta)}{(\theta_H-\theta_L)(4-\delta q-3\,\delta)}$$

$$\mathrm{D}^{*}_{P^2,\,2} = \frac{\theta_H(1-\delta q)}{(\theta_H-\theta_L)(4-\delta q-3\,\delta)}$$

$$\pi^{*}_{P^2} = \frac{\theta_H^2(1-\delta q)(1-\delta)}{(\theta_H-\theta_L)(4-\delta q-3\,\delta)}$$

Price in period 1 is always higher than price in period 2, and demand in period 1 is higher than demand in period 2 for $\delta < \frac{1}{2-q}$.

To analyze his results, Poddar (2005) takes partial derivatives of the equilibrium sets produced by the three models. The variables checked are the depreciation factor and the quality factor. He finds that piracy in either period decreases the price of movie tickets. Total demand for authorized viewings is non-increasing in quality of pirated copies, but the first-period demand is increasing. The first period demand is highest when a pirated copy is available already in the first period.

Further, Poddar (2005) finds that it is always better for the monopolist to enforce some sort of protection. Of course, this finding is not compared to the potential *cost* of enforcing intellectual property rights.

Finally, Poddar (2005) seeks insights as to the effect of piracy on *consumer surplus* and *social welfare*. Assuming that $\theta_H = 1$ and $\theta_L = 0$, he finds that consumer surplus – unsurprisingly – is highest in the case where piracy exists from the first period, and lowest in the case where no piracy exists. Moreover, total social welfare corresponds to this, and is highest when piracy exists from the first period, and lowest when there is no possible piracy.

The welfare analysis is limited by the fact that only short-term effects are considered. In the long-term, development incentives might be influenced, such that fewer films are produced, or that the films produced are of a lower quality than what otherwise would have been. These effects would harm social welfare. Acknowledging this, Poddar (2005) suggests that the society should compromise and allow piracy in the second period.

3.2 Frameworks for horizontal differentiation

The section describing economics of piracy includes the papers that are relevant for the existing literature on piracy. This section seeks to present frameworks that can be used in a new direction for research regarding the effects of piracy.

First and foremost, since the stance of this paper is that the sequential product line offered by movie studios are horizontally differentiated, the first part of this section describes the base models of horizontal differentiation.

Horizontal differentiation can be said to exist when two products are offered at equal price and both products have a positive demand.

This presentation is followed by an extension to horizontal differentiation models called the Launhardt model. This model incorporates different transportation rates for different products, and another article describing this effect is presented. Another extension of horizontal differentiation models follow.

Highly regarded as *the* paper on horizontal differentiation, Hotelling (1929) presented a new direction for analyzing competition between firms selling horizontally differentiated goods. While the framework initiated a large body of research, still continuing to grow today, Hotelling's initial conclusions were wrong, as proved by amongst others, Lerner & Singer (1937).

Hotelling (1929) considered a line of length l on which consumers are continuously distributed. Two businesses A and B are placed at points along the line. The businesses sell "identical" goods – such that no consumer has any preference for any good *"except on the ground of price plus transportation cost."* Total cost for a consumer is therefore the mill price p from either company, *plus* the transport cost c times the length he is located away from the business. All differences in consumer tastes are therefore proxied through the transportation cost. The transport cost thus represents the degree of disutility from the customer having to buy a good that differs from what he would optimally want.

As such, a business may have a positive demand, even though his price is higher than the competition. Hotelling's basic case looked like this:

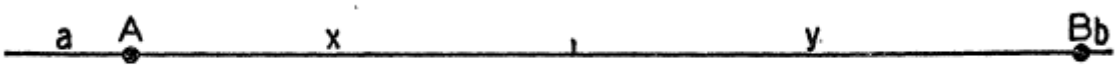

FIG. 1.

Figure 3.2 From Hotelling (1929), page 45.

The firms A and B are placed along the line of length *l*. Finding what is now known as the indifferent consumer, Hotelling equated the total cost of buying from both firms, such that

$$p_1 + cx = p_2 + cy$$

The length of the line *l* is given by

$$l = a + x + y + b$$

The lengths *x* and *y* are given by

$$x = y - \frac{p_1 - p_2}{c}\ ,\ y = \frac{p_1 - p_2}{c} + x$$

And independently

$$x = \frac{1}{2}\left(l - a - b + \frac{p_2 - p_1}{c} \right)$$

$$y = \frac{1}{2}\left(l - a - b + \frac{p_1 - p_2}{c} \right)$$

Optimal prices are found by differentiating the profit function dependent on p_1 and p_2 with respect to the firm's own price and equating them with zero. Inserting the price functions into one another yields the optimal prices independent of the other's price, given by

$$p_1 = c\left(l + \frac{a - b}{3} \right)$$

$$p_2 = c\left(l - \frac{a - b}{3} \right)$$

Equilibrium demands are easily computed, as are profits.

$$\pi_1 = \frac{c}{2}\left(l + \frac{a - b}{3} \right)^2$$

$$\pi_2 = \frac{c}{2}\left(l - \frac{a - b}{3} \right)^2$$

Hotelling (1929) considered the maximization of profits as a dynamic game – one company would maximize his profits dependent on the others, and change his behavior, the other would do the same and change his behavior, until equilibrium was reached. The behavior can be classified as a sort of tacit collusion.

He concluded that while the social optimum would be for the firms to settle in the quartiles of the line, their optimal behavior was to *"crowd together as closely as possible,"* a principle of minimum differentiation. While the framework introduced by Hotelling (1929) was undoubtedly seminal, his conclusions were wrong. When prices are fixed, and demand is all that matters, minimum differentiation will indeed be the optimum for profit-maximizing firms. This would equate well to a two-party political setting.

However, when prices are endogenous, it is actually in the firms best interest to locate as far away as possible from the competition – *maximum differentiation* – to induce higher profits. Doing this creates a much lower stress on prices, and creates "quasi-monopolies." This effect is stronger than the business-stealing effect that Hotelling believed made firms flock together.

This has been noted by, amongst others, Lerner & Singer (1937). Their notes are introduced by stating that "*a great part of the following notes emerges almost directly from the clearing-away of the belief that sellers always tend to cluster together."*

They also note the need for a reservation price in Hotelling's original model *"if we are going to be at all realistic"* – if consumers are assumed to have completely inelastic demands, any firm could just charge a single consumer with an infinite price, and no competition would have to take place. This need for a reservation price is essential in model II.

Introducing a reservation price may strengthen the possibility of "local monopolies" – by possibly changing the base model's solution of always having a fully served market.

Apart from further refining Hotelling's (1929) text, Lerner & Singer (1937) do not offer many insights directly useable in the second model of this paper. However, in their assignment of future research needs, they briefly discuss an aspect that will be essential to the second model, namely asymmetric transport rates.

They not only point out that it is possible that transportation rates differ in different directions; it is also possible to see transportation costs that are not linear. Of course, a case must be made for assuming that transport rates are indeed asymmetric.

Lerner & Singer's (1937) concluding remarks lead us towards what is colloquially referred to as the "Launhardt model." Carl Friedrich Wilhelm Launhardt was a German professor in engineering active during the late 19th century. He was highly interested in both technical and economic aspects of transportation, and he dedicated several chapters in his 1885 book "*Mathematische Begründung der Volkswirtsschaftslehre*" to seminal work on transportation rates. Sadly, this piece of work went untranslated from German until 1993, when J. Creedy released a translation called "*Mathematical principles of economics."*

Pinto (1977) reports some of the major findings of Launhardt's works. It was Launhardt's opinion that the best way to approximate the opportunity costs that arises from choice between different goods was the use of a transportation cost. With a high focus on the railway system, he introduced two market places with two goods A and B, quite alike Hotelling (1929). The main difference however, is that the transportation costs for the goods traveling from the different marketplaces can be different!

If a commodity is sold at market place A for a price *p,* the full cost for the purchaser at distance *x* from the market place A is

$$p + fx$$

Accordingly, the full cost for the purchaser located at *y* from market place B is given by

$$p_1 = f_1 y$$

The stand-alone cost function fully follows Hotelling (1929). However, when we put them together to find the indifferent consumer, we see that it differs from Hotelling (1929) in one aspect – transportation costs.

$$p + fx = p_1 + f_1 y$$

Launhardt used this to find the market areas in two-dimensional space, while Hotelling's (1929) analysis takes place on a one-dimensional line. The market areas are as given by figure 3.3. The good sold at market place B enjoys the demand inside the circle.

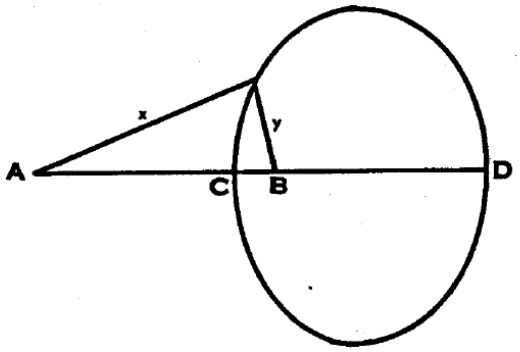

Figure 3.3 From Pinto (1977), page 22.

Pinto (1977) follows through by presenting other valuable insights gathered by Launhardt. What is important for the use in this paper, however, is the use of asymmetric transportation costs.

Also proposing that Launhardt's findings are more important than what his fame suggests are Dos Santos Ferreira & Thisse (1996). They offer a deeper view into the use of asymmetric transportation costs as introduced by Launhardt to suggest that horizontal and vertical differentiation models are special cases of the same model.

For this paper, the relevant aspect of the article is the first two sections, where they discuss how asymmetric transportation costs can affect the outcome of a model. Acknowledging what Pinto (1977) did not; they propose that Launhardt (1885) indeed had insights that were relevant for horizontal differentiation models long before Hotelling (1929) analyzed his linear city.

Dos Santos Ferreira & Thisse (1996) understands that Launhardt meant that different producer's of goods had *different transportation technologies*, being the basis for unequal rates of transportation. For them, this means that Launhardt (1885) incorporates both horizontal and vertical differentiation. When products are located at the same place, and are offered at same price, all consumers will purchase the good that has the lowest transportation cost. For the use in this paper, unequal rates of transportation correspond to a demand influx for the lower transportation cost good. With the introduction of piracy, we can create a model with both vertical differentiation (original better than copy) and horizontal differentiation (different originals for different types of consumers.)

Shortly reviewed is the modified model presented by Dos Santos Ferreira & Thisse (1996).

Two firms 1 and 2 are located at a_1 and a_2 on a straight line [0,1]. Firm 1 is located to the left of firm 2, with $a = a_1$, $a_2 = a + \delta$ and $\delta \geq 0$. The cost of production is assumed to be zero, and firms may differ in two things; price and transportation cost.

The consumers are located uniformly along the straight line with a density of 1. They have completely inelastic demand for 1 unit of the good – and purchases the good with the lowest total cost.

Firms choose their mill prices, and total cost for the consumer at point *x* on the line is

$$p_i + t_i|a_i - x|$$

In this setup, firm 1 is assumed to have a lower transportation rate than firm 2. If the transportation rates were equal, the model would be equivalent to Hotelling (1929).

Calculating the indifferent consumers, it is shown that with asymmetric transportation costs, the firm with the lowest transportation cost can actually have demand from the good's backyard. This is impossible in a Hotelling (1929) setting. A graphic presentation of possible demand is shown in figure 3.4.

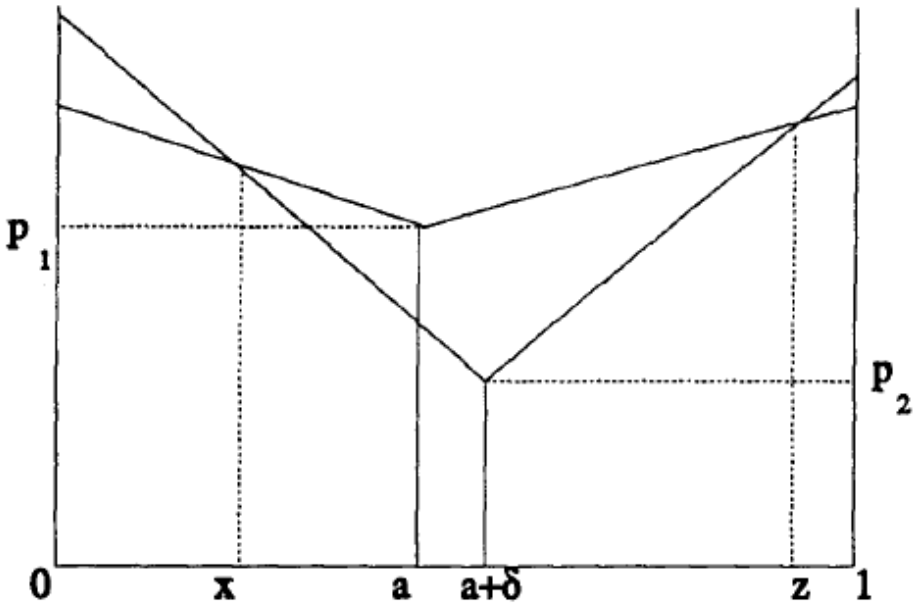

Figure 3.4 From Dos Santos Ferreira & Thisse (1996), page 489

Other papers have also discussed asymmetric transportation costs. Nilssen & Sørgard (2002) consider a model for news broadcasts in a mixed oligopoly – and have consumers that have

asymmetric transportation rates in different directions on the Hotelling line. While their setup is different from Launhardt (1885), it underlines that symmetric transportation rates are not necessary for real life applications.

A final specification of horizontal differentiation models with possible application for the motion picture industry is the one presented by Garella & Martinez-Giralt (1988). In their model, the Hotelling line is inhabited by consumer masses located only at the end-points, in so-called "cities." Transportation costs are different amongst consumers, and there is a continuum of different transportation costs. In a motion picture model, the "cities" could be inhabited by consumers who prefer DVD over theatre and the other way around, where the differing transportation rates signify how much they prefer one over the other.

3.3 Empirical papers

After summarizing important theoretical contributions, we now turn to looking at some empirical results. Empirical work confirms or denies the theories lain out by theoretical economists - empirical confirmation of economic theories indicates that they have real life applications. The symbiosis of empirics and theories is what drives the expansion of knowledge.

This review of empirical papers seeks to inform the reader of the results found about the possible significance of piracy – criticism of the methods used is outside the scope of this review. Readers interested in a critique of the methods used in the empirical work concerning piracy are pointed toward Dejean (2009), who offer a thorough look into flaws of the applied methods. All papers reviewed in the empirical section should be subject to critical caution from the reader.

As the industry review and technical literature review explicitly handle important aspects of the motion picture industry, this section is limited to the questions: *Is piracy a significant threat to the motion picture industry? What is the approximate size of the losses piracy inflict upon the motion picture industry?*

3.3.1 Piracy and information goods

The effects of online file-sharing has been noted by industries producing information goods such as music and software, several years before the motion picture industry stakeholders opened their eyes for the new online threat. Because of this, before economists even considered testing the effects of piracy on motion pictures, they had a wide range of papers trying to magnify the size of losses inflicted upon software and music producers.

Gaustad (2009) has reviewed the empirical results of Internet file-sharing in the music industry. For the seven papers he included in his overview, only one paper found a positive or no effect of piracy, while the six others found a significant negative effect of the piracy. Readers interested in reading more about these studies are referred to Gaustad's paper for their sources.

As early as 1995, Givon et al. presented a paper estimating the effects of lost sales for software. They introduce their article by noting that a 1992 Business Week article estimated a loss of up to $9 billion from software piracy alone. While the article was probably sensationalistic – and assuming that one pirated copy equaled one sale, there was a sense of urgency in the software industry. Givon et al. (1995) present a diffusion model, and then seek

to prove it by using a data set covering the diffusion of spreadsheets and word processors in the United Kingdom. They find that shadow diffusion – diffusion of the illegal copy – could have a significant impact on legal diffusion. Furthermore, they find that pirates can influence other buyers through network effects, but that these can also affect new consumers into purchasing the software legally. Their results claim that six out of seven copies in the late 80s were of a pirated nature, but that pirates also contributed to over 80% of the unit sales in this period.

A newer paper concerning software piracy is Holm (2001). Holm undertakes a study consisting of 234 Swedish undergraduates, and uses a contingent valuation method in studying their willingness to pay for original software in the presence of illegal copies. Their use of undergraduates is argued for with the conjecture that they are more advanced in using computers – and are therefore more able to obtain illegal copies. In the study, the researchers are trying to specify results through the subjects "additional willingness to pay for originals" (AWTPO) Indeed, this variable could be essential for the copyright-owning companies to better understand their future pricing decisions.

Holm (2001) finds that only 2% of social science students (who are thought of as a proxy for the entire generation) are willing to pay the full retail price of the software. This is contingent on them being "very anxious" to acquire the software. On the contrary, only 31% of the students have AWTPO of less than a tenth of the retail price when the software costs 1000 SEK, implicating that the consumers are in fact willing to pay a positive amount for the software. Using an additional group that is thought to have higher expertise in the area of computers, they also find that expertise is relevant for the AWTPO. The direction of this result is that the more skilled a user is, the less he is willing to pay for the original. While assuming that piracy is accommodated, Holm suggests that firms should lower prices with up to 80% - assuming zero marginal cost. The researcher states that the results indicate that perfect substitution is not the case between the original and an illegal copy. He also concludes that a moderate price cut will likely be an inferior way of deterring piracy.

Still, there are important differences between the way the music and software industry works, and the way the motion picture industry works. Much of the literature concerning music piracy has controlled for the so-called "sampling effect" – it is believed that piracy in some cases could positively affect legal demand because file-sharers would listen to an illegal music file and subsequently buy the record the music file was from (Liebowitz, 2006). Motion

pictures are unlikely to experience a significance of this effect – because movies are *generally watched only once* (Bounie et al., 2006).

The software industry, while experiencing the same effect in form of little or no sampling effect – you wouldn't need two different kinds of Microsoft Office or STATA – is highly different from the motion picture industry because there is no sequential distribution. A software company typically offers their product in only one format, unless you take into consideration the possibility of versioning – an example is Adobe's split of Reader and Writer. Still, this type of versioning will seldom – if ever – involve a sequential release pattern.

Founded in these limitations, it is evident that the best way to empirically prove piracy in motion pictures is testing datasets about piracy *in the motion picture industry.*

3.3.2 Piracy and the motion picture industry

The empirical literature concerning Internet file-sharing in the motion picture industry is limited by its young age. The first paper listed in this literature review was not published until 2006 – six years before this paper is written. This was to be expected before the general search – mainly because broadband diffusion did not have a significant impact before this time period. Most of the papers find significant negative and cannibalizing effects of file-sharing. However, in several cases, this effect is stronger for DVD rentals and sales than for movie theaters. Furthermore, some papers offer empirical explanations as to *why* files are shared by consumers. This offers interesting policy implications for the motion picture industry. While reviewing motion picture piracy empirics, a chronological layout has been adopted.

Bounie et al. (2006) utilizes survey data gathered from 620 university members in French universities to estimate effects of digital piracy upon theater attendance, video sales, and video rentals. Motivated by the question of whether digital copies have a high enough "quality" to compete with the legitimate product, Bounie et al. (2006) seeks to understand if piracy is the reason behind the slowdown of video purchases. They acknowledge that the sampling effect of movies is probably negligible, due to consumers regularly not watching a movie more than once. The research data was gathered by administering an *"anonymous online survey"* in 2005. The survey was available to members of 31 French universities. The main questions were how often the respondents consumed different forms of movie products, and the extent of their file-sharing activities.

Using both OLS and probit routines, Bounie et al. (2006) reports the effect of piracy upon three different legal alternatives – theater attendance, video purchases, and video rentals. The data offers no significant results to conclude that piracy cannibalizes theater attendance. An interesting side result is that a TV subscription does not deter theater attendance, implying that TV and the theater experience are inferior substitutes.

Piracy has a negative and significant effect upon the probability of purchasing a single video. However, piracy reduces the *probability* of purchasing, but not the number of videos purchased. Piracy therefore mostly affects consumers who already purchase a small amount of videos. No significance is found between the number of video rentals and piracy levels. The probability of purchasing a video is significantly lowered, however.

De Vany & Walls (2007) develop a statistical model to estimate the effects of piracy on the box-office admissions of a single motion picture – and then test the model with data from a non-specified widely released motion picture. Seeing problems with previous empirical literature violating the "nobody-knows" principle, De Vany & Walls (2007) estimate their model completely without the need for counterfactual claims. They postulate that piracy should accelerate the process of declining sales at the box-office. Their analysis looks at the pirated alternatives at the time before and during the box-office admission – indicating that the pirated alternative is of a technically inferior quality. Their hypothesis that *"piracy adversely affects the dynamics of demand and supply in the theatrical market"* is tested in a model where the number of available *pirated prints* is the main variable of piracy. The source for the print data is originally from a study commissioned by a major studio. Using the method they find to fit best, results show that the median loss per pirate site is $437.91. Estimated total losses are, with the 18,134 pirate sites uncovered, in the magnitude of $42 million. Results are in stark contrast to Bounie et al. (2006) who finds no significant effect of piracy on theater admissions.

De Vany & Walls' (2007) results show that Internet file-sharing both before and under the theatrical period caused about $42 million in revenue loss for the motion picture. Total box-office revenue for the motion picture is not revealed, creating difficulties in defining the loss ratio.

Rob & Waldfogel (2007) estimate displacement effects on paid movie consumption by unpaid consumption using survey data collected from about 500 college students at the University of Pennsylvania. The surveyed students were asked a number of questions describing whether

"*…unpaid consumption stimulates or depresses demand for various forms of paid consumption…"* The surveyed population does not correspond well to the general U.S. population. The data set provided shows that unpaid consumption amounts to 5.2% of total consumption –3.1% are burned and 2.1% are downloaded. Distribution of burning and downloading are likely to change as broadband speeds rise. In their sample, the average number of viewings of a single movie is merely 1.3, indicating that the "watching only once"-effect is very much in place in the motion picture industry. After discussing and testing several different approaches to empirically analyze the data, the authors argue for what is the best approach. This approach suggests that the 5.2% of total consumption that is unpaid consumption displaces paid consumption by an estimated **3.5%.** In conclusion, they argue that unpaid consumption is a small share – even when consumers with a high Internet competence are surveyed. Moreover, the empirical evidence shows that the displacement effect is large for the consumption that is unpaid – even larger than for the music industry. Even with the small total displacement effect, the rate of displacement is high. Should unpaid consumption rise rapidly, this effect would concurrently pose a significant threat to the motion picture industry.

Hennig-Thurau et al. (2007) use a panel data study where they ask German consumers about their intentions and actual behaviors in regards to piracy and legal viewing of 25 newly released motion pictures. The consumers are asked questions at several different points in time – allowing the researchers to study a vast range of effects bounded in utility theory. The method used is several ReLogit regressions.

Hennig-Thurau et al. (2007) present quantifications of the losses from piracy, and on a more detailed level, offer answers as to *why* consumers engage in file-sharing. The paper introduces five possible file-sharing drivers: "*perceived degree of substitution between an original movie and its illegal copy, utility of the original, (transaction) cost of the illegal copy, specific utility of the copy and a consumer's file-sharing knowledge."* These drivers are also split into several categories. Specific utility of the illegal copy can for example be *transaction utility, mobility utility, storage utility, anti-industry utility, social utility and collection utility.*

The data is used to test several important aspects of file-sharing activity. The hypothesis that obtaining an illegal copy does not affect the probability of watching the same movie in a theater can barely be concluded at a 95% significance level. The estimated losses are substantial, however. File-sharing *intentions* have negative effects on DVD rentals and

purchases – while file-sharing *behavior* does not have a significant effect on DVD rentals. File-sharing behavior has a significant effect on DVD purchases. The numbers indicate that file sharing is *a bigger threat for home entertainment alternatives than for the movie theaters.*

Testing for the determinants introduced using utility theory, Hennig-Thurau et al. (2007) finds that at least one of the sub-categories in every driver category has a significant, direct effect on obtainment of an illegal copy. All significant parameters (except gross utility of the movie original) are in the proposed directions. 8 of 15 determinants have significant impacts. This includes the collection utility, indicating that consumers have a positive value of collecting the illegal copies on their storage devices – an effect that could be utilized by the motion picture industry.

Hennig-Thurau et al. (2007) find evidence of cannibalization of theater visits, DVD rentals and DVD purchases. The results amount to total annual revenue losses of $300 million in Germany alone. The results, however large, indicate that the industry over-exaggerates the effects of illegal file-sharing in motion pictures.

Danaher & Waldfogel (2008) observe that the lag between U.S. and international release creates readily available pirate copies abroad before the movie has had its theatrical release in the country in question. Therefore, a natural research question is whether longer lags leads to depressed box-office admissions. The data used is from 2003-2006 - including only Hollywood movies – a set of 678 films.

There seems to be a correlation between the length of the lag between U.S. and foreign release and lower foreign box-office admissions. In addition to this, the relationship is affected by diffusion of BitTorrents – a longer lag is even more damaging in the later period of the data set. Danaher & Waldfogel's (2008) results strongly indicate that longer lags between national and international release windows are relevant for decreased box-office admissions. This delay may be the driver of the piracy losses experienced. However, other research materials find that U.S. and international piracy losses are about equal in size – somewhat undermining the results of this paper.

Danaher & Waldfogel (2008) argue that there are three reasons studios have a lag between U.S. and foreign release. First, film prints have a high cost. Using the same print in several locations will therefore save costs. Arguably though, the diffusion of digital cinemas will eventually void this effect. Second, there are many more theaters per inhabitant in the U.S.

than in most foreign markets. Therefore, studios may use the U.S. release to find out which movies should make it to a foreign release at all. Lastly, the stars of the movie should be available for the premiere in the major foreign markets. The question is whether these effects give a movie more positive revenue than piracy eats.

While there is a consensus that the effect of music piracy is negative for the music industry, they argue that there is yet no such consensus for motion picture piracy. Danaher & Waldfogel (2008) therefore seek to better understand motion picture piracy.

Controlling for a genre that generally experience higher downloads than others – science fiction – they still find that piracy caused the motion picture industry to lose in the magnitude of $240 million in weekend box-office in 2005 – in non-U.S. markets alone. This result is 7% lower than what they have estimated the counter-factual to be – the absence of pre-release piracy.

Since they only look at the relationship between lags and piracy in the foreign markets – the piracy levels they find are for foreign markets only. Therefore, their results may underestimate the effect of piracy, as U.S. piracy is not considered. Other research has specified that piracy is about equal in size in the U.S. and foreign markets. Danaher & Waldfogel (2008) conclude that studios should continue to reduce the release lag between U.S. and foreign markets.

Smith & Telang (2009) aims to estimate the effect on DVD demand from two different sources of free distribution – legitimate in the sense of movie broadcasts on TV, and illegitimate in the sense of online piracy availability. The data set includes all broadcasted movies (in the U.S.) over an eight month period spanning from 2005-2006 – a point in time where movie piracy was not yet fully recognized as a threat, conjecturing from Mayer-Schönberger (2008). A reason for undertaking this research, is that sales cannibalization in the motion picture industry may be especially eminent. This is particularly because movies are *"more prone to single-use consumption than other intellectual property categories."* Furthermore, "*it is unclear from a theoretical perspective what impact these two types of free goods might have on subsequent demand through legitimate channels."* The data used in the paper is collected through lists from the major broadcast networks in the United States, DVD sales data from Amazon.com. The piracy data comes from two major public BitTorrent trackers. BitTorrent is used as a proxy for piracy because "*BitTorrent is currently the most popular protocol for sharing large files"* – an assumption that still holds today.

Using television broadcasts as the free alternative, Smith & Telang (2009) find that an airing of a specific movie increases demand for the DVD largely and significantly – and that this effect persists for three to four weeks. These effects are also found for television broadcasts affecting piracy 'demand'. While controlling for movie popularity, they find no evidence that a movie's availability on a BitTorrent tracker negatively affects the positive demand shift of a DVD following a television broadcast. Their results suggest that *pirates and legitimate buyers are separate segments*. An implication of this result is that if two products are sufficiently differentiated, offering a free alternative may in fact increase demand for the costly alternative.

Smith & Telang's (2009) argumentation differs from Rob & Waldfogel (2007) in that they believe competing with free is possible due to the pirated product appealing to a different customer segment. Rob & Waldfogel (2007) assumes that piracy will be more prominent amongst potentially rich, high-class university students – the very group thought to have a high valuation of motion pictures.

In a related paper, Smith and Telang (2010) find that an increase in broadband Internet penetration leads to a significant *increase* in DVD sales. Conservative results indicate that up towards 10% of the increase in DVD sales in the estimated period (2000-2003) could be attributed to broadband penetration. If correct, this finding fully contradicts with classical models concerned that broadband penetration would significantly increase the threat of piracy. Smith and Telang (2010) do not, however, discuss how broadband penetration could be a threshold variable. Walls (2008) conclude similarly in a paper analyzing the differences in piracy rates between 26 diverse countries. In his study, a regression analysis indicates that piracy is *decreasing in internet usage*.

In a 2011 working paper, Martikainen estimates *short-term* effects of movie piracy on DVD sales. Effects are measured by analyzing sales and torrent data for newly released DVDs over a 13 week period in the United States. Martikainen (2011) follows Smith & Telang (2009) in using micro data from torrents instead of the usual proxy, broadband penetration. The goal of the paper can be inferred to be an estimation of how "harmful" movie piracy is for the motion picture industry – thus providing legal practitioners an economic leg to stand on. Differing from Smith and Telang (2009), Martikainen's data set includes sales data for both physical and online marketplaces, uses a dynamic panel method instead of television broadcasts, and

finally considers effects much earlier in the life cycle of a given DVD. Martikainen (2011) argues that sales and download patterns of new releases differ from older movies.

Using the dynamic panel method, Martikainen (2011) is unable to find significant deterring effects of file-sharing on the DVD sales of an *average* movie – consistent with the results of Smith & Telang (2009). While this contrasts earlier papers using survey data or proxying broadband penetration, Martikainen (2011) argues that his method is of a more robust nature – and that previous results are partly driven by poor data. It is of essence, however, to remember that the research only covers the short-term effects of DVD sales. Long-term effects could provide different results altogether.

4. Model I – Extension of Poddar

The preliminary work of Poddar (2005) offers a specific framework for analyzing piracy in motion pictures. The model presented in this section can be seen as an extension of Poddar's work – with some notable (and complicating) differences. One of the main questions asked by respecifying is if it reveals qualitative differences as compared to Poddar (2005).

A movie studio has finished producing a motion picture, and is about to release it. The motion picture is released in two periods. In the first period, it is shown in the movie theater, in the second it is released on a DVD. The movie studio controls both products being released, and chooses the price of the products. There exists an implicitly given positive fixed cost – normalized to zero, while the cost of reproducing a movie viewing or a DVD is assumed to be negligible. The consumers are assumed to be rational, and correctly predict second period prices at the start of the first period.

The consumers' value of a viewing of a motion picture is independent of whether it is DVD or through a cinema ticket. There is a continuum of consumers, X, uniformly distributed over their willingness-to-pay for the motion picture. This willingness-to-pay is defined over $X \in [\theta_L, \theta_H]$ where $\theta_H > \theta_L \geq 0$. The market size is normalized to 1.

In the model, motion pictures are considered a single-use good. Consumers who saw the movie in the first period will not watch it again in the second.

Consumers can choose between legitimately watching the motion picture in period 1 or 2, watch the pirated version in period 2 (when available) or not watching the motion picture at all. Consumers have a homogenous discount factor $\delta \in (0, 1)$ that reduces the value of consuming in the second period. The discount factor describes their impatience for consuming the good. Furthermore, there is a perceived quality difference between the DVD version and the pirated version $q \in (0, 1)$ that is homogenous over all consumers. A low q signifies that the pirated version is a bad substitute for the DVD version.

Finally – following Bae & Choi (2006) - consumers implicitly have some cost of piracy. This cost of piracy, C_p, includes all aspects which can be believed to cause disutility in the consumption of the pirated version such as legal cost (risk of being prosecuted), bandwidth costs and search costs. For the sake of simplicity, this cost is also assumed homogenous over all consumers.

The consumers' utility, therefore, is given by

$$U_t = \begin{cases} \delta^{t-1}X - P_t & if\ he\ watches\ the\ legal\ version\ in\ period\ t \\ \delta^{t-1}qX - C_p & if\ he\ watches\ the\ pirated\ version\ in\ period\ t \\ 0 & if\ he\ does\ not\ consume \end{cases}$$

Since we are assuming that piracy only exists when the DVD version has been released, Poddar's case of no protection serves no purpose – other than if a DVD copy were to be released while the motion picture was still in the theater. It is assumed, however, that the pirated copy is released at the same time as the DVD version.

The difference between this model and Poddar is therefore that it extends his model from $C_p = 0$ to the case where piracy can have a positive cost, similar to the cost structure presented by Bae & Choi (2006). Accordingly, all the derived equations can be simplified to the case of Poddar by evaluating them at $C_p = 0$.

In the first part, the benchmark case is presented. Then, the model with piracy in the second period is presented. Some results are analyzed mathematically, and a discussion follows.

4.1 Benchmark case – no piracy

In the benchmark case – where no piracy exists - the only difference compared to Poddar is the naming of the periods. Poddar's second period includes a continued theatre run, while the second period in this model assumes this is the DVD period. However, this is merely an effect of our argument that DVD will be more affected by piracy, and as such there are no *mathematical differences.*

A consumer's utility is given by

$$U_X = \begin{cases} X - P_1 & theatre\ version\ in\ period\ 1 \\ \delta X - P_2 & DVD\ version\ in\ period\ 2 \\ 0 & no\ consumption \end{cases}$$

The indifferent consumers follow Poddar exactly.

Following from Poddar's benchmark, equilibrium prices, demands and profit is

$$P^*_{B,1} = \frac{2\theta_H(1-\delta)}{4-3\delta}$$

$$P^*_{B,2} = \frac{\delta\theta_H(1-\delta)}{4-3\delta}$$

$$D^*_{B,1} = \frac{2\theta_H(1-\delta)}{(\theta_H-\theta_L)(4-3\delta)}$$

$$D^*_{B,2} = \frac{\theta_H}{(\theta_H-\theta_L)(4-3\delta)}$$

$$D^*_B = \frac{\theta_H(3-2\delta)}{(\theta_H-\theta_L)(4-3\delta)}$$

$$\pi^*_B = \frac{\theta^2_H(1-\delta)}{(\theta_H-\theta_L)(4-3\delta)}$$

where the B denotes the benchmark case. There can be noted a slight difference between Poddar's case and this one in total demand D^*_B. The summation of demands in Poddar is wrong – probably due to a mistyping. This has no implications for the results Poddar arrives at in his article.

As in Poddar, $P^*_{B,1} > P^*_{B,2}$ for all values of δ, while $D^*_{B,1} > D^*_{B,2}$ for $\delta < 0.5$.

4.2 DVD piracy

This scenario assumes the following specification: In the first period, the studio releases a theatrical version of the motion picture. There is no pirated version available in this period. In the second period, the studio releases a DVD, and a pirated copy becomes instantly available. This pirated copy is a partial substitute to the DVD version, and consumers associate a certain cost with its consumption. Consumers have four choices: Watch the motion picture in a theatre in the first period, watch the DVD in the second period, watch the pirated version in the second period, or do not consume. The utility of consumer X is defined as

$$U_X = \begin{cases} X - P_1 & theatre\ version\ in\ period\ 1 \\ \delta X - P_2 & DVD\ version\ in\ period\ 2 \\ \delta q X - C_p & pirated\ version\ in\ period\ 2 \\ 0 & no\ consumption \end{cases}$$

Both the studio and the consumers have full information and are rational, meaning that they know what versions are available, and at what price they will be offered.

The indifferent consumers X_1, X_2 and X_3 define the demand distribution. Consumer X_1, who is indifferent between consuming the theatre version in period 1 and the DVD version in period 2 is located at

$$X_1 - P_1 = \delta X_1 - P_2$$

$$\rightarrow \boldsymbol{X_1 = \frac{P_1 - P_2}{1 - \delta}}$$

The indifferent consumer X_2, who is indifferent between watching the DVD version in period 2 and the pirated version in period 2, is given by

$$\delta X_2 - P_2 = \delta q X_2 - C_p$$

$$\rightarrow \boldsymbol{X_2 = \frac{(P_2 - C_p)}{(\delta - \delta q)}}$$

Being indifferent between consuming the pirated version and not consuming at all, X_3 is located at

$$\delta q X_3 - C_p = 0$$

$$\rightarrow X_3 = \frac{C_p}{\delta \cdot q}$$

Figure 4.1 Distribution of consumers in case of DVD piracy

The consumers located between θ_H and X_1 watch the motion picture in the movie theater, the consumers located between X_1 and X_2 consume the DVD, the consumers located between X_2 and X_3 are the pirates, and consumers located between X_3 and θ_L do not consume at all. If X_3 is bigger than X_2, releasing the DVD is a bad move by the studio – and the case must be disregarded.

First period demand is given by

$$D_1 = \int_{X_1}^{\theta_H} \frac{1}{(\theta_H - \theta_L)} dx$$

$$D_1 = \frac{(1-\delta)\theta_H - p_1 + p_2}{(\theta_H - \theta_L)(1-\delta)}$$

In the same fashion, demand in period 2 is given by

$$D_2 = \int_{X_2}^{X_1} \frac{1}{(\theta_H - \theta_L)} dx$$

$$D_2 = \frac{(\delta - \delta q)p_1 + (1-\delta)C_p - (1-\delta q)p_2}{(\theta_H - \theta_L)(1-\delta)(\delta - \delta q)}$$

Thusly, profits for the studio in period 1 and 2 is

$$\pi_1 = p_1 \cdot \frac{(1-\delta)\theta_H - p_1 + p_2}{(\theta_H - \theta_L)(1-\delta)}$$

$$\pi_2 = p_2 \cdot \frac{(\delta - \delta q)p_1 + (1-\delta)C_p - (1-\delta q)p_2}{(\theta_H - \theta_L)(1-\delta)(\delta - \delta q)}$$

In this setting, profit maximization is found by using backward induction. We maximize π_2 with respect to P_2 to find the second period's price as a function of the price in period 1. Profit maximization is found where $\frac{\partial \pi_2}{\partial P_2}$ is equal to zero.

$$\frac{\partial \pi_2}{\partial P_2} = 0$$

This maximization yields the result

$$P_2(P_1) = \frac{(\delta - \delta q)P_1 + (1-\delta)C_p}{2(1-\delta q)}$$

With this result, we can obtain demand and profit functions as expressions of P_1 :

$$D_1(p_1) = \frac{2(1-\delta q)(1-\delta)\theta_H - (2-\delta q - \delta)p_1 + (1-\delta)C_p}{2(\theta_H - \theta_L)(1-\delta)(1-\delta q)}$$

$$\pi_1(p_1) = p_1 \cdot \frac{2(1-\delta q)(1-\delta)\theta_H - (2-\delta q - \delta)p_1 + (1-\delta)C_p}{2(\theta_H - \theta_L)(1-\delta)(1-\delta q)}$$

$$D_2(p_1) = \frac{(\delta - \delta q)p_1 + (1-\delta)C_p}{2(\theta_H - \theta_L)(1-\delta)(\delta - \delta q)}$$

$$\pi_2(p_1) = \frac{(\delta - \delta q)^2 p_1^2 + (1-\delta)^2 C_p^2 + 2(\delta - \delta q)(1-\delta)p_1 C_p}{4(\theta_H - \theta_L)(1-\delta)(\delta - \delta q)(1-\delta q)}$$

$$\pi(p_1) = \pi_1(p_1) + \pi_2(p_1)$$

$$\pi(p_1) = \frac{4(1-\delta)(\delta - \delta q)(1-\delta q)\theta_H p_1 - (\delta - \delta q)(4 - 3\delta - \delta q)p_1^2 + 4(1-\delta)(\delta - \delta q)C_p p_1 + (1-\delta)^2 C_p^2}{4(\theta_H - \theta_L)(1-\delta)(\delta - \delta q)(1-\delta q)}$$

As can be readily verified, if C_p = 0 all equations still reduce to the case presented by Poddar.

Profit maximization is found where $\frac{\partial \pi(P_1)}{\partial P_1}$ equals zero. Solving the differential yields profit-maximizing prices and demands:

$$p_1^* = \frac{2(1-\delta q)(1-\delta)\theta_H + 2(1-\delta)C_p}{4-3\delta-\delta q}$$

$$p_2^* = \frac{2(1-\delta q)(1-\delta)(\delta-\delta q)\theta_H + (1-\delta)(4-3\delta q-\delta)C_p}{2(1-\delta q)(4-3\delta-\delta q)}$$

$$D_1^* = \frac{4(1-\delta q)(1-\delta)\theta_H - (\delta-\delta q)C_P}{2(\theta_H-\theta_L)(1-\delta q)(4-3\delta-\delta q)}$$

$$D_2^* = \frac{2(1-\delta q)(\delta-\delta q)\theta_H + (4-\delta-3\delta q)C_p}{2(\theta_H-\theta_L)(\delta-\delta q)(4-3\delta-\delta q)}$$

$$D^* = \frac{2(1-\delta q)(\delta-\delta q)(3-2\delta-\delta q)\theta_H + \left((1-\delta q)(4-\delta-3\delta q) - (\delta-\delta q)^2\right)C_p}{2(\theta_H-\theta_L)(1-\delta q)(\delta-\delta q)(4-3\delta-\delta q)}$$

Equilibrium profit is given by $\pi^* = P_1^* \cdot D_1^* + P_2^* \cdot D_2^*$. It can be calculated that equilibrium profit is

$$\pi^* = \frac{4(1-\delta)(\delta-\delta q)(1-\delta q)^2\theta_H^2 + 8(1-\delta)(\delta-\delta q)(1-\delta q)C_p\theta_H + (1-\delta)(4+\delta-5\delta q)C_p^2}{4(\theta_H-\theta_L)(\delta-\delta q)(1-\delta q)(4-3\delta-\delta q)}$$

In the special case where C_p equals zero, the equation reduces to Poddar's case.

$$\pi^* = \frac{(1-\delta q)(1-\delta)\theta_H^2}{(4-\delta q-3\delta)(\theta_H-\theta_L)}$$

This is also the case for the price and demand equations.

Notice that $p_1^* > p_2^*$ for

$$C_p > \frac{2(1-\delta q)(\delta q+\delta-2)\theta_H}{(\delta-\delta q)}$$

that is for all positive C_p, because $(\delta q+\delta-2)$ cannot be positive.

Furthermore, $D_1^* > D_2^*$ for

$$C_p < \frac{2\theta_H(1-\delta q)(\delta-\delta q)(1+\delta q-2\delta)}{(4-\delta-3\delta q)(1-\delta q)+(\delta-\delta q)^2}$$

By letting $C_p = 0$, this equation still corresponds to the findings of Poddar.

4.3 Analysis of results

We compare the size of the piracy results to the size of the benchmark results.

The price of cinema is higher in the benchmark case when $p^*_{B,1} > p^*_1$. This is the case for

$$C_p < \frac{3(\delta q - \delta^2 q)\theta_H}{4 - 3\delta}$$

The price of the DVD is higher in the benchmark case when $p^*_{B,2} > p^*_2$. This is the result for

$$C_p < \frac{8(1 - \delta q)(\delta q - \delta^2 q)\theta_H}{(4 - 3\delta)(4 - 3\delta q - \delta)}$$

Benchmark demand for attending the cinema is higher than with piracy when $D^*_{B,1} > D^*_1$. This corresponds to

$$C_p > \frac{4(1 - \delta q)(1 - \delta)(\delta q)\theta_H}{(\delta - \delta q)(4 - 3\delta)}$$

In the same manner, benchmark demand for DVD is higher than with piracy when $D^*_{B,2} > D^*_2$:

$$C_p < \frac{6(\delta - \delta q)(\delta q - \delta^2 q)\theta_H}{(4 - \delta - 3\delta q)(4 - 3\delta)}$$

Finally, benchmark profits are higher than profits under piracy, $\pi^*_B > \pi^*$, whenever the following second degree function holds:

$$12(\delta - \delta q)(1 - \delta q)(\delta q - \delta^2 q)\theta_H^2 - 8(\delta - \delta q)(1 - \delta q)(4 - 3\delta)C_p\theta_H - (4 + \delta - 5\delta q)(4 - 3\delta)C_p^2 > 0$$

Proposition I.1

The existence of a positive cost of piracy combines with an ambiguous effect of piracy on the profits of motion picture studios. The proposition has ***not*** *been checked under relevant first- and second-order conditions.*

As the equation above shows, benchmark profits can be lower than profits under piracy. This relation is unconstrained, however, and may show that benchmark piracy is always higher under the conditions that $X^*_1 > X^*_2 > X^*_3$.

We now turn our attention to some comparative statics. Prices, demands and profits are partially differentiated with respect to the cost of waiting, the quality cost of the copy, and the reproduction cost of the copy.

COMPARATIVE STATICS

PRICE	δ	q	C(p)
1st period BENCHMARK	-	0	0
1st period PIRACY			+
2nd period BENCHMARK	+	0	0
2nd period PIRACY			+

DEMAND	δ	q	C(p)
1st period BENCHMARK	-	0	0
1st period PIRACY			-
2nd period BENCHMARK	+	0	0
2nd period PIRACY			+
Total demand BENCHMARK	+	0	0
Total demand PIRACY			

PROFIT	δ	q	C(p)
Total profit BENCHMARK	-	0	0
Total profit PIRACY			+

The comparative statics section is not finished. The differentials produced by the mathematical program "Maple" can be found in the appendix. Results from the appendix are not checked for errors, and may therefore be incorrect.

The effect of the cost of piracy on total demand is defined when the following function holds

$$4 + (2q^2 - q - 1)\delta^2 - (1 + 7q)\delta > 0$$

Proposition I.2
A higher reproduction cost of piracy induces the studio to charge a higher price for the legitimate product in both the first and second period.

Proposition I.3
A higher reproduction cost of piracy has a positive effect on second period demand, but lowers first period demand.

Proposition I.4
The profits under piracy are unambiguously higher when the reproduction cost of piracy is raised.

4.4 Discussion of results

The analysis produced several ambiguous results. Furthermore, the comparative statics are far from finished. The combination of these makes it difficult to discuss results in a good way. However, it is possible to see that different values of the variables *may* produce different results – as compared to Poddar's base model.

A positive cost of piracy affects the model. With further testing, we can confirm whether relevant values for the cost of piracy may actually provide results that suggest profits are higher with piracy than without it. With the current setting, however, this is unlikely – there is no indirect appropriation because of the assumption of one-time viewing. Network effects are also not included in the model.

On a quite interesting note, the model shows that an increase in the cost of piracy *lowers* the demand for the first-period cinema. While the result is somewhat surprising, the effect arises because as "competition" from the pirated copy softens, the studio has an incentive to raise the price so much in the first period that demand in the same period actually falls. It is optimal to tend to fewer consumers, but to reap much higher revenues from each of them.

Prices are raised by an increase in the cost of piracy in both periods. This is a reasonable response to the softened competition. The total effect is that an increased cost of piracy unambiguously raises legal profits. This is just as we would expect before undertaking the analysis.

The main purpose of extending Poddar's (2005) original model was to see if the existence of a positive cost of piracy produced any *qualitative* differences. Alas, this cannot be proven with the current state of the model. To test for any qualitative differences, the model must be much closer to being finished – which it sadly is not at its current state.

A refining touch compared to Poddar's cases with piracy is that the market is not fully covered when there is a positive reproduction cost of piracy. Assuming that everyone with a marginally positive gross utility from a motion picture will consume, is a huge overstatement at the least. For this reason, and because it is much more likely that consumers implicitly assigns some cost to the act of watching a pirated copy, we feel that this specification of the model is more fitting. Nonetheless, it does indeed produce more ambiguous results – and as such, the benefits of the model's specification could be unwound by the effects of not being able to analyze it sufficiently.

This brings us to the point of what is missing to finish the models.

First and foremost, it would be highly interesting to finish the testing of comparative statics. The effects of a change in the environment, for example having the consumers become more impatient or the pirated copy become a better substitute to the legitimate good, are of importance to study the effects of piracy. This would also make it easier to check for differences between this model and the one specified by Poddar.

Testing the ambiguous results of the rest of the analysis under appropriate conditions will also improve the overall quality of the analysis. To ease understanding, it could also be interesting to present the model with a numerical example.

Finally, we would have liked to follow Poddar in providing a calculation of the welfare effects for both consumers and the society as a whole. Not only can it provide grounds to test for qualitative differences as compared to Poddar, it may also lay the basis for a discussion of long-term effects of piracy.

4.5 Limitations and possible extensions

A characteristic of any model is that it has drawbacks. This one is no exception. What follows is a discussion of the limitations of the model when compared to the real world. Additionally, we will discuss how the model might be further extended to better describe piracy in the motion picture industry.

First we need to address the effect of assuming that consumers are rational and have complete information. This assumption is a quite strict one. Motion pictures are under the class of goods that are called information goods, and an artifact of these goods is that they are *experience goods.* You have to consume it before realizing what its full value is. Real consumers then have a *risk* connected to consuming the motion picture. Since there is little re-watching of motion pictures, a risk-averse consumer would be willing to pay less for a motion picture because of the risk that it might not be in his taste. It might also induce a consumer to wait until another time to consume, after asking other consumers of their valuation of the motion picture to lessen the perceived risk.

Modeling with rationality also creates the scenario where consumers always know what is going to happen in the second period. This is the reason we see consumption only at two specific points in time in the model. In real markets, consumers buy for a number of different reasons, and might not even be aware that the motion picture exists until after the DVD has been released!

Some may have a problem with assuming that the motion picture cannot be consumed by the same consumer more than one time. While a model incorporating several purchases by a single consumer might be interesting, empirical evidence also suggest that the re-watching effect in motion pictures is fairly limited. In the data material provided by Rob & Waldfogel (2007), motion pictures in the sample were watched an average of 1.3 times per consumer. While this number is not equal to one, it is quite close – especially if you want to compare to how many times a consumer listens to, say, a song. A case can also be made that a consumer who is more likely to want to watch a motion picture several times will purchase only the DVD – a product that can be consumed several times without additional cost.

If this is the case, however, it means that consumers are different over other dimensions than just perceived quality of the motion picture. Some place a higher value on the cinema experience, because they like to go out, because they like the entire ordeal of going to a cinema – getting drinks and snacks, sitting down amongst many others, or because they just

find the quality of the screen to be much better than the at-home alternative. Alas, others may place a higher value on the at-home experience for a different range of reasons.

In the model presented above, there is no other difference between the DVD and the cinema version than that they are not released at the same time. But if this was the case, why would the DVD even exist? There must be other reasons for releasing a DVD than just to have inter-temporal price discrimination – this could be done easily by offering the cinema experience in two different periods. Of course, it is possible that cost gains are a part of it. Capacity constraints in the theaters are also relevant – because new motion pictures are produced all the time, and if all motion pictures were to be shown in the cinema for an extended period of time, the capacity constraint would indeed become binding. It might also be because new consumers enter the market after DVD release. When all is said, though, it is likely that both products exist because some consumers prefer one, and other consumers prefer the other. This case of horizontal differentiation will be the focus of the model presented after this section.

That there are no capacity constraints in the model is a limitation in itself – even in a single period, some consumers will be unable to watch a motion picture because the theatre is fully booked at their preferred location.

The limitations associated with non-differentiated goods sold at different periods in time are evident only in the presented model. Poddar (2005) consider a model where theatre tickets are sold in two periods – and assuming that cinema is non-differentiated with cinema is indeed not an issue.

By assuming that q and c_p are both uniform over all consumers, we disregard some information of differences between consumers. For the degradation cost, it may be that some consumers care less about the technical quality of the motion picture than others – completely unrelated to their valuation of the quality of the motion picture's content. The reproduction cost can be different because some consumers see fewer moral problems with copyright infringements, some are more skilled with a computer, and some have cheaper broadband connections albeit at the same speed.

Finally, it is easily argued that motion pictures do indeed compete with other motion pictures, and even other leisurely goods and activities. In this model, this very real effect is completely disregarded. The marketing efforts of the motion picture industry suggest that it is of great importance to know the competitive landscape. With the basis of our model, it is possible to

speculate that a motion picture faces somewhat monopolistic competition when it is available in the movie theater – because few other movies are released at the same time, but that the competition could be comparatively harder when the motion picture is released on DVD, because a DVD run can last much longer than a theatre run.

How can this model be extended further? Without considering the technical difficulties, we outline some extensions that could be interesting to analyze.

What would be the effect if, for some reason, a DVD copy was leaked during the first period? Such a scenario would correspond well to the "no protection" case presented by Poddar. Piracy from the first period obviously hurts the studio more than piracy in only the second period – but comparing the results to Poddar's "no protection" will nonetheless be interesting. It is not uncommon that a pirated DVD is leaked before the retail DVD is available – a relevant case is the leak of the Norwegian films *Max Manus* and *Uro*, which caused substantial media coverage.

In the real world it is often possible to find a copy of a motion picture produced by filming it while it's airing in a movie theatre. This CAM-rip is often of a significantly lower technical quality than the legitimate alternatives – and the DVD-rip. It could be of interest to see how the model handles the early introduction of a low-quality pirated copy. As far as the real world goes, consumers who are substantially impatient, or care very little about technical quality are the ones who are likely to consume the first-period pirated copy. It is questionable whether the approach of this model – assuming that consumers are different across how they view the quality of the actual motion picture – can handle yet another indifferent consumer, however.

It is possible to foresee a model where some of the exogenous variables in this model are endogenized. An example is where the studio can choose the quality of the original good, and by extension, the quality of the pirated copy. If this variable is endogenized – one could see a solution where it is profitable for the studio to lower the quality of the good that is exposed to piracy – because the positive effects for the cinema version are bigger than the destructive effects of the DVD. Furthermore, it could be possible for the model to endogenize the reproduction cost of piracy. Assume that a studio can invest in technology that raises the cost of piracy. This would add another layer to the model, where the studio has to weigh the gains from a higher reproduction cost of piracy up against the studio's costs from raising it.

The degradation cost of the pirated copy is likely to fall as new technologies continue to diffuse. In some cases, it seems likely that the degradation cost of piracy might be non-relevant. As such, it could be interesting to test the model when assuming that $q=1$. Comparing to Poddar, such a case would mean that the cost structure changes entirely from one that is proportional to the consumers' valuation of the motion picture, to one that is completely linear amongst all consumers.

If we want to make the case that DRM and other restrictions put on legal alternatives causes a disutility for the consumers that does not exist in the pirated copy – we can see a scenario where the degradation cost of piracy is no longer a cost, but a benefit. This happens for $q>1$. The studio now has to set a price under the reproduction cost of piracy in the time periods where piracy exists to have positive demand in that period. That means limit pricing – or less – so that piracy will be deterred.

Both Poddar's model and this extension assumes that all consumers have the knowledge and possibility to pirate – and will do so if they find that pirating gives them the highest utility of all alternatives. In practice, however, it is highly unlikely that all consumers have the capability of downloading. Both the share of consumers who have enough knowledge to do so, and the share of consumers with a good enough broadband connection will continue to rise as technology progresses even further, and a bigger share of consumers have lived their entire life in the Internet age. However, a model where only a share of consumers can download a pirated copy would likely mitigate some of the ill-effects of piracy – depending, of course, on other assumptions. One could also contemplate expanding into a model where the reproduction cost of piracy is unequal over the consumer mass.

At last, the motion picture industry has several other product lines than just cinema and DVD. As discussed in the industry review, motion pictures are available in a wide range of formats, including video-on-demand, pay-per-view and cable television. Considerations of expanding the model from a two-period to one with three periods could produce interesting results for the industry.

5. Model II – Horizontal and vertical differentiation

We now turn to a model based on horizontal differentiation between the authorized goods. The model is based on the literature from the section presenting frameworks for horizontal differentiation.

Consider a motion picture studio that has finished producing a motion picture. The studio maximizes profits as a monopolist because no other product can be seen as a substitute to this specific motion picture. The studio will release the motion picture in two periods, with two different products: one that can be viewed in a movie theatre, and one that can be seen at home. The theatrical product is released and available only in period 1, while the at-home alternative is released and available only in period 2. The cinema product, *k*, and the at-home product, *DVD*, is offered at positive prices p_k and p_{DVD}.

It is assumed that the time between the two releases is short enough to omit considerations of rent, so that prices and profits have the same value for both producers and consumers in both periods. However, consumers have a depreciation factor $\delta \epsilon (0, 1)$ that identifies the disutility from having to postpone consumption of the motion picture until the next period. All consumers share a reservation price r_p, that symbolizes how much they are willing to pay for the motion picture. The depreciation factor affects the reservation price – so that a consumer is willing to pay at most δr_p for a product offered in the second period.

The two products are exogenously placed at the ends of a standard Hotelling line [0,1]. A consumer's placement along the line signifies his preference toward consuming the movie in the theater or at home. If a consumer is placed close to 1, he prefers to watch the movie at home, while a consumer placed close to zero prefers to attend the theatre. The number of consumers is normalized to unity. If both products are offered at the same price at the same time, both will have positive profits. The authorized products are thus horizontally differentiated.

The model lends inspiration from Dos Santos Ferreira & Thisse's (1996) use of the Launhardt model. However, they do not consider reservation prices – which are originally borrowed from Lerner & Singer (1937). This is also the only model, as far as we know, that uses the framework for a monopolistic firm competing against a non-profit maximizing copying threat. As such, the model becomes quite experimental. Corresponding to the Launhardt model, different products can have different transportation costs, indexed by t_i.

The at-home version can be subject to copyright infringement, in the sense that it can be pirated – symbolized by "RIP". The pirated version is located at the same place as the original DVD on the Hotelling line. To receive the pirated version, a consumer has to expend some cost $p_{RIP} > 0$. The pirated copy is assumed to have a higher transportation cost than the original – such that $t_{RIP} > t_{DVD}$. Indeed, this symbolizes vertical differentiation. If the monopolist chooses to limit price, $p_{DVD} = p_{RIP}$, all consumers who consume in the second period will choose the original.

Consumers have inelastic demand for one viewing of the motion picture, regardless of which product is consumed. They will choose the alternative that offers them the lowest full price, or, if all full prices are above their period reservation price, they will not consume. This opens up for scenarios where the market is not fully covered, which seems to correspond well to the real world.

For a consumer located at *x*, the full price of a product located at 0 is given by $p_i + t_i x$, while the full price of a product located at 1 is given by $p_i + t_i(1 - x)$. Consumers have full information, and correctly predict second period prices upon first period release.

5.1 The benchmark case – no piracy

Consider a scenario where it is impossible to pirate the at-home alternative. Consumers now choose between the legitimate cinema alternative, the legitimate DVD alternative and not consuming at all.

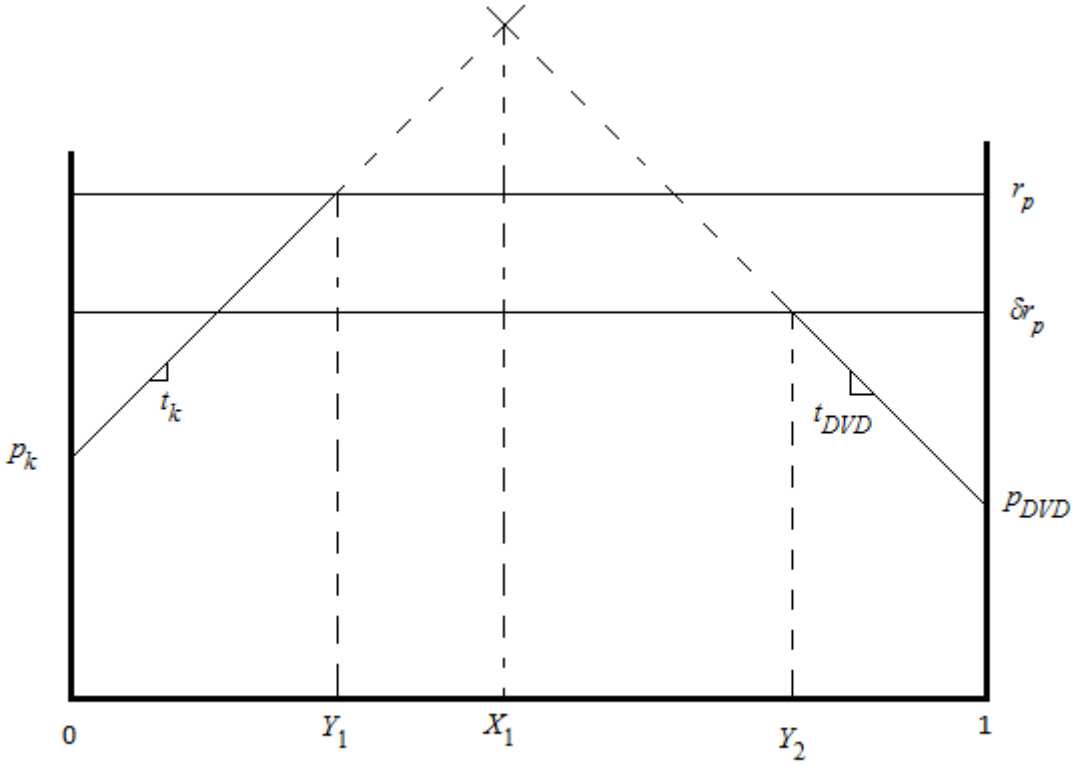

Figure 5.1 A case of local monopolies

Figure 5.1 graphically illustrates the indifferent consumers. The consumer that is indifferent between consuming the cinema version and not consuming at all, Y_1, is given by

$$p_k + t_k Y_1 = r_p$$

$$\rightarrow Y_1 = \frac{r_p - p_k}{t_k}$$

The consumer indifferent between consuming the DVD version and not consuming at all, Y_2, is given by

$$p_{DVD} + (1 - Y_2)t_{DVD} = \delta r_p$$
$$\rightarrow Y_2 = \frac{p_{DVD} - \delta r_p + t_{DVD}}{t_{DVD}}$$

Finally, the consumer that is indifferent between consuming the cinema version and consuming the DVD version is given by

$$p_k + t_k X_1 = p_{DVD} + t_{DVD}(1 - X_1)$$

$$\rightarrow X_1 = \frac{p_{DVD} - p_k + t_{DVD}}{t_k + t_{DVD}}$$

If $Y_2 \geq Y_1$, we will see local monopolies for the two goods. In the marginal case, $Y_2 = Y_1$, the marginal consumer X_1 is also marginally binding – and we have full market coverage. To test if and when local monopolies is the profit maximizing solution for the studio, we maximize profits for both goods separately, and check for when the solutions yield $Y_2 \geq Y_1$.

Maximizing profits for cinema , we have

$$\max_{(p_k)} \pi_k = p_k \cdot \mathrm{D}_k$$

And for DVD,

$$\max_{(p_{DVD})} \pi_{DVD} = p_{DVD} \cdot \mathrm{D}_{DVD}$$

Demand functions are given by the indifferent consumers, so

$$\mathrm{D}_k = Y_1$$

$$\mathrm{D}_{DVD} = 1 - Y_2$$

Inserting into the profit functions, we have

$$\pi_k = \frac{p_k \cdot (r_p - p_k)}{t_k}$$

$$\pi_{DVD} = p_{DVD} - \frac{p_{DVD}^2 - \delta r_p p_{DVD} + t_{DVD} p_{DVD}}{t_{DVD}}$$

If $Y_2 \geq Y_1$, profit max for the studio is where $\frac{\partial \pi_i}{\partial p_i} = 0$, separately.

$$\frac{\partial \pi_k}{\partial p_k} = \frac{(r_p - p_k)}{t_k} + p_k \cdot \left(-\frac{1}{t_k} \right) = 0$$

Optimal prices and demands of cinema are therefore,

$$p_k = \frac{r_p}{2}$$

$$\mathrm{D}_k = \frac{r_p}{2\,t_k}$$

For the DVD version:

$$\frac{\partial \pi_{DVD}}{\partial p_{DVD}} = 1 - \frac{\left(2\,p_{DVD} - \delta\, r_p + t_{DVD}\right)}{t_{DVD}} = 0$$

Optimal prices and demand for DVD is,

$$p_{DVD} = \frac{\delta\, r_p}{2}$$

$$\mathrm{D}_{DVD} = \frac{\delta\, r_p}{2\,t_{DVD}}$$

From now on, assume that transport costs are equal for both legitimate products, $t \equiv t_{DVD} = t_k$. This could be a reflection of a state where theatre is seen as an equally good substitute for DVDs as DVDs are seen as substitutes for theatre attendance. This is a reasonable assumption.

We have the indifferent consumers

$$Y^*_{1,\,B} = \frac{r_p}{2\,t}$$
$$Y^*_{2,\,B} = \frac{2\,t - \delta\, r_p}{2\,t}$$

Local monopolies are therefore optimal for the studio if

$$\frac{r_p}{2\,t} \leq \frac{2\,t - \delta\, r_p}{2\,t}$$
$$\boldsymbol{r_p \leq \frac{2t}{1+\delta}}$$

In the following, assume that the reservation price is sufficiently small to make local monopolies the optimal solution for the studio. This means that the market is not fully covered, which is a completely reasonable assumption. Furthermore, the consumers who choose not to consume are the ones who are not especially interested in any of the products

offered. The assumption is also made for mathematical simplicity; however, this is bound to remove some valuable insights.

The set of optimal prices, demands and total profit in the benchmark case is therefore (B denotes the benchmark case)

$$p^*_{k,B} = \frac{r_p}{2}$$

$$p^*_{DVD,B} = \frac{\delta r_p}{2}$$

$$\mathrm{D}^*_{k,B} = \frac{r_p}{2t}$$

$$\mathrm{D}^*_{DVD,B} = \frac{\delta r_p}{2t}$$

$$\pi^*_{k,B} = p^*_{k,B} \cdot \mathrm{D}^*_{k,B}$$

$$\pi^*_{k,B} = \frac{r_p^2}{4t}$$

$$\pi^*_{DVD,B} = p^*_{DVD,B} \cdot \mathrm{D}^*_{DVD,B}$$

$$\pi^*_{DVD,B} = \frac{\delta^2 r_p^2}{4t}$$

$$\pi^*_B = \pi^*_{k,B} + \pi^*_{DVD,B}$$

$$\pi^*_B = \frac{\left(\delta^2 + 1\right) r_p^2}{4t}$$

As can be readily verified, $p^*_{k,B} > p^*_{DVD,B}$ and $\mathrm{D}^*_{k,B} > \mathrm{D}^*_{DVD,B}$ for all local monopoly cases. By extension, it is obvious that cinema profits are larger than DVD profits.

5.2 Piracy exists

Consider now the case where a pirated copy of the DVD becomes available upon DVD release. The reservation price of consumers for the pirated copy is the same as for the DVD, δr_p . We continue to assume that the transportation costs are equal for the authorized products.

As in the benchmark model, we proceed to find indifferent consumers. If we assume that the market is still not fully covered in optimum, *the profit maximizing set of prices and demands for the cinema version is equal to the benchmark case*. The piracy analysis then reduces to looking at the effects of piracy for the DVD and its copy. If the existence of piracy does indeed make the studio cover the market in optimum, we also have to consider piracy effects on the cinema version.

Following the benchmark case, we have

$$p_k^* = \frac{r_p}{2}$$

$$\mathrm{D}_k^* = Y_1^* = \frac{r_p}{2t}$$

$$\pi_k^* = \frac{r_p^2}{4t}$$

Figure 5.2 graphically describes the case with piracy, assuming that the market is still not fully covered.

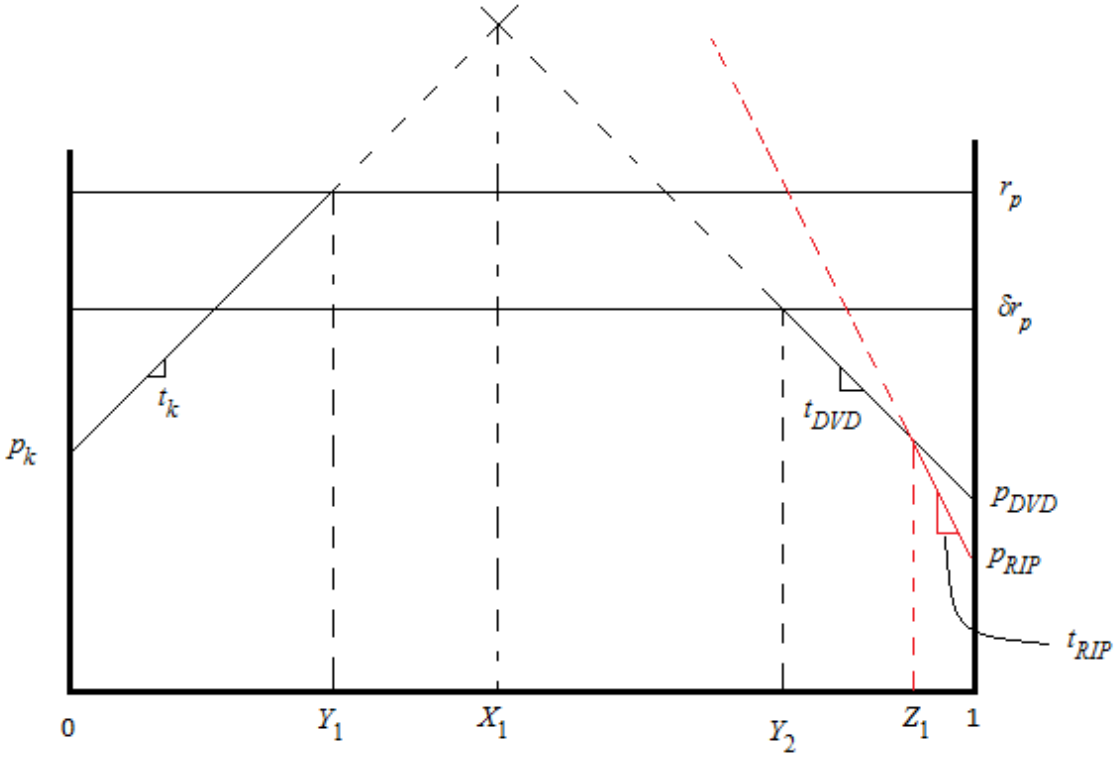

Figure 5.2 The model with DVD-piracy

The consumer that is indifferent between consuming the DVD and not consuming at all, Y_2, is still given by

$$p_{DVD} + (1 - Y_2)t = \delta r_p$$

$$\rightarrow Y_2 = \frac{p_{DVD} - \delta r_p + t}{t}$$

We also have a consumer indifferent between consuming the DVD and consuming the pirated copy, given by

$$p_{DVD} + (1 - Z_1)t = p_{RIP} + (1 - Z_1)t_{RIP}$$

$$\rightarrow Z_1 = 1 - \frac{p_{DVD} - p_{RIP}}{t_{RIP} - t}$$

Demand for the legitimate DVD is now given by the interval $[Y_2, Z_1]$. If the interval is negative in a local monopoly optimum, it is unprofitable to release the DVD. We will therefore assume that the interval is positive, that is, $Z_1 > Y_2$.

The demand and profit functions for legitimate DVD sales are

$$D_{DVD} = 1 - \frac{p_{DVD} - p_{RIP}}{t_{RIP} - t} - \frac{p_{DVD} - \delta r_p + t}{t}$$

$$\pi_{DVD} = p_{DVD} - p_{DVD}\left(\frac{p_{DVD} - p_{RIP}}{t_{RIP} - t}\right) - p_{DVD}\left(\frac{p_{DVD} - \delta r_p + t}{t}\right)$$

Again, for a local monopoly, profit maximization is found by differentiating the DVD profit with respect to DVD price, $\frac{\partial \pi_{DVD}}{\partial p_{DVD}} = 0$.

$$\frac{\partial \pi_{DVD}}{\partial p_{DVD}} = 1 - \frac{2p_{DVD} - p_{RIP}}{t_{RIP} - t} - \frac{2p_{DVD} - \delta r_p + t}{t} = 0$$

Solving, we find the optimal price,

$$p^*_{DVD} = \frac{\delta r_p(t_{RIP} - t) + p_{RIP}t}{2t_{RIP}}$$

The indifferent consumers are

$$Z_1^* = \frac{2t_{RIP}(t_{RIP} - t) - \delta r_p(t_{RIP} - t) + p_{RIP}(2t_{RIP} - t)}{2t_{RIP}(t_{RIP} - t)}$$

$$Y_2^* = \frac{t(p_{RIP} + 2t_{RIP}) - \delta r_p(t + t_{RIP})}{2t_{RIP}t}$$

hence optimal demand for the DVD is,

$$D^*_{DVD} = \frac{\delta r_p(t_{RIP} - t) + p_{RIP}t}{2t(t_{RIP} - t)}$$

Demand for the illegal copy is given by the interval $[Z_1, 1]$.

We have

$$D^*_{RIP} = \frac{\delta r_p(t_{RIP} - t) - p_{RIP}(2t_{RIP} - t)}{2t_{RIP}(t_{RIP} - t)}$$

Finally, *DVD profit under piracy* is given by

$$\pi_{DVD}^{*} = \frac{\left(\delta r_p\right)^2\left(t_{RIP}-t\right)^2+\left(p_{RIP}t\right)^2+2\,\delta r_p p_{RIP}t\left(t_{RIP}-t\right)}{4\,t_{RIP}t\left(t_{RIP}-t\right)}$$

If we observe $Y_2^* \geq Y_1^*$ we have local monopolies in the piracy case. The condition for local monopolies under piracy is

$$r_p \leq \frac{p_{RIP}t+2\,t_{RIP}t}{(1+\delta)t_{RIP}+\delta t}$$

In the piracy case, the cinema price is largest, $p_k^* > p_{DVD}^*$, when

$$r_p > \frac{p_{RIP}t}{(1-\delta)t_{RIP}+\delta t}$$

and the cinema demand is biggest, $\mathrm{D}_k^* > \mathrm{D}_{DVD}^*$, for

$$r_p > \frac{p_{RIP}t}{(1-\delta)\left(t_{RIP}-t\right)}$$

5.3 Analysis of results

This section explores some results for the case of local monopolies.

Proposition II.1
Piracy unambiguously expands the total market demand (sum of legitimate and piracy demand) under a local monopoly regime.

Proof:
If we observe that $Y_2^* < Y_{2,B}^*$, piracy expands the total number of consumers who consume any good. This is the case when $\delta r_p > p_{RIP}$, which is always true when piracy is a possible threat.

Proposition II.2
The DVD price under piracy is always lower than what it would be if piracy was not an issue, assuming a local monopoly regime.

Proof:
The benchmark DVD price is bigger than the piracy DVD price for $p_{DVD,B}^* > p_{DVD}^*$. This is the case when $\delta r_p > p_{RIP}$, which is the same condition as for Proposition II.1.

Proposition II.3
Piracy unambigously raises legal demand for DVD under local monopolies.

Proof:
Benchmark demand for DVD is larger than DVD demand under piracy when $D_{DVD,B}^* > D_{DVD}^*$.

This corresponds to $0 > p_{RIP} t$, which is never the case.

Profits in the benchmark case are higher than with piracy when $\pi_{DVD,B}^* > \pi_{DVD}^*$

This happens when

$$\left(\delta r_p\right)^2\left(t_{RIP} - t\right) - 2\delta r_p p_{RIP}\left(t_{RIP} - t\right) - p_{RIP}^2 t > 0 .$$

It should be checked whether this is always bigger than zero under the condition of local monopolies. However, for the ease of calculations – suppose that the cost of piracy $p_{RIP}$is zero.

Proposition II.4
Under local monopolies and zero cost of piracy, DVD prices are lower than in the benchmark case, DVD demand is the same as in the benchmark case, and profits for the studio is unambiguously lower than in the benchmark case.

Proof:
When the cost of piracy is assumed to be zero,

$$\left(\delta r_p\right)^2\left(t_{RIP}-t\right)-2\delta r_p p_{RIP}\left(t_{RIP}-t\right)-p_{RIP}^2 t>0$$

reduces to $\left(\delta r_p\right)^2\left(t_{RIP}-t\right)>0$, which is always the case. Profits are thus always lower than the benchmark case.

COMPARATIVE STATICS - DVD

	t	t(RIP)	p(RIP)	δ	r(p)
Price BENCHMARK	0	0	0	+	+
Price PIRACY	-	+	+	+	+
Demand BENCHMARK	-	0	0	+	+
Demand PIRACY	?	-	+	+	+
Profit BENCHMARK	-	0	0	+	+
Profit PIRACY	?	?	+	+	+

Following from what we learnt by the comparative statics, we see that

Proposition II.5
Under local monopolies, a raised transportation cost of piracy lowers the demand for the legitimate DVD.

5.4 Discussion of results, finishing touches

A reflection upon the results, and the insights they provide is in order.

The comparative statics give us unclear results when it comes to the effect of the pirated copy's transportation cost on profits. It would baffle us if a raised transport cost for piracy did not raise studio profits. As such, it will be important to test the differentials in the comparative statics under relevant conditions – to check if the result is as we would expect.

If consumers see piracy as a free alternative, demand will be the same as in the benchmark case, but prices will be lower. This means that if piracy is as big a threat as possible, it will doubtlessly lower profits. This is quite interesting, but as we see it fit that consumers actually have some sort of cost associated with the act of pirating, for whatever reason, the result does not prove much besides saying that people would like to consume a free alternative.

We see that the introduction of piracy has a positive effect on total consumption. Moreover, consumption of the authorized good also rises! The intuition for this result is that as piracy "enters the market," the optimal response of the studio is to lower prices so much that demand for the authorized good in fact increases. The total demand increase also shows that we can observe a case where the non-piracy optimal solution is local monopolies, while the introduction of piracy changes the market into a full coverage regime.

While a welfare analysis has not taken place, we can already make a brief argument that the short-term welfare is rising. Not only do more consumers enjoy the authorized good at lower prices, but some consumers also enjoy the pirated good at a price lower than the price of the authorized good! The studio will *likely* lose profits, but this effect should be mitigated by a falling deadweight loss – suggesting that the total welfare change is positive in the short run.

It is also interesting that a higher transportation cost of piracy, t_{RIP}, lowers authorized demand. Under local monopolies, however, this means that fewer consumers total are interested in the pirated copy, while the amount of consumers interested in the authorized product remain the same. The studio uses this change to charge a higher price from consumers located closer to their end of the line – with proportionally lower transportation rates for the legitimate product, and choosing to stop tending to consumers located far away. It is optimal to charge fewer with a higher price.

The cost of piracy , p_{RIP} ,is a proxy for the disutility a consumer has from for example ethical costs of pirating or the cost of being caught (penalty times the probability of being caught.) A

higher cost of piracy relates to higher prices and higher demand for the legitimate product. This intuition is that a higher cost of piracy reduces the threat posed by piracy to the studio, and they can enjoy unambiguously higher profit by raising both price and demand.

The discussion so far is assuming that the optimal response for the studio in the cases of both no piracy and piracy is to not fully cover the market – that is having "local monopolies." To finish this model, the number one priority would be to also find solutions for the cases when covering the market is optimal for both the benchmark case and the piracy case, and where covering the market is optimal for the piracy case but not for the benchmark case.

While the assumption that the market is not fully covered is not a silly one – it is only natural that someone who does not consume can have a positive gross utility from a motion picture; it has the effect that we cannot see any effect from DVD piracy on cinema. This implies that both DVDs and DVD-copies are sufficiently differentiated from cinema that they are not even in the same market. This is a much harder argument to make.

The cases of full coverage have not been carried through due to technical difficulties in simultaneous maximization of profits.

Other parts of the model that have gone unfinished are quite the same as in Model I. The section on comparative statics should be refined, with calculations under relevant conditions. Whether profits are always lower under piracy also for a positive cost of piracy should be investigated further. Moreover, a thorough calculation of welfare implications of piracy is much needed. Apart from that, some numerical examples could provide interesting insights.

5.5 Limitations and possible extensions

The model presented in this section offers a suggestion of how to mathematically treat motion picture piracy. It is, however, a work in progress. In this part, we will outline what the major limitations of the model are, and how it may be extended or altered for different analytic approaches.

A major drawback of specification with a Hotelling line is the result that the ones who have the highest net utility of consuming the original DVD chooses to consume the pirated copy. Making a legitimate argument for the existence of this result can be difficult. Respecifying the Hotelling line to mean the dimension along how "social" consumers are, could be a satisfactory response. Cinemas demand the consumer exiting their home and do something along others, while the DVD can be enjoyed in your own home. However, the DVD may have to be bought at a store (not necessary in the Internet age, though) – while a pirated copy can be acquired without setting a foot outside your door. The argumentation is indeed farfetched, and states that the result is a problem for the analysis. However, it does not necessarily mean that it cannot provide useful insights.

Another limitation is the assumption that all consumers share a reservation price. It is probable that consumers are differentiated along many dimensions, not only the one dimension that the Hotelling line offers. With this in mind, it is likely that consumers will have differing reservation prices depending on their tastes for certain aspects of the motion picture, such as their valuation of dialogue, special effects or specific actors.

Furthermore, when local monopolies are not optimal in the benchmark case, piracy can no longer expand the total market – something that is crucial for the understanding of piracy. The assumption that local monopolies holds in the benchmark case, however, is a natural one, and a simple way to circumvent this issue.

Indeed, this model has similar limitations as the extension of Poddar provided in the previous section. This includes both possible capacity constraints and the effects of not having exogenous competition from other motion pictures or other information goods. The difficulties associated with assuming full information is not as relevant for this model, however, but Hotelling models themselves are under scrutiny with this assumption. Finally, we also have the limitation of one purchase in this model. The argument for accepting this limitation is also found in the discussion of model I.

There are several ways to extend the present model for further insights about motion picture piracy.

A consumer located at the right endpoint of the Hotelling line will have the exact same net value of consuming both the DVD and the DVD-rip. As such, he will always choose the one that has the lowest price. To completely deter piracy, the studio has to limit price. Corresponding to the discussion in model I, where we point out that the technical qualities of pirated copies are likely to rise over time, we can discuss the effect of the technical quality of the copy in this model.

In the present specification, *q*, or the degradation rate of the pirated copy is implicitly assumed to be 1. We can easily introduce a scenario where this is not the case. If the degradation rate differs from 1, the total reservation price of a DVD copy is $\delta q r_p$. If the demand for the copy is now constrained by the new reservation price, we should find that this is beneficiary to the studio. However, if we consider a situation where DRM has a disutility for the consumers and the degradation cost is higher than one, piracy will pose a bigger threat if it was bounded by the reservation price in the base scenario. To understand which values of *q* seems most likely, empirical research is in order.

Introducing a *q* to the model might itself be a drawback, however, because the model would now have three different costs associated with piracy; *q*, p_{RIP} and t_{RIP}. While they all work in different ways; the degradation rate is a proportional cost, the cost of piracy is fixed for everyone, and the transportation cost of piracy signifies the cost of choosing a substitute far from their preferences, it might be too much to analyze three different types of piracy cost at the same time.

To fix some of the problems associated with the cinema version not being affected by DVD piracy in the local monopoly case, we could also introduce a pirated copy of the cinema version. This copy is normally assumed to be inferior to the DVD copy – and as such needs to be in some way distinguished from the DVD copy cost wise. This can be done in three ways.

First, we could introduce degradation rate in this model, and have the degradation rate of the cinema version a lower number than the DVD version, lowering the total reservation price for it. Second, we could assume that the cost of piracy associated with the cinema copy be higher than the DVD copy. And third, we could assume that the transportation cost of piracy were

higher for the cinema copy than for the DVD copy. All three alternatives would require a different argumentation for how motion picture piracy works.

As in the first model, we could accommodate the model into a scenario where the DVD copy is leaked "in the first period." In this model, that corresponds to changing the reservation price from δr_p to r_p . For some ranges of this model, the change has no effect. (See for example Figure 5.2**)** When the reservation price for the pirated copy is binding, however, this may deteriorate studio profits – corresponding to the discussion of adding a *q*.

It is also in this model possible to endogenize variables to further understand their effect. How would the studio respond to being able to invest in new digital theatres that changed the transportation cost of the DVD-copy (and the DVD itself) upward, for example? Endogenizing the waiting costs δ, would give the studios the opportunity to perfect the length of the video window.

A three-periodic extension would seem quite improbable in this setting, as would a case where consumers have unequal reproduction costs of piracy or where just a share of the consumers can pirate.

6. Integrated discussion

In this section, we present a short comparison between our two models, how they fit with the effects found by empirical works, why we believe that a model of horizontal differentiation can be a good fit for the motion picture industry, and finish with some remarks about the workings of the motion picture industry.

6.1 Comparison of models and empirical research

While the models are both by different degrees works in progress, it is still evident that there are clear differences between the basis for them. The model built on the work of Poddar (2005) works in a way where there is no differentiation between the two authorized goods, cinema and DVD. The second model builds on a model where the goods are horizontally differentiated. In its current format, however, inter-temporal concerns are not binding.

They are alike because they both assume that the pirated copy is an inferior good to the authorized ones, and hence we have vertical differentiation between original and copy. The vertical differentiation, however, works through different channels for the two models. In the first model, differentiation works through a reproduction cost of piracy, C_p and a degradation rate q. The horizontal differentiation model also has a reproduction cost of piracy, p_{RIP}, but works through a transportation cost of piracy aswell, differing from the transportation costs of the authorized goods. From the discussions of the models, we see that we could introduce a degradation rate for the original good, or omit it from both models, depending on how we believe consumers look at pirated copies.

When considering the effects of a (fixed for all consumers) reproduction cost of piracy, we see that in the first model, a higher reproduction cost of piracy raises the price in both periods, lowers demand in the first period and raises it in the second, while profits are elevated. In the second model, the reproduction cost of piracy raises price, demand and profits. The second model is limited because it cannot conclude if a higher reproduction cost of piracy negatively affects cinema prices, demand and profit, a case without local monopolies has not been calculated. We can see, however, that a raised transportation cost of piracy lowers *second* period demand in the second model. As such, we can see that changing costs of piracy can affect positively and negatively in both models.

In the literature review, we reported some results from empirical work. How do our models correspond to the findings of empirical research?

Bounie et al. (2006) finds a low substitution effect between pirated copies and theatre admissions, but a high effect between video and piracy. Our extension of Poddar (2005) shows inconclusive evidence for whether piracy affects demand of both cinema and DVD – depending on the reproduction cost of piracy. A higher reproduction cost of piracy, however, raises demand for the DVD and lowers demand for the cinema – to some degree contradictory with the results of Bounie et al. (2006). The second model's assumption means that there are no interactions between piracy and cinema. Results from Bounie et al. (2006) support the assumption of local monopolies.

Rob & Waldfogel (2007) finds that piracy displaces authorized demand. Both models presented in this paper show differing results. While model I is ambiguous in the demand effect of piracy, the specification in model II finds that piracy unambiguously raises legal demand! The result in the model presented here is much more surprising than the result of Rob & Waldfogel (2007). It should be noted that this result is not necessarily reproduced in the case of no local monopolies.

Amongst Hennig-Thurau et al.'s (2007) results are numbers that indicate a bigger threat to home alternatives than to movie theaters. The way we have set up our models should correspond well to that result – apart from how a raised reproduction cost of piracy in the second period lowers first period demand.

Smith & Telang (2010) find that piracy raises DVD sales (using a proxy.) A similar result can be found in model II – where legal demand is higher with piracy than in the benchmark case. Both are quite surprising results – especially considering the atmosphere of the media coverage. That both theory and empirics can provide the same results is interesting, nonetheless. Martikainen (2011) also somewhat support this result – finding no disruption of DVD sales from torrent downloads.

6.2 The case for horizontal differentiation

Our investigation of the literature provided only one model of piracy concerning the sequential distribution pattern of motion pictures. This model did not utilize an assumption of horizontal differentiation between the product lines offered by the motion picture industry. In this part, we will shortly present some arguments for why we believe modeling motion picture piracy in a horizontal differentiation landscape can provide useful insights.

Because the sequential release pattern of motion pictures does not only incorporate price changes, but also different "versions" – we may not call it pure "inter-temporal price discrimination" but rather "inter-temporal versioning." Or, if we make the argument that the different versions are horizontally differentiated, maybe "intertemporal Hotelling discrimination."

"Intertemporal versioning" between the goods would require that we believe the product line is vertically differentiated. However, if consumers could watch a movie in the theater free of charge or download a legal DVD free of charge, would everyone attend the cinema? It seems unlikely. What if we go even further and say that the consumers were reimbursed with their travelling costs? Still, it seems improbable that everyone would attend.

This should be due to some consumers drawing a *higher utility* from consuming other "versions" along the product line. Even with waiting costs included, Paul might prefer to watch *Titanic* in his couch as opposed to driving to the movie theater and enjoying it there.

In stark contrast with for example Calzada & Valletti (2012), we believe it is undoubtedly possible to make a case for horizontal differentiation between different versions of a motion picture.

According to Frank (1994), for example, "*it is clear that some consumers would have preferred video if the required film had been available on video before t(x).*" Vogel (2011, ch. 3) goes the other way, and states that "*in addition, it seems that, no matter how low the price at home, people still enjoy going out to the movies.*" Yes, some consumers would like to attend the cinema no matter the price, and some consumers would consume the DVD almost irrespective of the relative price to the cinema.

It seems that the literature on information goods piracy tends to borrow a lot of insights from the general theory of versioning. The problem with this approach is that versioning requires

vertical differentiation between goods – and if we want to model the sequential landscape of horizontally differentiated motion pictures, the fit is not perfect, to say the least.

If you want to argue for vertical differentiation – you could say that the "low quality" goods sold in the sequential periods are inferior because of waiting costs. This provides another issue, though, because waiting costs are already explicitly used as another variable in the models.

Considering Norwegian numbers, DVD and Blu-ray actually sold *more* in 2010 than did cinema. At about equal prices, this should correspond well to a hypothesis of horizontal differentiation. Of course, it could be argued that in any year, the number of motion pictures available on DVD is much higher than the number of motion pictures available on cinema.

We make the case for horizontal differentiation – and present model II – because we believe strongly in a horizontal differentiation between cinema, DVD and other ancillary releases of motion pictures.

6.3 Further remarks

Economists that research the motion picture industry in general argue that windows should be shorter throughout the distribution sequence. Concerning the foreign release window Eliashberg et al. (2006) state that *"opportunities to save interest on investments, prevent piracy from cannibalizing revenues, and capitalize on the buzz that a movie has generated in the United States, all push distributors toward a simultaneous release strategy."*

The quote paints a picture of important aspects. First of all, piracy can cannibalize revenues if it becomes available before important windows have yet to open – the foreign cinema release tends to be a very important one. Inter-temporal aspects of rent obviously plays a role, and finally, they point out that networks effects –a bandwagon effect - do in fact have a place in the motion picture industry.

Day-and-date has become a term in the motion picture industry. It can refer to both the simultaneous opening of the cinema and video windows, and the simultaneous release of domestic and foreign. As Eliashberg et al. (2006) propose, if piracy is a reasonable substitute for the cinema experience, it will indeed influence studios to cluster their domestic and foreign releases together. However, the same cannot be said for a day-and-date release of cinema and DVD. Our models propose that DVD piracy *can* have an adverse effect on cinema sales. If the only threat to motion pictures is DVD piracy, we could by that conclude that the video window should be *longer*. This effect goes in the opposite direction of bandwagon effects and rent considerations – and proposes that piracy affects windowing decisions, as stated by Waterman et al. (2007). If, on the other hand, DVD piracy is a highly inferior substitute to the cinema experience, we can postulate that the sequential release pattern should be shortened. In model 2, as long as the optimal adaption is a local monopoly, we would have a profit increase from a higher δ, that is a shorter video window. This discussion should be affected by the degree of multi-watching of motion pictures – which seems to be quite low. A day-and-date discussion could be formulated theoretically by endogenizing δ.

A single movie will compete with other movies released at about the same time, and in different parts of the release pattern. The movie will also compete with inter-industry substitutes. Piracy could be seen as just another substitute in the mix – albeit one that does not offer the motion picture industry any profits. As such, the negative effect of piracy arises from the cannibalization effect it has on other product alternatives. Seeing as the motion picture

industry has made windowing decisions for many years, analyzing an accommodation of piracy as part of this windowing decision could provide useful insights for the industry.

The assumption of vertical integration is carried throughout the paper. However, utilizing the fact that there is little vertical control in the value chain of the motion picture industry can reveal important insights into how piracy affects the industry. The discussion of shorter video windows would be very much affected by including vertical separation in a model. While a shortening of video windows might be seen as a good thing for the studios, a substitution effect between cinema and other ancillary products, including piracy, would mean less revenues for movie theatres. Their negotiation power will be important in concluding if the video windows will in fact become shorter. Competition between different studios can also affect an analysis – the motion picture industry is a seasonal industry, and as such, there will be times of the year when both demand and competition will be more prevalent.

The models presented do not consider network effects. Even if the degree of multi-watching is weak for motion pictures, network effects can still exist when one consumer affects other consumers to watch. In the motion picture industry, this is probable. However, the effects can be both positive and negative – depending on the quality of the film. Later consumers are also more prone to having close to full information than early consumers – this means that an assumption of full information should fit better for the DVD release than the cinema release.

In the motion picture industry, it has been stated that "nobody knows anything" – resulting in the "nobody knows"-principle. How a movie rates in early periods of the release sequence can be an important part of deciding future release windows. If piracy affects some movies more than others, it can completely change the way an individual motion picture is released by the studio – adversely affecting both studio revenues and consumer well-being.

Piracy can also change the studio's long term development incentives. If that is the case, and the quality of motion pictures is affected such that piracy produces negative social welfare effects, we could say that piracy is a "free rider"-problem. However, if social welfare increases in piracy, this is not an issue from an economical standpoint.

Fully understanding and utilizing network effects is of utmost importance to the motion picture industry, in a way existing theoretical literature is not even close to describing. Good reviews can prove to be an important driver for the revenues of a single motion picture – especially in early parts of the release sequence.

Neither the proposed models nor the existing literature take into account the fact that the at-home alternative is typically offered through both renting and selling. The split is causing consumers with different dimensions of valuation to self-select their best alternative. The model is assuming that purchase is the only possible option – but under the assumption of single use, the results gained actually correspond to the way renting works. Multi-use consumers will typically have an added utility of purchasing the good, as will consumers who have a positive "collection utility", as described by Hennig-Thurau et al. (2007). In a physical environment, purchasing has a higher utility than renting because you don't have to spend time to take it back to the place you rented it. With the advent of Internet streaming and downloading services, this should no longer be a significant effect. That purchasing in this landscape is a valuable alternative to the consumers does to some degree prove that there is an added utility from multi-use. Furthermore, purchased products are easier to share with friends and family. The price per viewer is important in this aspect – especially when compared to the one price per person setting of a movie theatre.

Finally, we will consider how the motion picture industry may solve the threat posed by piracy.

Corresponding to the discussion of how the quality of the pirated product may actually be equal to or higher than the original, we believe that consumers can have an added utility of choosing which platform to consume a motion picture on. With this in mind, it is likely that piracy can be seen as a high quality good because it is available online. In the early 2000s, the motion picture industry was reluctant to introduce solutions where the consumer could stream or download a motion picture legally. In the past few years, this has changed. Motion pictures are available through a range of online companies – including Netflix, Hulu, Voddler and YouView. We believe that the emergence of this business path is in part a response to the issue of piracy. Offering consumers a chance to purchase instantly and legally at home puts the industry in a better position to fight piracy.

If piracy is a force of habit, we can propose that the industry focusing on consumers who do not already pirate. As young males are thought to be the ones who pirate the most – a possible solution would be to focus production toward the other three quadrants – females both young and old, and old males. However, if the main revenue source is young males, this business strategy might not work out too well. Apart from that, as time goes on and new consumers enter the market, a larger share of the consumers could also be competent enough to pirate.

The positive effects of a business strategy focusing on the groups that pirate the least may be diminished over time.

Section 8 in Varian (2005) further summarizes possible solutions for reducing the threat of piracy for a general class of information goods.

7. Conclusion

The goal of this paper has been to further the understanding of piracy in motion pictures, through the use of theoretical frameworks. Piracy is the "unauthorized reproduction, use or diffusion of a copyrighted work" (Belleflamme & Peitz, 2010). After extensively reviewing the motion picture industry and the literature describing illegal copying and piracy, we present two models of piracy in the sequential distribution landscape of motion pictures.

First, we presented a model that extended a specific contribution to motion picture piracy, made by Poddar in 2005. In a landscape with no differentiation between the authorized goods and vertical differentiation between an original and a copy, we find that a positive cost of piracy can have ambiguous effects for prices, demands and profit when compared to a case with no piracy. When piracy exists in the second period, a rising cost of piracy raises prices in both periods, raises demand in the second period and lowers it in the second, and unambiguously raises profits.

In the following section, we presented a model based on general frameworks borrowed from theories of horizontal differentiation. This model was created because we believe that the products in the sequential distribution line of the motion picture industry are horizontally differentiated. Through the use of a model with asymmetric transportation rates between original and copy, we can specify that a copy placed at the same location as an original can have differing demands for close to equal prices. This means that the model incorporates both horizontal differentiation (between the originals) and vertical differentiation (between an original and a copy). The model is a work in progress, and highly experimental. However, when the market is not fully served – and the original goods enjoy local monopolies – we find that the existence of piracy not only raises total demand, but also legal demand. Moreover, the existence of piracy lowers prices of the good exposed to piracy. From this, we can conjecture that piracy in a local monopoly setting increases social welfare in the short run.

We follow up with a discussion of how the results are limited, and how they may be extended. We also discuss variables that are important to the motion picture industry, and shortly discuss how they may be modeled. While models are a crude way of understanding reality, it is our hope that further theoretical works can contribute to the future of the motion picture industry. The analysis of motion picture piracy can, in turn, have consequences for how we look at the current copyright legislature, and how it may be changed for the good of total welfare in years to come.

Appendix

Differentials for the comparative statics of Model I:

Period 1 price differentials:

$$\overline{p_1} = \frac{2(1-\delta q)(1-\delta)\theta_H + 2(1-\delta)C_p}{4-3\delta-\delta q}$$

differentiate w.r.t. C[p] →

$$0 = \frac{2-2\delta}{4-3\delta-\delta q}$$

differentiate w.r.t. q →

$$0 = -\frac{2\delta(1-\delta)\theta_H}{4-3\delta-\delta q} + \frac{\left(2(1-\delta q)(1-\delta)\theta_H + 2(1-\delta)C_p\right)\delta}{(4-3\delta-\delta q)^2}$$

differentiate w.r.t. delta →

$$0 = \frac{-2q(1-\delta)\theta_H - 2(1-\delta q)\theta_H - 2C_p}{4-3\delta-\delta q} - \frac{\left(2(1-\delta q)(1-\delta)\theta_H + 2(1-\delta)C_p\right)(-3-q)}{(4-3\delta-\delta q)^2}$$

Period 2 price differentials:

$$\overline{p_2} = \frac{1}{2}\frac{1}{(1-\delta q)(4-3\delta-\delta q)}\left(2(1-\delta q)(1-\delta)(\delta - \delta q)\theta_H + (1-\delta)(4-3\delta q-\delta)C_p\right)$$

differentiate w.r.t. C[p] →

$$0 = \frac{1}{2}\frac{(1-\delta)(4-3\delta q-\delta)}{(1-\delta q)(4-3\delta-\delta q)}$$

differentiate w.r.t. q →

$$0 = \frac{1}{2}\frac{1}{(1-\delta q)(4-3\delta-\delta q)}\left(-2\delta(1-\delta)(\delta-\delta q)\theta_H - 2(1-\delta q)(1-\delta)\delta\theta_H - 3(1-\delta)\delta C_p\right) + \frac{1}{2}\frac{1}{(1-\delta q)^2(4-3\delta-\delta q)}\left(\left(2(1-\delta q)(1-\delta)(\delta-\delta q)\theta_H + (1-\delta)(4-3\delta q-\delta)C_p\right)\delta\right) + \frac{1}{2}\frac{1}{(1-\delta q)(4-3\delta-\delta q)^2}\left(\left(2(1-\delta q)(1-\delta)(\delta-\delta q)\theta_H + (1-\delta)(4-3\delta q-\delta)C_p\right)\delta\right)$$

differentiate w.r.t. delta →

$$0 = \frac{1}{2}\frac{1}{(1-\delta q)(4-3\delta-\delta q)}\left(-2q(1-\delta)(\delta-\delta q)\theta_H - 2(1-\delta q)(\delta-\delta q)\theta_H + 2(1-\delta q)(1-\delta)(1-q)\theta_H - (4-3\delta q-\delta)C_p + (1-\delta)(-3q-1)C_p\right) + \frac{1}{2}\frac{1}{(1-\delta q)^2(4-3\delta-\delta q)}\left(\left(2(1-\delta q)(1-\delta)(\delta-\delta q)\theta_H + (1-\delta)(4-3\delta q-\delta)C_p\right)q\right) - \frac{1}{2}\frac{1}{(1-\delta q)(4-3\delta-\delta q)^2}\left(\left(2(1-\delta q)(1-\delta)(\delta-\delta q)\theta_H + (1-\delta)(4-3\delta q-\delta)C_p\right)(-3-q)\right)$$

Period 1 demand differentials:

$$\overline{d_1} = \frac{1}{2}\frac{4(1-\delta q)(1-\delta)\theta_H - (\delta-\delta q)C_p}{(\theta_H-\theta_L)(1-\delta q)(4-3\delta-\delta q)}$$

differentiate w.r.t. delta →

$$0 = \frac{1}{2}\frac{-4q(1-\delta)\theta_H - 4(1-\delta q)\theta_H - (1-q)C_p}{(\theta_H-\theta_L)(1-\delta q)(4-3\delta-\delta q)} + \frac{1}{2}\frac{\left(4(1-\delta q)(1-\delta)\theta_H - (\delta-\delta q)C_p\right)q}{(\theta_H-\theta_L)(1-\delta q)^2(4-3\delta-\delta q)} - \frac{1}{2}\frac{\left(4(1-\delta q)(1-\delta)\theta_H - (\delta-\delta q)C_p\right)(-3-q)}{(\theta_H-\theta_L)(1-\delta q)(4-3\delta-\delta q)^2}$$

differentiate w.r.t. q →

$$0 = \frac{1}{2}\frac{-4\delta(1-\delta)\theta_H + C_p\delta}{(\theta_H-\theta_L)(1-\delta q)(4-3\delta-\delta q)} + \frac{1}{2}\frac{\left(4(1-\delta q)(1-\delta)\theta_H - (\delta-\delta q)C_p\right)\delta}{(\theta_H-\theta_L)(1-\delta q)^2(4-3\delta-\delta q)} + \frac{1}{2}\frac{\left(4(1-\delta q)(1-\delta)\theta_H - (\delta-\delta q)C_p\right)\delta}{(\theta_H-\theta_L)(1-\delta q)(4-3\delta-\delta q)^2}$$

differentiate w.r.t. C[p] →

$$0 = \frac{1}{2}\frac{-\delta+\delta q}{(\theta_H-\theta_L)(1-\delta q)(4-3\delta-\delta q)}$$

Period 2 demand differentials:

$$\overline{d_2} = \frac{1}{2}\frac{2(1-\delta q)(\delta-\delta q)\theta_H + (4-\delta-3\delta q)C_p}{(\theta_H-\theta_L)(\delta-\delta q)(4-3\delta-\delta q)}$$

differentiate w.r.t. delta →

$$0 = \frac{1}{2}\,\frac{-2q(\delta-\delta q)\theta_H + 2(1-\delta q)(1-q)\theta_H + (-1-3q)C_p}{(\theta_H-\theta_L)(\delta-\delta q)(4-3\delta-\delta q)} - \frac{1}{2}\,\frac{\left(2(1-\delta q)(\delta-\delta q)\theta_H + (4-\delta-3\delta q)C_p\right)(1-q)}{(\theta_H-\theta_L)(\delta-\delta q)^2(4-3\delta-\delta q)} - \frac{1}{2}\left(\left(2(1-\delta q)(\delta-\delta q)\theta_H + (4-\delta-3\delta q)C_p\right)(-3-q)\right)\Big/\left((\theta_H-\theta_L)(\delta-\delta q)(4-3\delta-\delta q)^2\right)$$

differentiate w.r.t. q →

$$0 = \frac{1}{2}\,\frac{-2\delta(\delta-\delta q)\theta_H - 2(1-\delta q)\delta\theta_H - 3C_p\delta}{(\theta_H-\theta_L)(\delta-\delta q)(4-3\delta-\delta q)} + \frac{1}{2}\,\frac{\left(2(1-\delta q)(\delta-\delta q)\theta_H + (4-\delta-3\delta q)C_p\right)\delta}{(\theta_H-\theta_L)(\delta-\delta q)^2(4-3\delta-\delta q)} + \frac{1}{2}\,\frac{\left(2(1-\delta q)(\delta-\delta q)\theta_H + (4-\delta-3\delta q)C_p\right)\delta}{(\theta_H-\theta_L)(\delta-\delta q)(4-3\delta-\delta q)^2}$$

differentiate w.r.t. C[p] →

$$0 = \frac{1}{2}\,\frac{4-\delta-3\delta q}{(\theta_H-\theta_L)(\delta-\delta q)(4-3\delta-\delta q)}$$

Total demand differentials:

$$\overline{d} = \frac{1}{2}\left(2\left(1-\delta(\delta-\delta q)(3-2\delta-\delta q)q(\delta-\delta q)(3-2\delta-\delta q)\right)\theta_H + \left(1-\delta(4-\delta-3\delta q)q(4-\delta-3\delta q) - (\delta-\delta q)^2\right)C_p\right)\Big/\left(\theta_H(1-\delta q)(\delta-\delta q)(4-3\delta-\delta q) - \theta_L(1-\delta q)(\delta-\delta q)(4-3\delta-\delta q)\right)$$

differentiate w.r.t. delta →

$$0 = \frac{1}{2}\Big(2\big(-D(\delta(\delta-\delta q))(3-2\delta-\delta q)(-2-q)q(\delta-\delta q)(3-2\delta-\delta q) - \delta(\delta-\delta q)(3-2\delta-\delta q)D(q(\delta-\delta q))(3-2\delta-\delta q)(-2-q)\big)\theta_H + \big(-D(\delta)(4-\delta-3\delta q)(-1-3q)q(4-\delta-3\delta q) - \delta(4-\delta-3\delta q)D(q)(4-\delta-3\delta q)(-1-3q) - 2(\delta-\delta q)(1-q)\big)C_p\Big)\Big/\Big(\theta_H(1-\delta q)(\delta-\delta q)(4-3\delta-\delta q) - \theta_L(1-\delta q)(\delta-\delta q)(4-3\delta-\delta q)\Big) - \frac{1}{2}\Big(\Big(2\big(1-\delta(\delta-\delta q)(3-2\delta-\delta q)q(\delta-\delta q)(3-2\delta-\delta q)\big)\theta_H + \big(1-\delta(4-\delta-3\delta q)q(4-\delta-3\delta q) - (\delta-\delta q)^2\big)C_p\Big)\Big(D\Big(\theta_H(1-\delta q)(\delta-\delta q)\Big)(4-3\delta-\delta q)(-3-q) - D\Big(\theta_L(1-\delta q)(\delta-\delta q)\Big)(4-3\delta-\delta q)(-3-q)\Big)\Big)\Big/\Big(\theta_H(1-\delta q)(\delta-\delta q)(4-3\delta-\delta q) - \theta_L(1-\delta q)(\delta-\delta q)(4-3\delta-\delta q)\Big)^2$$

differentiate w.r.t. q →

$$0 = \frac{1}{2}\Big(2\big(D(\delta(\delta-\delta q))(3-2\delta-\delta q)\delta q(\delta-\delta q)(3-2\delta-\delta q) + \delta(\delta-\delta q)(3-2\delta-\delta q)D(q(\delta-\delta q))(3-2\delta-\delta q)\delta\big)\theta_H + \big(3D(\delta)(4-\delta-3\delta q)\delta q(4-\delta-3\delta q) + 3\delta(4-\delta-3\delta q)D(q)(4-\delta-3\delta q)\delta + 2(\delta-\delta q)\delta\big)C_p\Big)\Big/\Big(\theta_H(1-\delta q)(\delta-\delta q)(4-3\delta-\delta q) - \theta_L(1-\delta q)(\delta-\delta q)(4-3\delta-\delta q)\Big) - \frac{1}{2}\Big(\Big(2\big(1-\delta(\delta-\delta q)(3-2\delta-\delta q)q(\delta-\delta q)(3-2\delta-\delta q)\big)\theta_H + \big(1-\delta(4-\delta-3\delta q)q(4-\delta-3\delta q) - (\delta-\delta q)^2\big)C_p\Big)\Big(-D\Big(\theta_H(1-\delta q)(\delta-\delta q)\Big)(4-3\delta-\delta q)\delta + D\Big(\theta_L(1-\delta q)(\delta-\delta q)\Big)(4-3\delta-\delta q)\delta\Big)\Big)\Big/\Big(\theta_H(1-\delta q)(\delta-\delta q)(4-3\delta-\delta q) - \theta_L(1-\delta q)(\delta-\delta q)(4-3\delta-\delta q)\Big)^2$$

differentiate w.r.t. C[p] →

$$0 = \frac{1}{2}\Big(1-\delta(4-\delta-3\delta q)q(4-\delta-3\delta q) - (\delta-\delta q)^2\Big)\Big/\Big(\theta_H(1-\delta q)(\delta-\delta q)(4-3\delta-\delta q) - \theta_L(1-\delta q)(\delta-\delta q)(4-3\delta-\delta q)\Big)$$

Total profit differentials:

$$\pi = \frac{1}{4}\left(4(1-\delta)(\delta-\delta q)(1-\delta q)^2\theta_H^2 + 8(1-\delta)(\delta-\delta q)(1-\delta q)C_p\theta_H + (1-\delta)(4+\delta-5\delta q)C_p^2\right) \Big/ \left((\theta_H-\theta_L)(\delta-\delta q)(1-\delta q)(4-3\delta-\delta q)\right)$$

differentiate w.r.t. delta →

$$\begin{aligned}0 = \frac{1}{4}\Big(&-4(\delta-\delta q)(1-\delta q)^2\theta_H^2 + 4(1-\delta)(1-q)(1-\delta q)^2\theta_H^2 - 8(1-\delta)(\delta-\delta q)(1-\delta q)\theta_H^2 q - 8(\delta-\delta q)(1-\delta q)C_p\theta_H \\ &+ 8(1-\delta)(1-q)(1-\delta q)C_p\theta_H - 8(1-\delta)(\delta-\delta q)qC_p\theta_H - (4+\delta-5\delta q)C_p^2 + (1-\delta)(1-5q)C_p^2\Big) \Big/ \left((\theta_H-\theta_L)(\delta-\delta q)(1-\delta q)(4-3\delta-\delta q)\right) \\ &- \frac{1}{4}\left(\left(4(1-\delta)(\delta-\delta q)(1-\delta q)^2\theta_H^2 + 8(1-\delta)(\delta-\delta q)(1-\delta q)C_p\theta_H + (1-\delta)(4+\delta-5\delta q)C_p^2\right)(1-q)\right) \\ &\Big/ \left((\theta_H-\theta_L)(\delta-\delta q)^2(1-\delta q)(4-3\delta-\delta q)\right) \\ &+ \frac{1}{4}\left(\left(4(1-\delta)(\delta-\delta q)(1-\delta q)^2\theta_H^2 + 8(1-\delta)(\delta-\delta q)(1-\delta q)C_p\theta_H + (1-\delta)(4+\delta-5\delta q)C_p^2\right)q\right) \Big/ \\ &\left((\theta_H-\theta_L)(\delta-\delta q)(1-\delta q)^2(4-3\delta-\delta q)\right) \\ &- \frac{1}{4}\left(\left(4(1-\delta)(\delta-\delta q)(1-\delta q)^2\theta_H^2 + 8(1-\delta)(\delta-\delta q)(1-\delta q)C_p\theta_H + (1-\delta)(4+\delta-5\delta q)C_p^2\right)(-3-q)\right) \Big/ \left((\theta_H-\theta_L)(\delta-\delta q)(1-\delta q)(4-3\delta-\delta q)^2\right)\end{aligned}$$

differentiate w.r.t. q →

$$0 = \frac{1}{4}\left(-4(1-\delta)\delta(1-\delta q)^2\theta_H^2 - 8(1-\delta)(\delta-\delta q)(1-\delta q)\right.$$
$$\theta_H^2\delta - 8(1-\delta)\delta(1-\delta q)C_p\theta_H - 8(1-\delta)(\delta-\delta q)\delta C_p\theta_L$$
$$\left.-5(1-\delta)\delta C_p^2\right)\Big/\left((\theta_H-\theta_L)(\delta-\delta q)(1-\delta q)(4-3\delta\right.$$
$$\left.-\delta q)\right) + \frac{1}{4}\left(\left(4(1-\delta)(\delta-\delta q)(1-\delta q)^2\theta_H^2 + 8(1\right.\right.$$
$$\left.-\delta)(\delta-\delta q)(1-\delta q)C_p\theta_H + (1-\delta)(4+\delta-5\delta q)C_p^2\right)$$
$$\delta\Big)\Big/\left((\theta_H-\theta_L)(\delta-\delta q)^2(1-\delta q)(4-3\delta-\delta q)\right)$$
$$+\frac{1}{4}\left(\left(4(1-\delta)(\delta-\delta q)(1-\delta q)^2\theta_H^2 + 8(1-\delta)(\delta\right.\right.$$
$$\left.-\delta q)(1-\delta q)C_p\theta_H + (1-\delta)(4+\delta-5\delta q)C_p^2\right)\delta\Big)\Big/$$
$$\left((\theta_H-\theta_L)(\delta-\delta q)(1-\delta q)^2(4-3\delta-\delta q)\right)$$
$$+\frac{1}{4}\left(\left(4(1-\delta)(\delta-\delta q)(1-\delta q)^2\theta_H^2 + 8(1-\delta)(\delta\right.\right.$$
$$\left.-\delta q)(1-\delta q)C_p\theta_H + (1-\delta)(4+\delta-5\delta q)C_p^2\right)\delta\Big)\Big/$$
$$\left((\theta_H-\theta_L)(\delta-\delta q)(1-\delta q)(4-3\delta-\delta q)^2\right)$$

differentiate w.r.t. C[p]

$$0$$

$$= \frac{1}{4}\left(8(1-\delta)(\delta-\delta q)(1-\delta q)\theta_H + 2(1-\delta)(4+\delta\right.$$
$$\left.-5\delta q)C_p\right)\Big/\left((\theta_H-\theta_L)(\delta-\delta q)(1-\delta q)(4-3\delta-\delta q)\right)$$

References

Alvisi, M., Argentesi, E., & Carbonara, E. (2002). **'Piracy and quality choice in monopolistic markets',** Working paper.

Anderson, N. (2012) **'Why the feds smashed Megaupload',** *Ars Technica, Accessible from* http://arstechnica.com/tech-policy/2012/01/why-the-feds-smashed-megaupload/

Bae, S. H., & Choi, J. P. (2006). **'A model of piracy',** *Information Economics and Policy, 18*(3), 303-320.

Balestrino, A. (2008). **'It is a theft but not a crime',** *European Journal of Political Economy*, *24*(2), 455-469.

Belleflamme, P. (2002). **'Pricing information goods in the presence of copying',** *U of London Queen Mary Economics Working Paper*, (463).

Belleflamme, P., & Picard, P. (2004). **'Competition over piratable goods',** *Working paper*.

Belleflamme, P., & Peitz, M. (2010). **'Digital piracy: theory',** Working paper.

Bertelsen, M. (2009). **'Norsk film – En investors perspektiv',** *Universitetet i Bergen.*

Beyer-Olsen, A. (2012). **'Fildelingsgigant ble stoppet',** *Verdens Gang, accessible from http://www.vg.no/nyheter/utenriks/artikkel.php?artid=10076094*

BitTorrent.com press release (2012). **'BitTorrent and µTorrent Software Surpass 150 Million User Milestone: Announce New Consumer Electronics Partnerships'** Accessible from http://www.bittorrent.com/intl/es/company/about/ces_2012_150m_users

Boldrin, M. & Levine, D. (2002). **'The Case Against Intellectual Monopoly',** *Working paper available at SSRN 307859.*

Bounie, D., Bourreau, M., & Waelbroeck, P. (2006). '**Piracy and the demand for films: Analysis of piracy behavior in French universities',** *Review of Economic Research on Copyright Issues, 3* (2), 15-27.

Box Office Mojo, accessible at http://boxofficemojo.com

Buchanan, J. (1965), **'An Economic Theory of Clubs',** *Economica, 32(*125), 1-14.

Calzada, J. & Valletti, T. (2012) **'Intertemporal Movie Distribution: Versioning When Consumers Can Buy Both Versions',** *Marketing Science, 31*(4), 649-667

Chiou, L. (2008). **'The timing of movie releases: Evidence from the home video industry',** *International Journal of Industrial Organization, 26*, 1059-1073.

Cho, W. Y., & Ahn, B. H. (2010). **'Versioning of information goods under the threat of piracy',** *Information Economics and Policy, 22*(4), 332-340.

Cremer, H., & Pestieau, P. (2009). **'Piracy prevention and the pricing of information goods',** *Information Economics and Policy, 21*(1), 34-42.

Danaher, B., & Waldfogel, J. (2008). **'Reel piracy: The effect of online movie piracy on film box office sales',** Working paper. University of Pennsylvania, Philadelphia, Pennsylvania.

Dejean, S. (2009). **'What can we learn from empirical studies about piracy?',** *CESifo Economic Studies, 55*(2), 326-352.

De Vany, A. S., & Walls, W. D. (2007). **'Estimating the effects of movie piracy on box-office revenue',** *Review of Industrial Organization, 30*(4), 291-301.

Dos Santos Ferreira, R., & Thisse, J. F. (1996). **'Horizontal and vertical differentiation: The Launhardt model',** *International Journal of Industrial Organization, 14*(4), 485-506.

Dvorak, J. (2012). **'Google Goes After Torrent Sites',** *PCMag, Available from* http://www.pcmag.com/article2/0,2817,2408420,00.asp

Eggesvik, O. (2012). **'Kun én mann jobber med å overvåke norske fildelere',** *Aftenposten, accessible from http://www.aftenposten.no/digital/Kun-n-mann-jobber-med-a-overvake-norske-fildelere-6806030.html*

Eliashberg, J., Elberse & A. Leenders, M. (2006). **'The Motion Picture Industry: Critical Issues in Practice, Current Research, and New Research Directions',** *Marketing Science, 25*(6), 638-661.

enigmax. (2012) **'BitTorrent Bonanza: Monitoring File-Sharers Forbidden in Norway'** *TorrentFreak, accessible from https://torrentfreak.com/bittorrent-bonanza-monitoring-file-sharers-forbidden-in-norway-120825/*

Frank, B. (1994). **'Optimal timing of movie releases in ancillary markets: The case of video releases,'** *Journal of Cultural Economics, 18*(2), 125-133.

Færaas, A. (2012). **'Pirate Bay blokkeres i Storbritannia',** *Aftenposten, accessible from http://www.aftenposten.no/kultur/Pirate-Bay-blokkeres-i-Storbritannia-6818132.html*

Garella, P. & Martínez-Giralt, X. (1988). **'Price competition in markets for dichotomous substitutes',** *International Journal of Industrial Organization, 7,* 357-367.

Gaustad, T. (2009). **'Internett-basert piratkopiering av musikk og film: Økonomiske konsekvenser og forutsetninger for overgang til bærekraftig nettbasert distribusjon',** *Magma, 9*(12), 38-47.

Givon, M., Mahajan, V., & Muller, E. (1995). **'Software piracy: Estimation of lost sales and the impact on software diffusion',** *The Journal of Marketing*, 29-37.

Gopal, R., Bhattacharjee, S. & Sanders, G. (2006). **'Do Artists Benefit from Online Music Sharing?',** *The Journal of Business, 79*(3), 1503-1533.

Hadfield, G. (1992). **'The Economics of Copyright: A Historical Perspective',** *Copyright Law Symposium (ASCAP), 38*, 1-46.

Halliday, J. (2010). **'LimeWire shut down by federal court',** *The Guardian, accessible from http://www.guardian.co.uk/technology/2010/oct/27/limewire-shut-down*

Hennig-Thurau, T., Henning, V. & Sattler, H. (2007). **'Consumer File Sharing of Motion Pictures',** *Journal of Marketing, 71*(4), 1-18.

Henriksen, Ø. & Taule, L. (2012). *Kulturstatistikk 2010,* Statistisk Sentralbyrå (Statistics Norway).

Heyerdahl, N. & Akerhaug, L. (2010). **'Nordmann siktet for fildeling etter internasjonal storaksjon',** *Dagbladet, accessible from* http://www.aftenposten.no/nyheter/iriks/Nordmann-siktet-for-fildeling-etter-internasjonal-storaksjon-5344887.html

Holm, H. J. (2001). **'The Computer Generation's Willingness to Pay for Originals when Pirates are Present: A CV Study'**, *Lund University, Department of Economics Working Papers*.

Hotelling, H. (1929). **'Stability in Competition',** *The Economic Journal, 39*(153), 41-57.

Johnson, W. R. (1985). **'The economics of copying',** *The Journal of Political Economy*, 158-174.

Krishnan, R., Smith, M. & Telang, R. (2006). **'The Economics of Peer-To-Peer Networks',** *Heinz Research, Paper 52.*

Launhardt, W. (1885), *Mathematische Begründung der Volkswirtsschaftslehre* . B.G. Teubner, Leipzig.

Launhardt, W., & Creedy, J. (1993). *Mathematical principles of economics*. Edward Elgar Pub.

Lerner, A. P., & Singer, H. W. (1937). **'Some notes on duopoly and spatial competition',** *The Journal of Political Economy*, 145-186.

Liebowitz, S. J. (1985). **'Copying and indirect appropriability: Photocopying of journals',** *The Journal of Political Economy*, *93*(5), 945-957.

Liebowitz, S. J. (2006). **'File Sharing: Creative Destruction or Just Plain Destruction?',** *Journal of Law and Economics*, *49*(1), 1-28.

Martikainen, E. (2011). **'Does File-Sharing Reduce DVD Sales?',** *Available at SSRN 1742443*.

Mayer-Schönberger, V. (2008). **'Crouching Tiger, Hidden Dragon: proxy battles over peer-to-peer movie sharing'**, *Peer-to-Peer Video*, 251-263.

McKenzie, J. (2012). **'The Economics of Movies: A Literature Survey',** *Journal of Economic Surveys*, *26*(1), 42-70.

MI6 – The Home of James Bond 007, accessible from http://www.mi6-hq.com

Mortimer, J. (2008). **'Vertical Contracts in the Video Rental Industry',** *Review of Economic Studies, 75,* 165-199.

Mussa, M., & Rosen, S. (1978). **'Monopoly and product quality',** *Journal of Economic theory*, *18*(2), 301-317.

Nilssen, T., & Sørgard, L. (2002). **'A public firm challenged by entry: duplication or diversity?',** *Regional Science and Urban Economics*, *32*(2), 259-274.

Peitz, M., & Waelbroeck, P. (2006). '**Piracy of digital products: A critical review of the theoretical literature',** *Information Economics and Policy, 18*(4), 449-476.

Pindyck, R. & Rubinfeld, D. (2005). *Microeconomics,* Prentice Hall.

Pinto, J. V. (1977). **'Launhardt and location theory: Rediscovery of a neglected book',** *Journal of Regional Science, 17*(1), 17-29.

Plant, A. (1934). **'The economic theory concerning patents for inventions',** *Economica, 1*(1), 30-51.

Poddar, S. (2005). **'Some economics of movie piracy'**, *Department of Economics, National University of Singapore*.

Raaum, P. (2009) **'Piratene har gjort det parlamentariske rommet større',** *Dagbladet, accessible from* *http://www.dagbladet.no/2009/06/09/kultur/fildeling/piratpartiet/pirate_bay/tekno/6630812/*

Rob, R., & Waldfogel, J. (2007). **'PIRACY ON THE SILVER SCREEN',** *The Journal of Industrial Economics, 55*(3), 379-395.

Salop, S. C. (1979). **'Monopolistic competition with outside goods',** *The Bell Journal of Economics*, 141-156.

Schulze, H., & Mochalski, K. (2009). **'Internet Study 2008/2009',** *IPOQUE Report*.

Silver, J., & McDonnell, J. (2007). **'Are movie theaters doomed? Do exhibitors see the big picture as theaters lose their competitive advantage?',** *Business Horizons, 50*(6), 491-501.

Smith, M. D., & Telang, R. (2009). **'Competing with free: the impact of movie broadcasts on DVD sales and internet piracy',** *MIS Quarterly, 33*(2), 321-338.

Smith, M. D., & Telang, R. (2010**). 'Piracy or promotion? The impact of broadband Internet penetration on DVD sales',** *Information Economics and Policy, 22*(4), 289-298.

Takeyama, L. N. (1997). **'Intertemporal Consequences of Unauthorized Reproduction of Intellectual Property, The',** *JL & Econ., 40*, 511.

THR Staff (2011). **'MPAA's Chris Dodd: Piracy Is 'Single Biggest Threat We Face as an Industry''**, *The Hollywood Reporter. Available from* *http://www.hollywoodreporter.com/news/mpaas-chris-dodd-piracy-is-172346*

Towse, R., Handke, C. & Stepan, P. (2008). **'The Economics of Copyright Law: A Stocktake of the Literature',** *Review of Economic Research on Copyright Issues, 5*(1), 1-22.

Vaage, O. (2012) *Norsk mediebarometer 2011,* Statistisk Sentralbyrå (Statistics Norway).

Varian, H. (1998). **'Markets for information goods'**, *Mimeo, University of California, Berkeley. Available from* *http://hubcap.clemson.edu/~sauerr/classes/425/cases/varian_info%20goods.pdf*

Varian, H. R. (2005). **'Copying and copyright',** *The Journal of Economic Perspectives*, *19*(2), 121-138.

VCDQ frequently asked questions, *Available from www.vcdq.com/faq, accessed 02.11.2012.*

Vogel, H. (2011). *Entertainment Industry Economics,* Cambridge University Press.

Walls, W. D. (2008). **'Cross-country analysis of movie piracy',** *Applied Economics*, *40*(5), 625-632.

Waterman, D., Ji, S. W., & Rochet, L. R. (2007). **'Enforcement and Control of Piracy, Copying, and sharing in the movie industry',** *Review of Industrial organization*, *30*(4), 255-289.

Weinberg, C. (2006). **'Research and the Motion Picture Industry',** *Marketing Science, 25*(6), 667-669.

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In recent years, copyright-protected markets have been challenged by the sharp rise in usage of peer-to-peer networks. Many of these networks participate in illegal sharing of copyrighted materials, such as books, music and movies. The illegal copying and sharing of intellectual property – also known as piracy – is depicted by firms and media as a terrible crime. But what are the actual consequences of the file-sharing activity?

While the music industry has progressed toward lower investment costs at the same time as piracy arose, motion pictures are as – or even more – expensive to produce than before. When reproduction costs are negligible, this makes the motion picture industry more vulnerable to piracy.

With the aim of gaining knowledge about motion picture piracy, this paper extensively reviews the motion picture industry and reviews literature relevant to piracy in information good markets, motion pictures in particular. It then constructs two models of motion picture piracy with origins in different parts of the theory of industrial organization. Even though the models are not complete in any sense of the word, they nonetheless provide some interesting results.

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