Commercial piracy, copyright and ex-post enforcement

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Abstract

In this paper we examine the efficiency of law enforcement in restricting commercial piracy on the Internet when streaming technology is used. We present a simple theoretical model of copyright piracy where a right-holder competes in price with an Internet intermediary. The Internet intermediary offers two types of streaming goods (with and without restrictions). Goods are differentiated in quality. We choose to study this competition in a leader-follower game.

Copyright and intellectual property rights on the Internet are subject to ex-post adjudication. This means that enforcement can lead to uncertainty regarding the Internet intermediary's liability. The present analysis suggests that optimal government enforcement is not always appropriate in deterring piracy on the market. We also discuss the impact of quality parameters on piracy.

Keywords: copyright, streaming, commercial piracy, price competition, tort law

I- Introduction

Right-holders can differentiate their products (music or movie files) to attract consumers with varying levels of willingness to pay for quality. These right-holders choose different levels of quality for the same legal good. We call this method "versioning". For example, different levels of VOD subscription are available on the Internet.

Some illegal websites propose similar choices. They offer pirated goods with diverse quality and restrictions. These sites are illegal because they consciously post or host a piece of work (music or video) without the right-holder's authorization. They often use streaming technology to share and differentiate their products, offering two types of service: consumers can either choose to use the free version with restrictions (e.g. limited viewing time), or opt for unlimited access to all contents in return for paying a subscription fee. We call this situation piracy because a copy of the original goods exists on the market without a permit from the right-holder. The case of such websites is a thorny issue[1]. However, hosting platforms are legal when the owner of the website takes action to enforce copyright or intellectual property rights (e.g. YouTube or Dailymotion). To put it differently, legal and illegal versioning of goods are available on the market at the same time. We focus here on streaming of digital goods offered by illegal websites.

These legal and pirate websites are Internet intermediaries[2]. They host and provide contents on a platform. The definition is very broad and can apply to different forms: Youtube and eBay are Internet intermediaries but with different purposes. Their revenue comes mostly from advertisements and subscription fees.

The particularity of Internet intermediaries lies in their legal position. Regarding intellectual property rights and copyright, they have a particular status in the United States (Digital Millennium Copyright Act, 1998 - DMCA) as well as in Europe (Electronic Commerce Directive, 2000 - ECD). If platforms host someone's work (like a video) without the beneficiary's permission, they are not liable as long as nothing proves that they were aware of the infringement. Therefore, they do not have a general obligation to monitor infringements.

The case here comes under tort law. The aim of this paper is hence to apply this structure to piracy carried out by Internet intermediaries and to study the impact of ex-post enforcement of pirate websites.

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[1] In January 2012 the US justice ordered the well-known Megaupload platform to close. Its Internet domains were seized. The platform was also accused of other activities, like racketing and money laundering. Following this decision, other websites were closed down, such as Allostreaming in France. Kim Dotcom, the founder of Megaupload and the associated websites, announced the creation of new file storage system in 2013.

[2] "Internet intermediaries bring together or facilitate transactions between third parties on the Internet. They give access to, host, transmit and index content, products and services originated by third parties on the Internet or provide Internet-based services to third parties" (OECD, 2011).

DMCA and ECD also set up a "notice and take down" procedure: beneficiaries and right-holders can inform intermediary websites that they host infringing contents, which means that the content has to be removed. If this is not done, the website can be sued.
The decision of "knowledge of infringing content" relies on the judge's interpretation: in which cases can we say that an Internet intermediary is liable for the content hosted on its platform? Numerous law cases show that interpretation varies according to the context and the lawsuits[3]. This leads to uncertainty in legal enforcement. Conviction is not automatic as it depends on the probability of being discovered and on the severity of the judge. Thus, present legislation mainly concerns ex-post lawsuits.

We present a simple model of digital piracy in which an Internet intermediary (here called either pirate, internet intermediary or streaming website) offers two types of digital streaming goods (music or movie files) with and without content restrictions, and where a right-holder (also called copyright holder) offers the legal good. This is a case of commercial piracy: the pirate makes profit from its activity (from advertisements or subscription fees). Consumers have three possibilities if they want to consume the goods: they can purchase the goods legally from the right-holder, use them on the pirate platform but with restrictions, or pay a subscription to the pirate to obtain unlimited access. These three possibilities (or these three goods) are differentiated vertically. The original (legal) good is better quality than the two others.
The originality of our approach is studying streaming differentiation and applying tort law to copyright infringements. In our set-up we examine the influence of legal strength (and uncertainty) on the behavior of the two main actors. Moreover, we examine the conditions under which piracy takes place.
To analyze this we introduce a judge (representing legal authority) into our model who can inflict fines on the Internet intermediary if the latter is found guilty. As our legal framework is tort law (or civil law), the infringer has to pay compensation to the copyright holder and not to the state. Thus, he or she cannot be imprisoned.
The judge and the right-holder have different roles in protecting intellectual property rights. It is the copyright holder's responsibility to monitor illegal use and to cover the cost of monitoring. Once caught, a pirate is sued automatically. The judge's role is to decide on the amount of the fine (or compensation) and the liability of the Internet intermediary. Thus the judge's role is

[3] In *L'Oréal vs eBay* in July 2011, the European Court of Justice considered that eBay could not in this case benefit from the status of host since it had lent its technical assistance to the creation of online stores, which indicated awareness of the crime in the Court's opinion. However, in the French Dailymotion case of February 2011, Dailymotion was not punished for not having removed the movie "Joyeux Noel" hosted on its platform without authorization. In the United States in 2010, eBay won its case against Tiffany. The Court held that it was up to the trademark owner to police its own brand.

only to decide the degree of aggressiveness regarding copyright infringement. Pirate websites could to a certain extent be declared liable by legal authority, which raises legal uncertainty[4].
In this paper, we analyze competition in a leader-follower game when quality is exogenous. We find that the optimum choice of legal deterrence does not always match the level of piracy deterrence (i.e. deters or prevents the illegal Internet intermediary from entering the market). As the legal authority has to choose a single law parameter, this level of deterrence cannot fit in with all market outcomes (according to prices). Moreover, the optimum level chosen by the regulator depends on the pirate's quality and restriction choices.

The paper is structured as follows. Section 2 is a review of related literature. In section 3 we present the model and the main variables. Section 4 includes a description of consumer preferences. Section 5 examines the equilibrium. Section 6 analyzes the influence of legal strength on pirates' decisions. Section 7 studies the choice of the optimal policy from the point of view of the legal authority and the level required to deter piracy. Extensions to our analysis are presented in section 8, followed by the conclusion.

II- Related literature

The main approach is here to apply tort law to Internet intermediaries and illegal websites that offer streaming goods: they can be held liable for infringing intellectual property law. This is a new perspective in literature. Beginning with Shavell (1984a, 1984b and 1987) and Landes and Posner (1987), literature on tort law allows potential victims to receive compensation, and encourages economic agents to internalize the costs of externalities that their actions could cause. Economics and the law come together in the search for efficient behavior that minimizes the social cost of a potential tort by internalizing this externality.
Numerous rules of liability have been studied, taking into account the liability between victim and injurer (strict liability, negligence rule). This liability can in some cases be shared between parties (contributory and comparative negligence).
In the formalization of such a system, agents take action (called "care") to avoid accidents. Thus, convictions are not systematic and courts make decisions based on their interpretation of social optimum levels of precaution (for negligence rules).
The tort analysis was extended to errors in law operations (Dari-Mattiacci 2005), e.g. in a due care setting. Uncertainty of the legal system makes the issue of conflict resolution difficult to anticipate, as in our present case regarding the liability of intermediaries.

[4] The probability of being declared responsible can also involve the difficulty of finding the pirate if domiciled in a tax haven.

Focusing on copyright law, Arai (2011) compares the implication of civil and criminal penalty schemes (i.e. penalties paid to the copyright holder or the government) from the viewpoint of social welfare in cases of copyright violation. Another way to study the copyright law effect is to compare a broad-based enforcement policy with a targeted enforcement policy on some specific user groups (Harbaugh and Khemka, 2010). A targeted enforcement policy could increase piracy (for low-value consumers) because copyright holder monopoly can be reinforced if the price of a legitimate copy is raised.

There are two main approaches in economics literature on digital piracy[5]. The first deals with end-user piracy, i.e. piracy committed directly by users (Novos and Waldman, 1984, Conner et Rumelt, 1991). Novos and Waldman (1984) show that piracy causes an under-provision problem as it induces firms to create digital products of inefficient low quality (i.e. below the socially optimal quality). Cho and Ahn (2010) analyze how piracy cost influences the quality choice of the incumbent in an alternative specification of the model developed by Novos and Waldman (1984). Piracy induces a tradeoff between the under-provision of the high quality good and the low quality good both produced by the incumbent. Copyright protection can be defined as increasing consumer reproduction costs (as in Yoon, 2002).

The second approach investigates commercial piracy, that is, piracy achieved by organizations that illegally reproduce and sell copyrighted products on a large scale[6]. Banerjee (2003) studies competition between a copyright owner and a pirate who tries to enter the market, and the government's role in penalizing piracy. He finds that if monitoring is the optimal policy, then a monopoly situation results. Kiema (2008) extends this analysis to the competition between a monopolist and several commercial pirates. He models the punishment risk for the copyright infringer as an advertisement cost chosen by the government.

Alvisi, Argentisi and Carbonara (2003) show that the original monopolist has to produce more than one quality to deter consumers from the pirated good. This choice is an optimal strategy. It involves producing a good of lower quality to reduce piracy. But in the absence of piracy, the incumbent has no incentives to produce differentiated goods.

In addition to the previous results, there are two more articles related to our model. Martínez-Sánchez (2010) analyzes the role of the government and a legal producer in preventing the entry of a pirate in a sequential duopoly model of vertical product differentiation. The latter can bring the advantage of allowing the pirate to set the price first. Banerjee (2006) studies the effect of enforcement sharing between the government and the incumbent in a commercial piracy

[5] For a complete survey see Belleflamme and Peitz (2010) or Peitz and Walbroeck (2006).
[6] Belleflamme and Peitz (2010).

framework (the former penalizes and the latter monitors). Government sensitivity to piracy is an important condition to prevent infringement.

III- The model

We consider four types of agent: the consumers, the original owner of the digital good (or the right-holder), the Internet intermediary that offers streaming, and the legal authority represented by a judge. We focus on streaming goods that can be differentiated. This constitutes our distinctive framework.

A streaming website offers pirated content in one of the following two ways (versioning of the good). Consumers can benefit from free content but with restrictions (e.g. viewing time, as on Megaupload), or they can buy unlimited access at price p_i . The right-holder offers the legal good at price p.

As for Mussa and Rosen (1978), there is a quality differentiation: streaming goods are of lower quality than legal ones. For example, there is a difference between watching DVDs and watching movies directly on the Internet (audio, image, etc.). Hence, quality parameters represent the quality of the files. Furthermore, we have a double quality differentiation since the pirate two distinctive goods.

Consequently, the legal good has a higher quality a than the two streaming goods. The parameter a can take different values, indicating that the copyright-holder has the possibility of differentiating its own good. The copyright-holder may possibly downgrade the quality in the future: e.g. movies are released in cinemas first and available on DVD later. Thus the aim is to attract different types of consumer who attach various values to quality.

Free content with restriction has a quality c (c can represent the restrictions here). The quality b for unlimited access is lower than the quality of the legal product but superior to that of goods with restrictions (e.g. no limitation on the contents visualized). This assumption takes into account not only the quality of the file, but also the restrictions the intermediaries can impose.

Moreover, legal goods and unlimited streaming goods cannot be of equal quality, but the two streaming goods could be of the same quality ($b=c$).

Assumption 1: Here $0 \leqslant c \leqslant b < a \leqslant 1$.

Consumers

There is a continuum of consumers indexed by θ who value the digital good differently. θ also represents their willingness to pay and it is uniformly distributed on [0. 1][7].

[7] We assume that the market is always covered by the legal or the streaming good.

Consumers have three options: First they can purchase the good legally at price p. Second, they can use it freely on the Internet but with restrictions. Lastly, they can buy unlimited access to the streaming website and its contents at a price p_i . p_i can be seen as a subscription fee. Users do not face the risk of prosecution from the use of streaming websites.

Consumer's utility is defined as follows:

$$U=\begin{cases} a\theta - p \ if \ consumer \ buys \ the \ legal \ product \\ b\theta - p_i \ if \ consumer \ pays \ to \ a \ have \ unlimited \ access \\ c\theta \ if \ consumer \ uses \ streaming \ with \ restriction \end{cases}$$

Legal protection

The legal copyright framework for Internet intermediaries is the same as in the DMCA, or in the ECD: the court has to decide on the ex-post liability of these websites.

We are in a civil law set-up, meaning that there is only a monetary transfer from the copyright infringer to the copyright holder.

The first move is made by the right-holder: after having discovered a pirate or illegal streaming website, the legal beneficiary can bring the case to court. Then the right-holder can demand financial compensation. Subsequently, the judge has to determine the liability of the Internet intermediary (i.e. was it aware of the infringement?). Due to the uncertainty of law enforcement (e.g. decisions different between cases, between judges, etc.), the pirate is declared responsible and has to pay an exogenous penalty G to the copyright holder with probability q, otherwise it is not punished with probability $1-q$. q represents the strength of the copyright law as well as uncertainty in the law enforcement for intermediaries (as we explained in the introduction). q is chosen ex-ante by the law-maker (tort law). The optimal level of q is given by the maximization of social welfare, which is the sum of right-holder profit, Internet intermediary profit and consumer surplus.

Right-holders

Digital goods can be purchased legally. We suppose that there is only one monopolist producer (or right-holder) selling them at price p. This can be justified by arguing that cultural goods are sufficiently horizontally differentiated to make the demand independent of the price of other goods in the same category.

Copyright holders have to enforce their right (e.g. notice and take down procedure). They choose an exogenous monitoring intensity e ($e \in [0,1]$), meaning that the pirate is discovered with probability e. The monitoring effort has a cost $c(e)$ that increases with its intensity level.

Assumption 2: $c'(e) > 0$ and $c''(e) > 0$

We suppose that e is an exogenous parameter.

In reality, the intensity level varies according to the significance of the legal producer, its resources and its market power. This is true for trademark as well as copyright legislation (e.g. the luxury goods industry spends a lot of money protecting trademarks, and firms monitor auction and shopping websites).

Moreover, we make an extreme assumption in our framework: we suppose that the pirate is always sued and that there is no private settlement. However, for the most part, going to court is costly for the right-holder.

In practice, the expected penalty is given by eqG. However, the result does not change if we take e and G together since there are both exogenous parameters. Therefore, we suppose that the expected penalty is only qG. The right-holder profit function is:

$$\pi_p = pD_l + qG - c(e) \qquad (1)$$

Where D_l is the demand for the legal product and qG the compensation paid by the copyright infringer if it is discovered and found guilty by the judge.

For simplicity, we also suppose that production costs are nil.

Internet intermediary

The Internet intermediary offers illegal streaming i.e. streaming of pirated goods. There is only one Internet intermediary in our framework.

The Internet intermediary has two sources of revenue: the price paid for unlimited content access, and advertisement[8] revenue normalized to 1 generated by demand for the free version.

The Internet intermediary is discovered by the right holder with probability e, it is found liable (and has to pay the fine) with probability q.

The Internet intermediary profit function is:

$$\pi_i = (1-e)(p_i D_u + D_r) + e[(1-q)(p_i D_u + D_r) - qG] = (1-q)(p_i D_u + D_r) - qG \qquad (2)$$

Where D_u is the demand for unlimited access and D_r the demand for free access. We also suppose reproduction costs to be nil.

[8] On this type of website, advertisement comes mainly from pop-ups and banners (Idate, 2012, *Etude du modèle économique de sites ou services de streaming et de téléchargement direct de contenus illicites*, Rapport à l'attention de la Hadopi).

The main questions are, how the illegal website and the legal buyer compete in pricing, how they take into account copyright legislation, and the role played by quality. We will study competition in a leader-follower game (the right-holder is first in the market). This game seems closer to reality: usually a legal producer creates a work and then this work may be copied or pirated.

The strategic variables here are prices and the legal strength q. We consider that quality parameters and fine G are exogenous.

The sequence of events is:

1. The government chooses a penalty G and an enforcement level (or law uncertainty) q. The right-holder chooses a monitoring level e (or the probability of the pirate being discovered).
2. The producer and the pirate compete and choose their prices p_i and p_m.
3. The consumer decides whether to buy the legal good, use it illegally with restrictions, or pay for unlimited access.
4. Any intermediary who is caught and found guilty has to pay penalty G.

The law is constructed ex-ante and the law-maker chooses the severity of the rule. The judge enforces the law ex-post according to his or her interpretation (as in tort law).

IV- Consumer demand

What is the demand for the different goods?

We need to distinguish between different cases depending on the parameters. Moreover, consumers choose products already available on the market.

We take three marginal consumers that are indifferent to two options: θ_{lr} is indifferent to buying the legal product or consuming it freely with restriction, θ_{ru} is indifferent to consuming the free illegal version or paying a fee for unlimited access, θ_{lu} is indifferent to buying the good legally or paying p_i to consume the good without restriction but illegally.

$$a\theta_{lr} - p = c\theta_{lr} \Rightarrow \theta_{lr} = \frac{p}{a-c}$$

$$c\theta_{ru} = b\theta_{ru} - p_i \Rightarrow \theta_{ru} = \frac{p_i}{b-c}$$

$$a\theta_{lu} - p = b\theta_{lu} - p_i \Rightarrow \theta_{lu} = \frac{p - p_i}{a - b}$$

Lemma 1

Given the quality parameters and the strength of intellectual property enforcement, the consumer's optimal choice is to only use simple streaming (streaming with restriction) if

$\theta \leqslant min\ \{\theta_{lr}\ , \theta_{ru}\}$

A consumer will choose to pay a subscription fee to the Internet intermediary if

$\theta_{ru} < \theta < \theta_{lu}$

A consumer will buy the legal good if

$\theta \geqslant max\ \{\theta_{lr}\ , \theta_{lu}\}$

Consumer valuation depends on price and quality, and consumers choose goods from among those offered by the right-holder.

From the lemma 1, we can derive price conditions. The consumer will only buy the legal good if it is not too expensive, meaning θ_{lu} cannot be higher than 1, i.e. $p > a - b + p_i$.

On the other hand, the consumer will not pay the price p_i, if it is too high. No users find it profitable to pay p_i if the legal price is low enough. There is no subscription if $\theta_{ru} > \theta_{lu}$ i.e. $p < \frac{p_i(a-c)}{b-c}$.

Thus, there is a demand for the legal good only if its price p is not too high and if unlimited access is too expensive (p_i too high).

Lemma 2

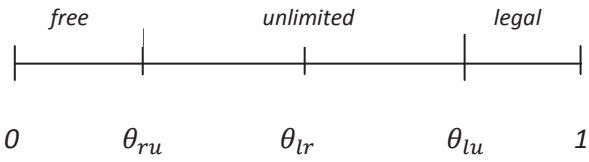
From these conditions, we can derive different demand cases:

- *Case 1:* $p < 1 - \alpha + p_i$ *and* $\theta_{lr} < \theta_{lu}$
- *Case 2: no demand for unlimited access when* $p < \frac{p_i(a-c)}{b-c}$
- *Case 3: no demand for the legal good when* $p > a - b + p_i$

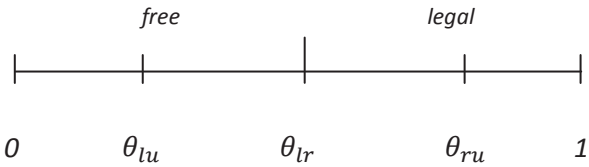
These cases are represented by figure 1.

Figure 1: Demand for the different cases

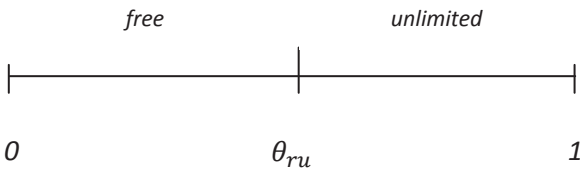
Case 1



Case 2



Case 3



In the next part, we focus only on cases where competition exists between the right holder and the Internet intermediary (cases 1 and 2). We do not study case 3, in which the pirate wins the entire market.

V- Equilibrium characteristics and the impact of quality

In this section, we examine pricing games between the pirate and the copyright holder for the two cases described previously. We derive the equilibrium prices (cf Table 1) and equilibrium profits in each situation. We also examine the impact of quality choices.

We are in a leader-follower game: the incumbent takes into consideration that a pirate will enter and therefore incorporates the reaction function of the pirate into its profit function and chooses the profit-maximizing price. The incumbent is the legal developer.

1- Case 1

In this case, the consumer can buy three different goods.

The right-holder profit function is now (from Eq. 1):

$$\pi_{p,1} = p(1-\theta_{lu}) + qG - c(e) = p\left(1-\frac{p-p_i}{a-b}\right) + qG - c(e) \qquad (3)$$

The pirate profit function is (from Eq. 2):

$$\pi_{i,1} = (1-q)(p_i(\theta_{lu}-\theta_{ru})+\theta_{ru}) - qG = (1-q)\left[p_i\left(\frac{p-p_i}{a-b}-\frac{p_i}{b-c}\right)+\frac{p_i}{b-c}\right] - qG \qquad (4)$$

The result is summarized in proposition 1. The proof is provided in annex 1-1. We must first make the following assumption:

Assumption 3: $2a - c - b > 0$

Proposition 1

The equilibrium prices are (with assumption 3 and k<α to have positive prices):

$$p_1^* = \frac{(a-b)(2(a-c)+1)}{2(2a-c-b)} \text{ and } p_{i,1}^* = \frac{(a-b)}{2(a-c)} + \frac{b-c}{2(a-c)}\left(\frac{(a-b)(2(a-c)+1)}{2(2a-c-b)}\right)$$

Equilibrium profits are:

$$\pi_p^* = \left(\frac{(2(a-c)+1)(b+c-2a)+(2a-c-b)(1+4a-4c)}{4(a-c)(2a-c-b)}\right)\left(\frac{(a-b)(2(a-c)+1)}{2(2a-c-b)}\right)+qG - c(e)$$

$$\pi_i^* = (1-q)*\left[\frac{(a-b)}{2(a-c)}+\frac{b-c}{2(a-c)}\left(\frac{(a-b)(2(a-c)+1)}{2(2a-c-b)}\right)\right]\left(\frac{p(2a-b-c)+a-b}{2(a-c)(a-b)} + \frac{a+b-2c+p(c-b)}{2(a-c)(b-c)}\right)-qG$$

Proof: cf Annex 1-1

We note that the equilibrium prices take into account the quality parameters and quality differences (*a-b* or *a-c*). The legal parameter q has no impact on equilibrium prices but does impact general profits.

2- Case 2

Here, there are only two possibilities for the consumer: buying the legal good or using free streaming access. This is because unlimited access is too expensive.

The copyright holder profit function is (from Eq.1):

$$\pi_{p,2} = p(1-\theta_{lr}) + qG - c(e) = p\left(1-\frac{p}{a-c}\right) + qG - c(e) \qquad (5)$$

The pirate profit function is (from Eq.2):

$$\pi_{i,2} = (1-q)(\theta_{lr}) - qG = (1-q)\left(\frac{p}{a-c}\right) - qG \qquad (6)$$

The pirate only earns revenue from advertising because there is no demand for unlimited access at price p_i.

Proposition 2

The right − holder equilibrium price is : $p_2^* = \dfrac{a-c}{2}$

Equilibrium profits are:

$$\pi_{i,2}^* = \frac{1-q-2qG}{2} \text{ and } \pi_{p,2}^* = \frac{a-c}{4} + qG - c(e)$$

Proof: cf Annex1-2

Here the legal parameter q does not influence the pirate's profit. Moreover, the right-holder and Internet intermediary share the market equally:

$D_{p,2} = 1 - \theta_{lr} = 1/2$

$D_{i,2} = \theta_{lr} = 1/2$

When the Internet intermediary offers only the free streaming good on the market, it cannot fix the price. Its only degree of freedom is quality parameter *c*. This parameter negatively impacts the right-holder's price and therefore its profit. As *c* increases p_2^* goes down. To keep its market, the incumbent has to decrease its price when the intermediary chooses to increase the quality *c*. At the same time, the pirate's profit function decreases with *q*: the pirate is more likely to be sued and found guilty of damages to the right-holder.

Table 1: Summary of cases (prices)

	p^*	p_i^*
Case 1	$\frac{(a-b)(2(a-c)+1)}{2(2a-c-b)}$	$\frac{(a-b)}{2(a-c)} + \frac{b-c}{2(a-c)}\left(\frac{(a-b)(2(a-c)+1)}{2(2a-c-b)}\right)$
Case 2	$\frac{a-c}{2}$	X

3- Quality and maximum differentiation

After computing the equilibrium prices and profits, we study the impact on piracy of quality choices and quality difference.

We use equilibrium pirate demands as a measure of piracy[9]. We call θ_{lr}^* and θ_{lu}^* the equilibrium market shares. We examine the effect of *c* on θ_{lr}^* and the effect of *b* on θ_{lu}^*. If these decrease with pirate's quality parameters, it means that the pirate's market share and degree of piracy decrease. On the contrary, if they increase, the pirate's market share increases and there is more piracy. We study the sign of the derivative of θ_{lr}^* and θ_{lu}^* with respect to *b* or *c* (proof in *Annex 1-3*).

A change in quality parameters affects the market. Intuitively, when the quality of the pirate's product increases, the right-holder's profits go down. Indeed, to stay on the market, the producer has to lower its price. Therefore, the pirate's market share and profit increase when *b* or *c* go up.

[9] See Banerjee (2003).

At this point we can make diverse conclusions. As quality parameter c goes up, piracy increases meaning that it affects the market. A rise in quality increases demand. Yet surprisingly, when b increases, there is no effect on piracy:

$$\frac{\delta \theta_{lu}^{*}}{\delta b} = 0$$

In this case, the pirate's market share of unlimited access does not change. When b goes up, good quality unlimited streaming rises to the level of the legal good and it may be worthwhile for the consumer to buy the legal good instead of the streaming one. The positive demand for the unlimited streaming good on the market may only come from its unlimited characteristic. For the pirate, increasing the quality of its goods does not always guarantee greater market power.

For case 2, we show through Proposition 2 that the monopolist price is a decreasing function of c. This is consistent with our previous argument: to stay on the market, the right-holder has to decrease its prices when pirate quality increases. However, an increase in c does not change market shares because demand is constant in that case.

Is it worthwhile for the right-holder and the Internet intermediary to maximize the quality parameter differentiation? For fixed prices in case 1, we study the impact of quality differences, a-b, on profits: if the difference between a-b increases, it means that the quality difference increases (i.e. the legal good is of better quality and the streaming good of lower quality). We find two results. Proof is given in *Annex 1-4*.

First, if $p_i < p$ the right-holder benefits from the low quality of the Internet intermediary, its profit increases, but the latter does not benefit from the high quality of the legal good. Since the pirate's price is lower than the right-holder's price, increasing the quality of the legal good compared to the streaming good is a way of attracting consumers that are more sensitive to quality. In addition, competitive pressure can be translated into quality differences. The right-holder appropriates profit indirectly, through rising quality (and if the pirate chooses a lower level of quality).

Moreover if $p_i > p$, the result is the opposite: the incumbent does not benefit from the low quality of the Internet intermediary.

These two conclusions show that maximum quality differentiation is not always beneficial for these two agents. In this case, this may be due to the fact that price competition prevails over quality competition.

We do not study the impact of the difference a-c because it is not translated into demand (cf figure 1) and appears only in prices.

For case 2, increasing the difference between a and b increases copyright-holder profit but decreases streaming website profit. Indeed, when b tends towards zero, the utility of unlimited streaming goods also tends towards zero and the pirate's profit goes down. In this case, the

pirate cannot choose its prices. Therefore, it can only use quality parameters to attract consumers.

VI- Pirate's decision

In this section we study which conditions of legal strength will evict the Internet intermediary.

The Internet intermediary will remain in the market as long as he can make a profit, which puts a limitation on q. For the different cases, we equate the pirate's profit to zero and we find the level of q, called $\tilde{q}$, which deters the pirate's entry.

This level results from a policy and legal decision. The higher q is, the higher the probability that the pirate will be caught and stop its activity.

We compute the $\tilde{q}$ which prevents the entry of the intermediary in the two different situations studied previously (case 1 and case 2). There is a single q level in these different cases: $\tilde{q}_1$ for case 1, $\tilde{q}_2$ for case 2. $\tilde{q}$ is the maximum probability (or legal strength) that allows the pirate to remain in business. If $q \geq \tilde{q}$, the pirate leaves the market.

Proposition 3

Case 1

We introduce $\beta(p^*_{m,lf}, p^*_{i,lf})$ which represents the equilibrium demand for the streaming good ($p_i D_u + D_r$), in the case 1:

$$\beta(p^*, p^*_{i,}) = \left[p^*_i \left(\frac{p^* - p^*_i}{a-b} - \frac{p^*_i}{b-c}\right) + \frac{p^*_i}{b-c}\right]$$

From Proposition 1 we know that $\beta(p^*_m, p^*_{i,})$ is positive.

$\pi^*_{i,lf} = 0$ *means:*

$$\tilde{q}_1 = \frac{\beta}{(\beta + G)}$$

Case 2

$\pi^*_{i,2} = 0$ *means:*

$$\tilde{q}_2 = \frac{1}{(1 + 2G)}$$

Proof: cf Annex 2-1

When the fine G goes up, the level of legal enforcement necessary to evict the pirate from the market decreases. This is due to the fact that when G goes up, the loss expected is more significant for the illegal intermediary.

We note that $\tilde{q}_2$ is independent of quality, whereas $\tilde{q}_1$ is dependent on these parameters. From Proposition 2, we know that in case 2 the pirate's profit is independent of the quality choices. Moreover, demand is fixed, thus it is not necessary to take quality into account to deter the pirate. This explains why $\tilde{q}_2$ depends only on G.

We examine the impact of quality differences on $\tilde{q}_1$. $\tilde{q}_1$ is an increasing function of β. And β increases with quality difference (a-b) if $p_i > p$. We provide evidence in *Annex 2-2*. In this case, higher quality difference implies higher q to evict the pirate. As we have shown in section V, if $p_i > p$, the Internet intermediary benefits from a higher quality difference a-b. Its profit increases with a-b and thus q has to be higher.

From section V we also know that piracy increases when pirate quality parameters go up. Subsequently $\tilde{q}_1$ has to be higher to evict the pirate from the market if the Internet intermediary chooses to increase the quality of streaming goods[10].

In conclusion, we point out that an efficient level of q is contingent to quality parameters and fine G.

VII- Choice of optimal law enforcement

We now consider the optimal level of enforcement chosen by the legal authority to evict the Internet intermediary from the market and establish a monopoly situation for the right-holder. Or, in other words, the uncertainty level in law execution. The authority chooses the level q in order to maximize social welfare (SW) (i.e. the sum of right-holder and intermediary profit, and consumer surplus (CS)[11]). Let q^* be the law-maker's optimal enforcement rate. We would like to see when $q^* > \tilde{q}_n$where $\tilde{q}_n$ $(n \in (1,\ 2))$, is the general level which deters piracy in our framework. The level q^* is unique.

The social welfare function is:

$$SW(q) = \pi_p + \pi_i + CS = pD_a + (1-q)(p_i D_u + D_f) - c(e) + CS \quad (7)$$

[10] This is consistent with Banerjee (2003): he finds that increasing the quality parameter increases the government's optimal monitoring rate (to have a monopoly situation).

[11] For case 1, consumer surplus is: $CS_1 = \int_0^{\theta_{ru}} (c\theta)d\theta + \int_{\theta_{ru}}^{\theta_{lu}} (b\theta - p_i)d\theta + \int_{\theta_{lu}}^{1} (a\theta - p)d\theta$

For case 2, consumer surplus is: $CS_2 = \int_0^{\theta_{lr}} (c\theta)d\theta + \int_{\theta_{lr}}^{1} (a\theta - p)d\theta$

Proposition 4

The social welfare is a decreasing function of the legal strength, q and the monitoring level, e.

Proof: cf Annex 3-1

Intuitively, as the level of enforcement increases, the pirate's profit decreases. Consumer surplus is independent of q because equilibrium prices (and demands) do not take q into account. Therefore, we do not compute the consumer surplus functions here. The right-holder's profit increases with the penalty paid by the pirate. Since the penalty is a transfer between the two agents, it has no effect on social welfare. In conclusion, social welfare decreases when the legal authority chooses to raise q.

From section V we know that different outcomes are possible. From proposition 4 we also know that social welfare is a decreasing function of q. Therefore, the authority will choose a minimal level of q to maximize social welfare.

Consequently, the authority has two choices among the minimalist levels of enforcement to evict the pirate and maximize social welfare in the above situations (case 2 and case 1). $q = \tilde{q}_1$ and $q = \tilde{q}_2$ are the minimalist rates that lead to the equilibrium without the pirate's entry (or monopoly outcome) respectively in case 1 and case 2. We also have to include the number 0 because q ∈ [0,1]. We study two situations: one where the legal authority can only choose q among the levels that deter piracy, and one where we add the level 0 (no enforcement, no protection) to the previous choices.

In summary, all the possible solutions for q^* are 0, $\tilde{q}_1$ and $\tilde{q}_2$.

To determine which level the authority will choose in equilibrium, we compare the different social welfare functions in these three cases (from Eq. 7):

$SW(\tilde{q}_1) = \pi_{mopole} + CS_{monopole}$ (8)

$SW(\tilde{q}_2) = \pi_{p,lf} + CS_{monopole}$ (9)

$SW(0) = \pi_{p,lf} + \pi_{i,lf} + CS_{lf}$ (10)

For levels $\tilde{q}_1$ and $\tilde{q}_2$ the Internet intermediary leaves the market and the right-holder is in a monopoly situation. Since we are in a leader-follower game, the incumbent still anticipates the pirate's entry, but it is not profitable for the latter to enter the market.

If we focus only on cases where the Internet intermediary is evicted, the legal authority will choose between $q^* = \tilde{q}_2$ and $q^* = \tilde{q}_1$ according to the sign of $SW(\tilde{q}_2) - SW(\tilde{q}_1)$:

$SW(\tilde{q}_2) - SW(\tilde{q}_1) = \pi_{mopole} - \pi_{p,lf}$ (11)

Using equation (11), we make the following proposition.

Proposition 5

Only when the choice is made between $\tilde{q}_1, \tilde{q}_2$ *:*

(i) *If* $SW(\tilde{q}_2) - SW(\tilde{q}_1) > 0 \;\; q^* = \tilde{q}_2$

(ii) *If* $SW(\tilde{q}_2) - SW(\tilde{q}_1) < 0 \;\; q^* = \tilde{q}_1$

Proposition 5 shows that the choice made by the legal authority is not unique. It depends on the value of the welfare and its parameters. As the authority is forced to choose a unique level of q, it cannot take all the competition situations into account ($\tilde{q}_1$, $\tilde{q}_2$) and inefficiency will result.

Now we introduce the possibility that the authority can choose q^* from among all the minimalist levels including 0. From the comparison of welfare, we see that $SW(0) > SW(\tilde{q}_2)$. This is because in the leader-follower game with the pirate's entry, social welfare now includes intermediary profit function (not included in $SW(\tilde{q}_2)$) and the consumer surplus is higher (some of the consumers switch from not buying in a monopolist case to buying from the pirate). So $q = 0$ strongly dominates $q = \tilde{q}_2$. Hence, the government will now choose between $q = 0$ or $\tilde{q}_1$ according to the sign of $(0) - SW(\tilde{q}_1)$:

$$SW(0) - SW(\tilde{q}_1) = \pi_{p,lf} + \pi_{i,lf} + CS_{lf} - \pi_{monopole} - CS_{monopole} \quad (12)$$

Proposition 6 gives the result.

Proposition 6

For all the levels:

(iii) *If* $SW(0) - SW(\tilde{q}_1) > 0 \;\; q^* = 0$

(iv) *If* $SW(0) - SW(\tilde{q}_1) < 0 \;\; q^* = \tilde{q}_1$

Proposition 6 shows that the optimal government choice may be no enforcement (*q=0*).

Propositions 5 and 6 have shown that there is not a unique level of q^* for all the situations presented. The choice of q depends on the social welfare functions presented above. The ex-ante law parameter can therefore be interpreted differently and leads to different equilibrium results. Moreover, the level chosen cannot be compatible with the one that deters the Internet intermediary from entry. The ex-ante choice of q relies on ex-post quality parameters. Quality plays a role in law effectiveness.

Now we would to see under what conditions the optimal level q^* deters piracy in all situations. We search for conditions that allow a unique level q^* that suits all situations (case 1 and case 2). In other words, to the copyright infringer from the market, we need $q^* \geq \tilde{q}_n$ for all $n \in (1, 2, 3)$ where $\tilde{q}_n$ is the actual level of deterrence for the pirate, and q^* is the enforcement level chosen by the law-maker based on a social welfare comparison. Thus, we obtain the following result (Proposition 7) from Propositions 5 and 6.

Proposition 7

(i) *If* $q^* = 0$ *there is no law enforcement*

To deter piracy in all situations:

(ii) *If* $q^* = \tilde{q}_1$, *we need* $\beta \geq 1/2$

(iii) *If* $q^* = \tilde{q}_2$, *we need* $\beta \leq 1/2$

Proof: cf Annex 3-2

For *(i)* when $q^* = 0$ no one level $\tilde{q}_n$ can be superior to the optimal level chosen.

In case *(ii)*, when $q^* = \tilde{q}_1$, q^* can stop piracy only if we also have $q^* \geq \tilde{q}_2$. The same is true for case *(iii)* when $q^* = \tilde{q}_2$: q^* deters piracy only if $q^* \geq \tilde{q}_1$. These two conditions lead to the previous results in Proposition 7.

$q^* = \tilde{q}_1$ is efficient when the demand for Internet intermediary goods in case 1 is high ($\beta \geq 1/2$). On the contrary $q^* = \tilde{q}_2$ is efficient when demand for streaming goods is low ($\beta \leq 1/2$).

The fine G is a complementary tool to prevent the pirate from entering the market. But it does not appear to be a condition to reach the optimal level of q^* .

We have shown that there are three possible optimal policy levels q. However, in reality the law maker can only choose a single parameter to supervise all piracy situations. Proposition 7 states that demand conditions (β) are needed to deter piracy in all situations.

The intuition of Proposition 7 is quite straightforward. According to our statement in section V, quality influences profit and demand. Therefore a strengthener q is required if Internet intermediaries change the quality of their goods.

In essence, the choice of a unique optimal q is linked to demand functions and quality parameters.

We suppose throughout this paper that when a pirate is discovered, the right-holder immediately sues it. Nevertheless, in practice all infringements do not lead to a lawsuit. Private settlements between the pirate and the right-holder may be preferable: beneficiaries can choose to negotiate or ask the intermediary to remove the infringing content. In addition, it may prove very expensive for the right-holder to sue all pirates. Therefore, we present here an extreme case in which private settlements are preferred.

We can see from Proposition 4 that when e increases, its cost is higher and social welfare goes down. Therefore, private arrangements can reduce costs when the right-holder knows who the pirate is or has already sued it in the past.

VIII- Extensions

In this section we consider possible extensions. Further steps could be taken to extend this analysis. These are related to tort law and the role that other Internet actors can play to enforce copyright.

First, other economic agents can be involved in influencing Internet intermediaries to enforce the law. We have assumed that only right-holders monitor possible infringements. However, payment intermediary systems (e.g. PayPal) can also play a role. Since one source of revenue for streaming websites is subscription fees, payment intermediaries could block money transfers. However, this set-up requires knowing which intermediaries host illegal contents. The incumbent can still monitor and denounce websites, but the threat does not come solely from law.

The new pirate's profit is:

$$\pi_i = (1-q)(p_i D_u) + D_r \qquad (13)$$

Where q now represents the probability that the payment intermediaries block money transfers.

Another possible extension involves the right-holder and the intermediary choosing to self-regulate through voluntary agreements to share the costs of surveillance. They could also choose a private settlement before going to court. Nonetheless, these solutions give rise to transaction costs given that Internet intermediaries and copyright holders have divergent interests.

Finally, tort law could be adjusted to combine ex-post liability and ex-ante regulation (Shavell, 1984a and 1984b). In an ex-ante regulatory regime, the government observes a level of care (i.e. before accidents occur). In an ex-post regime, the government observes damage and the occurrence of accidents and sometimes the level of care if there is a negligence liability rule. Thus in an ex-ante case, the level of care is fixed and monitored before damages occur through actions, triggering accidents. Shavell (1984a) proposes four determinants to analyze these two regimes: difference in knowledge about risky activities between private and legal parties, administrative costs, incapacity to pay for harm done, and the possibility of escaping lawsuits. The first two favor liability and the other two favor safety regulation.

IX- Conclusion

This paper explores the strategic behavior of a copyright-holder and an Internet intermediary (i.e. an illegal streaming website). The pirate offers two types of goods, one of which is restricted and one which is not. We model a situation involving only ex-post adjudication. This situation leads to uncertain enforcement. It corresponds to the concept of a "safe harbor" for Internet intermediaries.

First, we show that right-holder prices take into account Internet intermediary quality choices. Moreover, increasing pirate quality parameters can in some cases increase the Internet intermediary's market share. In addition, we analyze the judge's role in restricting piracy, by penalizing illegal operation by Internet intermediaries. The judge's social-welfare maximizing policy determines the market outcome. Moreover, the uncertainty of the law plays a decisive role in a pirate's profit and its decision to enter the market. The legal authority has to choose a single optimal level of policy enforcement q^* to deter pirates.

On the whole, the choice of q^* can be different from the level necessary to deter piracy in some cases and is influenced by quality parameters. However, to obtain an optimal policy that corresponds to all situations with one level of q^* demand conditions are needed.

These results have policy implications for copyright rules and innovation in the field of legal content supplied on the Internet. We have shown that the optimal enforcement rule cannot ignore the version strategies chosen by Internet intermediaries and right-holders. Conversely, right-holders and pirate websites have to appropriate current legislation. Furthermore, the extent and cost of private monitoring raise real issues regarding the efficiency of legal procedures.

Extensions in Section 8 suggest other forms of monitoring policy (i.e. ex-ante versus ex-post rule or self-regulation). The role of private settlement is highlighted in reducing the expected costs of an infringement.

The model presented in this paper could be used to study the influence of key parameters (like e, q or quality) on market outcomes in a less restrictive set-up.

We consider possible avenues for extending our results. In our model we studied legal enforcement's sensitivity to quality parameters. However, for a more general representation, we could extend this sensitivity analysis to private enforcement (i.e. monitoring). Moreover, some assumptions could be revised to extend our model: endogenous quality, other tort law rules (like strict liability), separation between legal and private enforcement (by right-holders) and monitoring.

Annexes

Annex 1

Annex 1-1: Proposition 1-Case 1

The pirate reaction function is:

$$p_i(p) = \frac{p(b-c)}{2(a-c)} + \frac{a-b}{2(a-c)}$$

We substitute the reaction function of the pirate into the right-holder profit functions (Eq. 2) and obtain the optimal prices.

These are maximum prices since:

$$\frac{\delta^2 \pi_{p,1}}{\delta^2 p} = \frac{c+b-2a}{(a-c)(a-b)} < 0 \text{ because } c+b-2a<0 \text{ and } 0 \leqslant c \leqslant b < a \leqslant 1$$

$$\frac{\delta^2 \pi_{i,1}}{\delta^2 p} = \left(-\frac{2}{a-b} - \frac{2}{b-c}\right) * (1-q) < 0$$

Annex 1-2: Proposition 1-Case 2

$$\frac{\delta \pi_{p,2}}{\delta p} = \left(1 - \frac{p}{a-c}\right) - \frac{p}{a-c} = 0 \text{ and } p^* = \frac{a-c}{2}$$

This is a maximum since:

$$\frac{\delta^2 \pi_{p,2}}{\delta^2 p} = -\frac{2p}{a-c} < 0$$

Annex 1-3: Quality impact on privacy

We study the sign of the derivative of θ_{lr}^* with respect to c and θ_{lu}^* with respect to b.

$$\theta_{lr}^* = \frac{p^*}{a-c} = \frac{(3-2k)(1-\alpha)}{2(2-k-\alpha)(1-k)}$$

$$\frac{\delta \theta_{lr}^*}{\delta c} = \frac{a-b}{2} * \frac{(2a^2+2c^2-4ac+3a-2c-b)}{[(2a-c-b)(a-c)]^2}$$

$$\frac{\delta \theta_{lr}^*}{\delta c} > 0 \text{ because } 0 \leqslant c \leqslant b < a \leqslant 1 \text{ and } (2a^2+2c^2-4ac+3a-2c-b) > 0$$

$$\theta_{lu}^* = \frac{p^* - p_i^*}{a-b} = \frac{2(a-c)+1}{2(2a-c-b)} * \left(1 - \frac{b-c}{2(a-c)}\right) - \frac{1}{2(a-c)}$$

$$\frac{\delta \theta_{lu}^*}{\delta b} = \frac{2(a-c)+1}{2(2a-c-b)} * \left(\frac{1}{(2a-c-b)} - \frac{b-c}{2(a-c)(2a-c-b)} - \frac{1}{2(a-c)}\right) = 0$$

Annex 1-4: Quality differentiation

Case 1

$$\frac{\delta\pi_{p,1}(p,p_i)}{\delta(a-b)} = \frac{p(p-p_i)}{(a-b)^2} \text{ and } \frac{\delta\pi_{p}(p,p_i)}{\delta(a-b)} > 0 \; if \; (p-p_i) > 0$$

$$\frac{\delta\pi_{i,1}(p,p_i)}{\delta(a-b)} = -\frac{p_i(p-p_i)}{(a-b)^2} * (1-q) \text{ and } \frac{\delta\pi_{i}(p,p_i)}{\delta(a-b)} < 0 \; if \; (p-p_i) > 0$$

Case 2

$$\frac{\delta\pi_{p,2}(p,p_i)}{\delta(a-b)} = \frac{p^2}{(a-b)^2} > 0$$

$$\frac{\delta\pi_{i,2}(p,p_i)}{\delta(a-b)} = -\frac{p}{(a-b)^2} * (1-q) < 0$$

Annex 2

Annex 2-1: Proposition 3

To find the level $\tilde{q}$ for the three different cases, we equalize $\pi_i^* = 0$.

For case 1: $\pi_i^* = (1-q) * \beta\left(p^*, p_{i,}^*\right) - qG = 0$

For case 2: $\pi_i^* = \frac{1-q-2qG}{2} = 0$

Annex 2-2: Effect of quality difference on $\tilde{q}_1$

$$\frac{\delta\tilde{q}_1}{\delta\beta} = \frac{G}{(\beta+G)^2} > 0$$

And from section V-2, we know that if $p_i > p$ the pirate's profit increases with the quality difference (a-b). Thus β increases with quality difference and $\tilde{q}_1$.

Annex 3

Annex 3-1: Proposition 4

$\frac{\delta SW}{\delta e} = -c'(e) < 0$ (*Assumption 2*)

$\frac{\delta SW}{\delta q} = -(p_i D_u + D_f) < 0$ because $(p_i D_u + D_f) > 0$

Annex 3-2: Proposition 7

(ii) If $q^* = \tilde{q}_1$, we need $\beta \geq 1/2$

We need $q^* \geq \tilde{q}_2$.

$$q^* = \tilde{q}_1 \geq \tilde{q}_2 \Leftrightarrow \frac{\beta}{(\beta+G)} \geq \frac{1}{(1+2G)}$$

This implies $(\beta+G) \leq \beta(1+2G) \Leftrightarrow (2\beta-1)G \geq 0 \Leftrightarrow (2\beta-1) \geq 0 \Leftrightarrow \beta \geq 1/2$

(iii) *If* $q^* = \tilde{q}_2$, *we need* $\beta \leq 1/2$

We need $q^* \geq \tilde{q}_1$.

$$q^* = \tilde{q}_2 \geq \tilde{q}_1 \Leftrightarrow \frac{1}{(1+2G)} \leq \frac{\beta}{(\beta+G)}$$

This implies $(\beta+G) \geq \beta(1+2G) \Leftrightarrow (2\beta-1)G \leq 0 \Leftrightarrow (2\beta-1) \leq 0 \Leftrightarrow \beta \leq 1/2$

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