Baywatch: two Approaches to Measure the Effects of Blocking Access to The Pirate Bay

Working paper, 22 August 2013

Joost Poort[a*], Jorna Leenheer[b], Jeroen van der Ham[c], Cosmin Dumitru[c]

[a] *Institute for Information Law, University of Amsterdam, The Netherlands*

[b] *CentERdata, Tilburg University, The Netherlands*

[c] *System and Network Engineering, University of Amsterdam, The Netherlands*

Abstract

In the fight against the unauthorised sharing of copyright protected material, aka piracy, Dutch Internet Service Providers have been summoned by courts to block their subscribers' access to The Pirate Bay (TPB) and related sites. This paper studies the effectiveness of this approach towards online copyright enforcement, using both a consumer survey and a newly developed non-infringing technology for BitTorrent monitoring. While a small group of respondents download less from illegal sources or claim to have stopped, and a small but significant effect is found on the distribution of Dutch peers, no lasting net impact is found on the percentage of the Dutch population downloading from illegal sources.

Keywords:

Unauthorised File Sharing; Piracy; p2p; BitTorrent monitoring; Blocking Access; The Pirate Bay; Online copyright enforcement

1. Introduction

Early 2012, Dutch rights holders representatives were able to claim two potentially important legal victories in their fight against unauthorised sharing of copyright protected material on the Internet, commonly referred to as 'online piracy'. As of February 1st, 2012 two large Internet Service Providers (ISPs) were ordered by the Rechtbank 's Gravenhage, a lower Dutch court, to block access to The Pirate Bay (TPB) website and a list of subdomains and mirror sites (Rechtbank 's Gravenhage, 2012, January 11). In a second ruling in May 2012, the same court ordered four other Dutch ISPs (UPC, KPN, T-Mobile and Tele2) to block access to TPB within ten days (Rechtbank 's Gravenhage, 2012, May 10). Effectively, both rulings combined imply that more than 80% of Dutch Internet subscribers cannot access The Pirate Bay directly through their ISP. Both rulings are currently under appeal from the ISPs.

These rulings are part of a manifold of legal actions against TPB in Sweden, Germany, and other countries. According to the Dutch court, TPB is currently the world largest index site for BitTorrent files, and as such an important platform for online piracy. Other legal efforts to take down this site have failed so far. The court considers blocking access to TPB for all subscribers of these ISPs proportional, as an estimated 90 to 95% of the material offered via this site is illegal. At the same time, legally offered material via TPB can also be obtained

[*] Corresponding author. Postal address: Kloveniersburgwal 48 / 1012 CX Amsterdam, The Netherlands. Tel.: +31 20 5253324. E-mail addresses: poort@uva.nl (J. Poort), j.leenheer@uvt.nl (J. Leenheer), vdham@uva.nl (J. v.d. Ham).

through other sites. If this situation were to change, withdrawal of the ruling could be ordered (Rechtbank 's Gravenhage, 2012, January 11, 4.27-4.29).

The effectiveness of the requested measures was an important issue in both lawsuits. Rights holders' representative Stichting Brein presented evidence from Italy and Denmark that blocking access to TPB had significantly reduced the number of unique visitors of this site, despite the claim by the defendants that it is easy to circumvent such an intervention, for instance by making use of 'virtual hosting' or an anonymous web proxy provider (Rechtbank 's Gravenhage, 2012, January 11, article 4.34-36). However, the economically more relevant question is not whether blocking access to TPB decreased the number of visitors to this particular website, but what the effect of the blocking is on online copyright infringement as a whole. This paper aims to answer this question by providing empirical evidence using two different approaches next to each other. The first approach consists of consumer surveys among two waves of representative consumer samples. The second approach consists of an innovative data collection technique that directly measures BitTorrent participation by monitoring the distribution of peers for a sample of torrent files, without actually participating in the process of downloading and uploading. Both methods combined lead to the conclusion that while a small group of respondents download less from illegal sources or claim to have stopped, and a small but significant effect is found on the distribution of Dutch peers, there is no lasting net impact on the percentage of the Dutch population downloading from illegal sources, as people learn to use alternatives to TBP.

By doing so, this paper contributes to the literature on the effectiveness of online copyright enforcement measures. In addition, the paper provides a novel and non-infringing technology for BitTorrent monitoring.

The rest of the paper is structured as follows. Section 2 gives a short technical introduction to the BitTorrent file sharing mechanism and the definition of some related concepts. Section 3 gives an overview of the emerging literature on possible measures for copyright enforcement and other ways to combat online copyright infringement. Section 4 present the design and results of two consumer surveys: one conducted after the first two ISPs had to block access to TPB but the others not yet, and another half a year later when all ISPs had blocked access for six to ten months. Section 5 presents the methodology used for measuring participation in BitTorrent swarms using direct software monitoring as well as the outcomes of these measurements. Section 6 discusses the results from both methods to assess the effectiveness of blocking access to TPB and concludes.

2. The BitTorrent file sharing mechanism

The Bittorrent protocol is a peer-to-peer protocol, in which peers cooperate in distributing files or content. A *peer* is a program running on a computing node that participates in downloading and uploading content. This content is divided into *blocks* of data, which are exchanged between peers and together form the complete content. A *swarm* is a set of peers sharing a single set of files, also called a *torrent file*. This torrent file describes metadata of the files being distributed to support the Bittorrent protocol, such as information on the blocks that are distributed, and how these blocks should be put together to form the final files.

Trackers are used to bootstrap and accelerate Bittorrent swarms, they participate in swarms by keeping track of all participants, and provide a (new) peer with information on other peers participating in the swarm. A peer that has joined a swarm can discover other peers through *peer exchange*, i.e. sharing known peers with connected peers.

The initial version of the BitTorrent protocol used torrent files to describe content. Later versions have added another layer of distribution by storing the bittorrent files in a *Distributed Hash Table* (DHT) storage network created by all global peers. A so-called *magnet link* can then be used to address content in this DHT network, which provides the contents of a torrent file, and several participating peers. Often the magnet links also contain pointers to trackers.

3. Literature

3.1 Effectiveness of measures against unauthorised file sharing

Since the turn of the century, a substantial empirical economic literature emerged on the effects of unauthorised file sharing on the legal sales of entertainment products. Early contributions focused on the music industry (e.g. Peitz & Waelbroeck (2004), Rob & Waldfogel (2006), Zentner (2006), Liebowitz (2006) and Oberholzer-Gee & Strumpf (2007)). A few years later, a smaller number of studies appeared on the effect for movies (e.g. Bounie, Bourreau, & Waelbroeck (2006) Hennig-Thurau, Henning, & Sattler (2007), Rob & Waltfogel (2007)). A recent literature review was performed by Smith and Telang (2012). Apart from one much cited exception (Oberholzer-Gee & Strumpf, 2007), these studies find a negative effect of unauthorised file sharing on sales, although this effect is generally found to be much smaller than a one-to-one displacement of sales by illegal copies and also substantially smaller than the loss of revenues from recorded music that the industry experienced since the late 1990s.

Over the years, the entertainment industry pursued a variety of strategies to combat unauthorised file sharing. Some of these strategies concern their own supply, for instance the use of Digital Rights Management (DRM) technology to prevent users from sharing legally acquired content. For the music industry this strategy proved to be counterproductive and was abandoned (see: Sinha, Machado, & Sellman, 2010; Vernik, Purohit, & Desai, 2011), while for audio-visual products, e-books and games the use of DRM is still fairly common.

Another strategy is to offer legal digital alternatives. Relating to this, Danaher et al. (2010) study the effect of the removal of NBC content from the iTunes store in December 2007 and its restoration in September 2008, on BitTorrent piracy and DVD sales on Amazon. They associate the removal with an 11.4% increase in piracy of this particular content, which is in fact twice as much as the legal digital sales prior to removal. No significant effects on DVD sales were found, nor on piracy levels after the content was restored. A more controversial strategy involves the pollution or poisoning of illegal file sharing networks with a plethora of useless decoys (Christin, Weigend, & Chuang, 2005).

Blocking access to TPB, the primary object of this study, stands in a tradition of *legal actions* against file sharing. These can be distinguished in action against individual file sharers, the demand side of the illegal market, and actions against the supply side, platforms that accommodate unauthorised file sharing.

3.1.1 Legal action against individual file sharers

In June 2003, the Recording Industry Association of America (RIAA) initiated a series of lawsuits against individual file sharers. The effects on piracy levels of these lawsuits was studied by Bhattacharjee et al. (2006), who tracked the online file sharing behaviour of over 2,000 individuals. They find that the majority of substantial file sharers decreased the number of file shared, typically by 90%. Small time file sharers decreased their sharing activity less, typically to a third. However, the individuals who continued to engage in unauthorised file sharing increased their activity again after a court ruling that made it harder for the RIAA to request the names of file sharers from ISPs. On top of this, the authors note that individuals may have gone off the radar, using more covert file sharing technologies.

Adermon & Liang (2011) study the effects of the implementation of the IPRED directive in Sweden on music and movie sales. This directive, which was implemented on April 1, 2009, substantially increased the risk of being caught and prosecuted for online file sharing. The authors find an 18% drop in Internet traffic during the six months following the implementation. Using difference-in-difference analysis with Finland and Norway as controls, they conclude that the implementation led to an increase in the sale of physical music by 27% and digital music by 48%. No significant effects were found on cinema visits or DVD sales. On the other hand, Adermon and Liang also find that ‘the reform effects more or less disappeared after six months except for

digital music sales'. On could however argue the substantial and sustained increase in digital music sales may at least to some extent be due to the home advantage of the popular Swedish streaming music service, Spotify.

Interestingly, Adermon & Liang (2011) also report the outcome of two consumer surveys concerning their file sharing behaviour. In 2009, 23% of the respondents state they have stopped using file sharing sites as a result of the new legislation while 37% state they use file sharing sites less (n = 429). In a 2010 survey, 52% state they use file sharing sites less for downloading music than the year before (n = 1060). Asked for the reason they are using file sharing sites less for music, 56% of this group mentions Spotify, 34% the IPRED, and 25% 'better legal services'.

Danaher et al. (2012) study the effect of the French HADOPI legislation on digital sales in the iTunes store. Under this 'three strikes' legislation, which was implemented in October 2009, infringers that are caught first receive a warning. Caught again, they get a second warning and if they do not stop infringing after that, suspension of their Internet connection may be ordered. Using a difference in difference approach comparing the French data with other countries, the authors find a positive effect on song and album sales at iTunes of 22.5% respectively 25%. They note, however, that the effect of the actual legislation and the education campaigns accompanying the introduction of HADOPI cannot be separated. In fact, most of the effect seems to have created before the (amended) legislation was finally accepted by the Constitutional Council and even seems to have diminished since then.

3.1.2 Legal action against platforms that accommodate file sharing

A more consumer friendly strategy is directed towards platforms that accommodate file sharing: the supply side of the illegal market. Blocking access to TPB stands in this tradition. A notable early victory of right holders against the supply side of the illegal market was the shutdown of the peer-to-peer file sharing platform Napster in July 2001. However, Napster was soon succeeded by alternative platforms such as KaZaA and BitTorrent clients who decentralise the file sharing process. The bootstrapping of the process occurs at tracker sites such as TPB. An alternative technology is provided by cyberlockers (also known as 'one-click hosters', where copyright protected content is stored anonymously 'in the cloud' by individuals while other users can access these lockers to download this content.

In January 2012, Megaupload, the most popular cyberlocker was shut down. Danaher & Smith (2013) study the effects of this 'natural experiment' on unauthorised file sharing and on legal digital movie rentals and purchases. They analyse cross-country variation in the use of Megaupload before, and the change in legal sales after the shutdown. No relation is found between the penetration of Megaupload and the digital sales *prior* to the shutdown. However, a significant positive relationship is found between this penetration and the sales change *after* the shutdown. For each additional 1% of pre-shutdown penetration, the post-shutdown sales increased an extra 2.5-3.8%. Note however, that the lack of a relation between Megaupload penetration and digital sales prior to shutdown hints at the fact that the effect found after the shutdown may be temporary until consumers have found their way to alternative suppliers of illegal video content.

Peukert & Claussen (2013) study the effect of the Megaupload shutdown on movie box office revenues and find a negative effect of the shutdown on revenues for smaller and mid-range movies. According to the authors, only large blockbusters benefit from the shutdown of Megaupload. Smaller movies may benefit more from file sharing through word-of-mouth marketing in social networks.

Lauinger et al. (2013) also study the effect of legal actions against cyberlockers, for instance to remove certain content from their sites. They find that such legal actions are a nuisance to the users of these services, but their effect on overall availability of content and on file sharing activity is limited. They conclude that cyberlockers 'are probably most vulnerable to antipiracy measures targeted at removing external sources of

revenue. Indexing sites may be less affected, especially those that are less driven by (and reliant on) monetary gain' (Lauinger et al., 2013, p.12).

From this review of the literature, it becomes apparent that legal actions against file sharers and against platforms for unauthorised file sharing often have an immediate effect which may disappear after a period of typically six months, as illegal supply and demand find other places to meet. This contribution adds to this literature by studying the effect of blocking access to TBP at several points in time during the first year after this measure is introduced.

3.2. BitTorrent monitoring

There is a large body of research describing monitoring of Bittorrent and other peer-to-peer networks. Many studies focus on detecting monitors, and to escape detection from these monitors. Piatek et al. (2008) describe a reverse-engineering approach to bittorrent monitoring by copyright holders attempting to identify infringing users. They find that this monitoring has become more systematic, yet not conclusive. In their experiments they are able to inject false information, which is then served with complaints about copyright infringement. Furthermore, at the time blacklists used by the BitTorrent community were not effective in identifying these monitors.

Toro et al. (2009) have written a Bittorrent monitor which examines the behaviour of peers participating in swarms. This can then be used to heuristically classify peers, so that "suspicious" peers showing deviant behaviour can be identified and thus be avoided.

Bauer et al. (2009) note that passive monitors often produce false positives, and that active monitoring of a bittorrent swarm is much more effective. They created a tool, BitStalker, which probes participating peers, exchange a block of data and then request a peer exchange. This allows for monitoring of a bittorrent swarm, in a way that is robust against trackers providing false data, and also verifies whether peers are actively participating. Jünemann et al. (2010) and Wolchok et al (2010) monitor the Distributed Hash Table (DHT) storage network. The BitMON tool created by Jünemann et al. monitors the participants in the DHT network, and allows tracking of their behaviour and the stability of the DHT network overall. Wolchok et al. instead crawl the DHT to discover the stored torrent files, but also identify peers downloading these torrent files. This is an indirect way of identifying BitTorrent participants.

Hoßfeld et al. (2010) use the PlanetLab distributed testbed to perform monitoring of BitTorrent swarms to measure performance and locality. The objective is to identify how much the performance can be improved by adjusting the BitTorrent distribution protocol by leveraging distance in the network in forming the overlay network. There they show that it is possible for most swarms to identify almost all of the participating IP addresses.

While Kryczka et al. (2011) do not perform monitoring themselves, they classify many different BitTorrent monitoring techniques: portal, tracker, and peer crawling, but also a custom client/plugin. They identify the possibilities of these techniques, and identify a custom client/plugin as the best method for gathering as much information about peers as possible. Chothia et al. (2013) classify different monitoring techniques as direct and indirect, equivalent to the active and passive techniques mentioned earlier. They observe that both techniques are used to identify infringing peers.

4. Consumer survey

Blocking access to TPB (and a number of subdomains and mirror sites) may have an effect on unauthorised file sharing through two mechanisms. First, blocking access could make illegal content less attractive, by making it more difficult to find and download illegal content, which may cause people to download less or stop downloading altogether. As a result of these increased transaction costs, they may turn to legal sources to

satisfy at least part of their demand. In the most positive scenario, by doing so they may learn how attractive these legal offers are and stick with them. On the other hand, the increase in transaction costs may be largely temporary, because looking for alternative (illegal) platforms occurs only once. If the assortment of these alternative platforms is smaller or less attractive, search costs may not disappear completely, but as time goes by, the alternatives that are not blocked are likely to improve. Second, blocking access may raise awareness that downloading from illegal sources is not appreciated by rights holders and may deprive authors from their income.[1]

To study the (self-reported) effect of blocking access to TPB, two surveys were held among representative samples of the Dutch population aged 16 years and over. The first survey was held in May 2012 (weeks 19-20), when the first two ISPs (Ziggo and XS4ALL) had been blocking access to TBP for 3 months. By that time, the court had already ruled that several other ISPs (UPC, KPN, Tele2, and T-Mobile) had to do the same, but this had not yet been effectuated. The second survey was held seven months later, November-December 2012 (weeks 48-49). By that time, Ziggo and XS4ALL had been blocking access to TBP for 10 months, while the other ISPs (UPC, KPN, T-Mobile, and Tele2) had been doing so for 6 months. Combining both surveys yields a multi-periodical measurement of individuals' expected reaction to blocking access, and measurements of their (self-reported) reaction after 3, 6 and 10 months.

4.1 Sample and response

Both surveys were conducted in the CentERpanel, a representative online household panel that is based on a probability sample. That is, households are selected randomly from Dutch address databases and all household members 16 years and older are invited for panel participation (in contrary to most access panels). The panel attracts participants with the argument that panel members support scientific and societal research, and no commercial studies will be undertaken. The panel exists since 1990, and aims to keep panel members attached to the panel on a permanent basis. However, because some panel attrition exists, panel recruitment takes place periodically. In fact recruitments occurred between the first and second measurement, meaning that some sleeping members were dropped from the panel, whereas a wave of new participants had entered the panel.

A total of 3,118 panel members aged 16 years and over were invited to complete the first questionnaire; 2009 people fully completed the questionnaire – a response rate of 64.4%. The second survey was distributed within the same panel and revealed a response of 2422, a response rate of 78.4%. 1692 panel members (54.3% of the first response) have participated in both the first and second study. To prevent losing the information of panel members that participated only once, the measurements are treated as two independent cross-sections in the analysis below.

The first sample consists of 55% men, 38% have a college degree, 40% live in highly urbanized area. For the second sample the numbers are 53% men, 41% with a college degree and 38% live in highly urbanized area. As file sharing is likely to differ strongly among age groups, all data were weighted by age.

4.2 Results

4.2.1 Market Developments

The first measurement (May 2012) reveals that 27.8% of Dutch consumers purchased music in a physical format (CD, LP) in the past six months, in an offline or online store (Table 1). For 63.1% buying physical music was longer than a six months ago , whereas 9.1% has never bought music. Overall 51.7% obtained music from a legal source in the past half year: in a physical format (27.8%), as paid download or streaming (14.2%),

[1] In the Netherlands, downloading from illegal sources is allowed under the private copying exception, but uploading is illegal, and by default BitTorrent clients download as well as upload content.

and/or a free download or streaming from a legal source (33.2%). Finally 18.3% had downloaded from an illegal source such as Pirate Bay in the past six months.

In the second measurement (November-December 2012), purchasing music in physical format has increased slightly: 30.4% did this in the preceding six months. Paid downloading also increased slightly. Downloading and streaming from an illegal source remained constant, while free downloading and streaming from a legal source decreased slightly. In sum, the slight market growth observed between these measurements is unlikely to be caused by the blocking of the Pirate Bay, given that achieving music from illegal sources has not decreased.

Table 1 Downloading, streaming and purchasing of music (cross section)

Last time	Purchased offline and online store (1)	Downloading & streaming from a legal source		Downloading & streaming from an illegal source (4)	All channels (1 to 4)	Total legal (1 to 3)
		Paid-for (2)	Free (3)			
May 2012 (N=2009)						
past 6 months	27.8%	14.2%	33.2%	18.3%	53.6%	51.7%
6-12 months	12.2%	2.9%	3.3%	3.4%	9.4%	9.0%
> a year ago	50.9%	11.7%	11.6%	12.4%	30.6%	32.5%
Never	9.1%	71.2%	51.9%	65.9%	6.4%	6.7%
November-December 2012 (N=2422)						
past 6 months	30.4%	14.8%	31.5%	18.2%	55.3%	53.3%
6-12 months	12.3%	3.5%	4.2%	3.5%	9.8%	9.7%
> a year ago	49.7%	12.6%	14.0%	13.7%	29.0%	30.9%
Never	7.7%	69.0%	50.4%	64.6%	5.9%	6.1%

Table 2 provides data on downloading and streaming for four content types, next to music it includes films & series, books, and games. Downloading music from an illegal source is most common, closely followed by downloading of films and series. The majority of Dutch consumers have never downloaded any of the content types from an illegal source (58.7% in the second measurement). Whereas for music the percentage downloading in the past six months was practically equal between both measurements (-0.1%) , for films & series (+1.0%), games (+2.0%), and books (+3.4%) the percentage increased somewhat.

Table 2 Downloading & streaming from illegal sources

	Music	Films & series	Books	Games	Total
May 2012 (N=2009)					
past 6 months	18.3%	16.8%	5.1%	4.4%	24.0%
6-12 months	3.4%	1.5%	1.2%	1.9%	3.2%
> a year ago	12.4%	5.6%	2.3%	7.1%	12.0%
Never	65.9%	76.0%	91.4%	86.7%	60.8%
November-December 2012 (N=2422)					
past 6 months	18.2%	17.8%	8.5%	6.4%	24.5%
6-12 months	3.5%	2.1%	1.7%	1.7%	3.4%
> a year ago	13.7%	8.2%	3.2%	8.7%	13.4%
Never	64.6%	72.0%	86.6%	83.2%	58.7%

4.2.2 The Effects of the Pirate Bay blocking

Table 3 describes the self-reports of the changes in downloading from illegal sources of consumers, in reaction to the blocking of the Pirate Bay for the two sets of ISP's.[2] During the first measurement customers of UPC, KPN, Tele2 and T-Mobile were not confronted with the blocking yet and were asked about their expected reaction to the blocking. More than half of the downloaders (56.1%) expect to keep downloading at the same rate as they currently did. But 28.8% expect to decrease their downloading, and will download less (21.7%) or stop downloading entirely (7.1%). On the other hand 15.2% expect to increase their downloading.

After the blocking has been effective consumer were asked what has been the impact of the blocking. There is a significant difference between the expected change as reported before the blocking and the effective behavior three months after the blocking (χ^2=7.8; *p=0.007*; *df*=3): the percentage of downloaders that did not change their downloading behavior is higher (71.4%) than was initially expected (56.1%). The percentage of downloaders that stopped downloading was slightly higher than previously expected (8.0% versus 7.1%), but the share of customers that downloaded less was lower than expected (14.9% vs. 21.7%). On the other hand the percentage of customers that increased their downloading was also lower (5.7%) than initially expected (15.2%).

There is no significant difference between the reported reaction 6 months after the blocking compared to 3 months after the blocking (χ^2=0.6 ; *p*=0.91; *df*=3), and between 10 months after the blocking and 6 months after the blocking (χ^2=0.7 ; *p*=0.87; *df*=3). Thus, an immediate effect of the blocking is found that does not change over time. In the end it is important to realize that the majority of customers did not download (anymore) at the time of the blocking, so that for them the blocking has no effect at all. Overall between 4-6% of all consumers have decreased their downloading as a result of the blocking, whereas for 94-96% of the population the blocking has had no effect on their behavior.[3]

Table 3 Reaction or expected reaction to blocking access to The Pirate Bay (Percentages of customers downloading from illegal sources at the time of blocking; two measurements, split sample)

	UPC, KPN, Tele2 & T-Mobile (expected reaction, *t* = 0)*	Ziggo & XS4ALL (reaction *t* = 3)**	UPC, KPN, Tele2 & T-Mobile (reaction *t* = 6)*	Ziggo & XS4ALL (reaction *t* = 10)**
Stop	7.1%	8.0%	9.2%	8.4%
Less	21.7%	14.9%	14.5%	15.3%
Just as much	56.1%	71.4%	70.2%	71.8%
More	15.2%	5.7%	6.1%	4.6%
N	198	262	228	131
Comparison with previous measurement:				
χ^2		7.8	0.6	0.7
(*p*-value)		(0.007)	(0.91)	(0.87)

* part of 1st measurement, ** part of 2nd measurement

Table 4 confirms that downloading from illegal sources has not decreased since the intervention. In fact, both for UPC, KPN, Tele2 & T-Mobile (χ^2=43.6 ; *p*<0.001; *df*=6) and for Ziggo and XS4all (χ^2=942.8 ; *p*<0.001; *df*=6) the percentage of consumers who downloaded in the preceding six months increased. For UPC, KPN, Tele2, and T-Mobile that percentage increased from 15.7% just before the blocking to 18.4% six months after the

[2] Because the primarily focus is on the developments of these subsamples, unweighted observations of those who were downloaders at the time of the blocking are used.

[3] Approximately 25% of consumers downloaded from an illegal source in the past six months, of which 20-25% decreases their downloading in reaction to the blocking.

blocking. For Ziggo and XS4all the percentage of customers that had downloaded from an illegal source in the preceding half year increased from 22.5% three months after the blocking to 25.2% ten months after the intervention. For both sets of ISP's, also the percentage of customers that downloaded very recently (in the past week or past week-month) increased. Thus, though a small share of downloaders report a decrease in their downloading activities after the blocking, this effect is not reflected in the overall numbers, possibly because there are other consumers who have started downloading from illegal sources.

Table 4 Downloading & streaming from illegal sources per blocking situation (1st & 2nd measurement, split sample)

	UPC, KPN, Tele2 & T-Mobile		Ziggo & XS4ALL	
	No blocking, *t*=0	**Blocking, *t*=6**	**Blocking, *t*=3**	**Blocking, *t*=10**
past 6 months	**15.7%**	**18.4%**	**22.5%**	**25.2%**
< week	6.0%	8.1%	7.8%	11.3%
week-month	3.7%	4.2%	6.8%	4.1%
1-3 months	3.7%	3.4%	6.0%	5.4%
3-6 months	2.3%	2.7%	1.9%	4.4%
6-12 months	2.8%	3.3%	3.0%	3.5%
> a year ago	9.5%	12.0%	13.2%	15.1%
never	72.1%	66.4%	61.3%	56.3%
χ^2	43.6		942.8	
(*p*-value)	<0.001		<.001	

5. Bittorent monitoring

5.1 Monitoring tools used and torrent samples

The initial monitoring started as an ad hoc way to chart effects of the initial blocking in Ziggo and XS4ALL. This monitor was put together quickly to be able to measure shortly after this intervention, and used a programmable interface of the popular Transmission client. Using a script, a torrent magnet link was added programmatically, and then every minute the list of peers the client was interacting with was requested and stored. The default limit of peers to interact with was raised to 1024 (the maximum allowed value) to record as many peers as possible. This methodology recorded activity on several different magnet links at several different times over the period of a few days.

The above method of recording peers yielded a list of IP addresses for each of the torrents. To convert this list to usable information, several different sources were used. First the Team Cymru IP-to-ASN mapping service (www.team-cymru.org/Services/ip-to-asn.html) was used to record which ISP the IP address came from. This service has combined all the IP address registrations from the Internet Registries. Unfortunately, the country data from these registries is not always up-to-date or accurate. Many Internet providers also have IP subnets registered with location as "EU". To further pin down the location, the MaxMind GeoIP database was used (www.maxmind.com/en/country). In case of conflicting results the latter was preferred.

Using the above method measurements were performed in April 2012, when only Ziggo and XS4ALL had been summoned to block access to TBP. A set of 60 torrents (with Dutch subtitles or Dutch spoken) was selected in this measurements and the number of Dutch peers and their ISPs were measured. 5 torrents that yielded less than 50 Dutch peers were removed from the data set, resulting in a list of 55 torrent files and a total of 12902 Dutch peers (See Table 6 in the Appendix).

A second measurement was performed in May 2012, directly after the second ruling but before the other ISPs actually had to enact it.[4] This time, 20 Dutch spoken or subtitled torrents were selected. After removal of 3 torrents with less than 50 Dutch peers, this resulted in a set of 17 torrents and a total of 2445 Dutch peers (See Table 7 in the Appendix).

While the above methodology provides a valid insight into the Bittorrent activity, the monitoring could be improved in terms of effectiveness in recording peer activity; such an improved technique was used in the third measurement.. The monitor described above is an active client, from which data are exported. For the third measurement, a new monitor was designed from scratch using Python and the libtorrent library. The libtorrent library (www.rasterbar.com/products/libtorrent/) implements the Bittorrent protocol, and is used in many Bittorrent clients. The new monitor uses the library to appear as an active client, but is configured such that it does not download any files (and thus also can not upload). The monitor joins the torrent swarm and records activity, and as often as is allowed the monitor requests a new set of peers from the tracker, and records all these IP addresses.

The above monitor is a stand-alone process, which submits all its recorded peers to a database server, where they are stored and later processed. Each of the peer records contains the IP address, the torrent it was recorded in, and the time it was recorded. During February 2013 the server and three monitors in different locations on the Internet ran and recorded activity in 10 torrent swarms over a period of two weeks. The new monitoring configuration proved to be much more effective, and recorded over 2 million peer activity records during this period. After recording the analysis was performed with the same methodology as before, using the Team Cymru IP-to-ASN mapping and the MaxMind GeoIP database. Table 8 in the Appendix lists these 10 Dutch spoken or Dutch subtitled torrents, that yielded a total of 98807 Dutch peers.

5.2 Results

The Dutch peers in each measurement were attributed to a total of 137 ISPs (112 of which recorded less than 50 peers over all three measurements). The IPSs of interest are the ones that were affected by either the first (Ziggo and XS4ALL) or the second ruling (UPC, KPN, T-Mobile, and Tele2 including its subsidiary Versatel), and therefore had to block access to TPB since February or May 2012 respectively. Together, they represent 85-87% of the Dutch peers in the sample of each measurement. Some other ISPs also block access to TPB since the second ruling, even though the ruling does not apply to them. Others may or may not be entitled to the ruling as subsidiaries or the IPSs in the ruling. To prevent errors, the present analysis focuses on the ISPs explicitly addressed in either of the two rulings (including Versatel).

Table 5 presents the distribution of Dutch peers amongst the ISPs of interest for the three consecutive measurements. Overall the changes in the distribution are small, which implies limited effects of the intervention on BitTorrent file sharing.

The market share of the ISPs affected by the 1st ruling increased by a small but significant amount between April and May 2012, while the market share of the ISPs affected by the 2nd ruling decreased. This could be the sum effect of two mechanisms: First, due to the attention the 2nd ruling received in the media subscribers of the IPSs affected by it may anticipate the blocking (anticipation or awareness effect, as Danaher et al. (2012) suggest with respect to the HADOPI legislation). Second, subscribers of the ISPs affected by the 1st ruling may become increasingly familiar with platforms other than TPB for finding torrent trackers (learning effect).

Between May 2012 and February 2013, the market share of the ISPs affected by the 1st ruling decreased again while the market share of the ISPs affected by the 2nd ruling increased, albeit not back to the April 2012 level. A likely explanation for this is a learning effect for the subscribers affected by the 2nd ruling.

[4] The Ruling ordered the blocking to be enacted within ten working days, i.e. no later than May 24th, while measurements were done at May 13th, 14th and 22nd.

Table 5 Distribution of peers amongst ISPs affected by 1st or 2nd ruling

ISP	April 2012	May 2012	February 2013
ZIGGO	31.9%	36.6%	34.3%
XS4ALL-NL	2.5%	2.0%	2.8%
KPN	32.2%	27.3%	33.5%
UPC	25.4%	27.5%	22.3%
Tele2 + VERSATEL	7.9%	6.7%	6.6%
T-Mobile	0.1%	0.0%	0.4%
Total 1st ruling	*34.4%*	*38.6%*	*37.1%*
Total 2nd ruling	*65.6%*	*61.4%*	*62.9%*
χ^2		*16.6*	*74.8*
(*p*-value)		*(<0.001)*	*(<0.001)*
Relevant Dutch peers	11112	2202	84386

6. Conclusions

Following rulings from a Dutch court, the major Dutch Internet Service Providers have blocked access to The Pirate Bay (TPB) since February or May 2012. As a result, more than 80% of Dutch Internet subscribers can no longer (directly) access this popular website for the unauthorised exchange of copyright protected material. This paper presents two empirical methods to assess the effects of this intervention on downloading of content from illegal sources, possibly in favour of legal channel (physical formats or paid for downloads and streaming).

Two consecutive consumer surveys provide insight in consumers' reactions to the intervention after 3, 6 and 10 months, as well as the reaction they expect shortly before blocking. First of all, the intervention can only affect consumers who (intend to) download from illegal sources, about 24% over the past six month or 27-28% over the past year. For this segment of the population, it is found that a large majority (70-72%) are non-responsive to blocking access to TPB. This is significantly more than consumers expect in advance of the blocking. About half of those who report a response to the intervention state they download less while a third state they stopped downloading altogether. The rest claim to download more as a result of the intervention.

This would suggest a small negative effect of the intervention on the percentage of the population who download copyright protected content from illegal sources. However, no such effect is found. Instead, the percentage who downloaded films & series, games and books from illegal sources in the preceding six month has increased between May and November-December 2012, while the percentage downloading music from illegal sources remained constant. This implies that any behavioural change in response to blocking access to TPB has had no lasting net impact on the overall number of downloaders from illegal sources, as people learn to use alternatives to TBP.

These findings are corroborated by those of a second method presented to assess the impact of blocking access to TBP: BitTorrent monitoring. The two measurement techniques provide complementary insights. In contrast to surveys, the second technique measures observed rather than reported behaviour, but with the short-coming that it cannot observe consumers circumventing the blocking by downloading via VPN connections or by resorting to newsgroups and cyberlockers.

BitTorrent monitoring reveals only small changes in the distribution of Dutch peers over the different ISPs for the three measurements, which implies limited effects of the intervention on BitTorrent file sharing. For the

small changes observed over the measurements it is impossible to disentangle between the different and opposing effects of blocking access to TPB over time: When the intervention is announced consumers may start downloading less as a result of an “anticipation” or “education effect”. The decrease may further progress when the blocking is effectuated (“blocking effect”). Over time consumers may learn how to circumvent the blocking (“learning effect”) and education effects may wear off. The fact that the consumer surveys observe less downloading decreases compared to consumers’ initial expectations, and the BitTorrent monitoring observing a decrease in market share of the ISPs affected by the first ruling that weakens over time, indicates that the market has returned towards the earlier equilibrium, with only very small structural effects. This is in line with a tendency found in the literature, that the effect of legal action against file sharing often has an immediate effect which tends to fade out after a period of typically six months, as illegal supply and demand find other places to meet.

This paper studies the potential of blocking access of the Pirate Bay as an intervention to withhold consumers from downloading from illegal sources, and hopefully more intensively make use of legal channels. Making use of two different research methods, consumer surveys and BitTorrent Monitoring, we do not find strong indications of the long-lasting effectiveness of such an approach in preventing consumers from making use of illegal sources. Therefore it is unlikely that the increased use of legal channels, as we found for music, was caused by this intervention.

Appendix

Table 6 Sample of torrent files and Dutch peers, 1st measurement April 2012

Torrent	Dutch peers
21 Jump Street (2012) TS NL subs DutchReleaseTeam	170
21 Jump Street(2012)Ts NL subs NLT(Divx)	68
21.Jump.Street.2012.TS2DVD.DD2.0.NL.Subs	137
Act Of Valor 2012 HDRip Xvid nl subs DutchReleaseTeam	81
Act.of.Valor.2012.HDRip2DVD.DD5.1.NL.Subs	243
All Stars 2 Old Stars (2011) DVDRip NL gesproken DutchReleaseTeam	304
Bad Teacher (2011) TS XviD DutchReleaseTeam (dutch subs nl)	168
Big Bang Theory S05E21 HDTV - NL Subs - StRaLa	69
Cars 2 (2011) DVDRip NL gesproken DutchReleaseTeam	159
Chronicle (2012) TS NL subs DutchReleaseTeam	324
De Bende van Oss (2011) DVDRip Nl subs DutchReleaseTeam	234
De Gelaarsde Kat (2011) DVDR(xvid) NL Gespr DMT	529
De President (2011) DVDRip NL gesproken DutchReleaseTeam	147
Dr. Seuss The Lorax (2012) TS(xvid) NL Subs DMT	90
Game of Thrones. Seizoen2 Afl 02 HDTV (XviD) NL Subs DMT	199
Game.of.Thrones.S02E01.720p.HDTV.x264-IMMERSE.NL.Subs	120
Ghost.Rider.Spirit.of.Vengeance.2012.HDRip.Cropped.NL.Subs	169
Gooische Vrouwen (2011) DvdRip XviD DutchReleaseTeam (dutch spoken nl)	146
Hasta la Vista! (2011) DVDRip NL subs DutchReleaseTeam	64
Haywire (2011) R5 NL subs DutchReleaseTeam	589
Intouchables 2011 DvdRip Xvid nl subs DutchReleaseTeam	605
Jack and Jill (2011) BRRip NL subs DutchReleaseTeam	213
John Carter (2011) TS NL subs DutchReleaseTeam	144
John.Carter.2012.TS2DVD.DD2.0.NL.Subs	318
John.Carter.2012.TS2DVD.NTSC.DD2.0.NL.Subs	302
Killer Elite (2011) HDRip NL subs DutchReleaseTeam [Actie&Thriller]	153
Kung Fu Panda 2 (2011) DVDRip NL gesproken DutchReleaseTeam [Animatie&Actie]	148
Loft (2010) DVDRip DutchReleaseTeam(NL gesproken)	121
Man on a Ledge (2012) R5 NL subs DutchReleaseTeam	155
Man.on.a.Ledge.2012.R5.PAL.DD5.1.NL.Subs	282
Mission.Impossible.Ghost.Protocol.2011.HDRip.DD5.1.NL.Subs	217
New Kids Nitro (2011) CAM Nl gesproken DutchReleaseTeam	292
Nova Zembla (2011) DVDRip NL gesproken DutchReleaseTeam	1075
Nova Zembla (2011) DVDR(xvid) NL Gespr DMT	190
Nova.Zembla.2011.PAL.Retail.DD5.1.NL.Subs	426
Rabat (2011) DVDRip NL gesproken DutchReleaseTeam [Roadmovie]	191
Razend (2011) DVDRip NL gesproken DutchReleaseTeam	115
Safe House (2012) TS NL subs DutchReleaseTeam	340
Seven Below (2012) BRRip(xvid) NL Subs DMT	236
The Hangover Part II (2011) DVDRip NL subs DutchReleaseTeam [Komedie]	135
The Help (2011) DVDRip NL subs DutchReleaseTeam	146
The Hunger Games (2012) TS Versie 2(xvid) NL Subs DMT	332
The Hunger Games (2012) TS(xvid) NL Subs DMT	92
The Hunger Games (2012) TS2DVD V2 DD5.1 NL Subs TBS	88
The Hunger Games 2012 TS Xvid nl subs DutchReleaseTeam	237
The Woman In Black (2011) DVDSCR NL subs DutchReleaseTeam	151
The.Darkest.Hour.3D.2011.1080p.AC3.DTS.NL.Subs.Half.SBS	90
The.Hunger.Games.2012.TS2DVD.DD2.0.NL.Subs	313
The.Hunger.Games.2012.TS2DVD.V2.DD5.1.NL.Subs	436
This Means War (2012) TS NL subs DutchReleaseTeam	152
Titanic(1997)DVDRip NL subs NLT(Divx)	166
War Horse (2011) DVDSCR Nl subs DutchReleaseTeam	146
Wrath of the Titans (2012) TS NL subs DutchReleaseTeam	370
Wrath of the Titans (2012) TS(xvid) NL Subs DMT	211
Wrath.of.the.Titans.2012.TS2DVD.PAL.DD2.0.NL.Subs	304
TOTAL	**12903**

Table 7 Sample of torrent files and Dutch peers, 2nd measurement May 2012

Torrent	Dutch peers
American.Reunion.2012.TS2DVD.DD5.1.NL.Subs	87
Chronicle.2012.D.C.1080p.MKV.x264.AC3.DTS.Eng.NL.Subs	154
Dolfje Weerwolfje (2011) DVDRip NL gesproken DutchReleaseTeam	188
Dr. Seuss The Lorax (2012) TS(xvid) NL Subs DMT	107
Game Of Thrones S02E06 720P NLSubs Disnoxxio	112
Gers Pardoel - Deze Wereld Is Van Jou (2011) DutchReleaseTeam	131
Get.the.Gringo.2012.HDTVRip.PAL.DD5.1.NL.Subs	162
Intouchables 2011 DvdRip Xvid nl subs DutchReleaseTeam	236
New Kids Nitro (2011) DVDRip NL gesproken DutchReleaseTeam	225
Nova Zembla (2011) DVDRip NL gesproken DutchReleaseTeam	168
Project X (2012) TS NL subs DutchReleaseTeam	119
Sherlock Holmes A Game of Shadows (2011)720p BRRip Nl-ENG subs DutchReleaseTeam	173
The Devil Inside (2012) DVDRip NL subs DutchReleaseTeam	166
The Hunger Games (2012) TS Versie 2(xvid) NL Subs DMT	110
The Vow (2012) BRRip NL subs DutchReleaseTeam	194
The.Cabin.in.the.Woods.2012.TS2DVD.AC32.0.NL.Subs	121
Wrath of the Titans (2012) TS(xvid) NL Subs DMT	92
TOTAL	**2545**

Table 8 Sample of torrent files and Dutch peers, 3st measurement February 2013

Torrent	Dutch peers
Alleen Maar Nette Mensen (2012) DVDrip (xvid) NL Gespr. DMT	21110
Django Unchained (2012) DVDSCR NL subs DutchReleaseTeam	19653
Django Unchained (2012) NTSC DVDScr DD5.1 NL Subs	6950
Hansel and Gretel Witch Hunters (2013) Cam2DVD DD2.0 NL Subs	3326
Hansel and Gretel Witch Hunters (2013) TS2DVD DD2.0 NL Subs	6947
Jack Reacher (2012) TS2DVD NTSC DD2.0 NL Subs	4651
Les Miserables (2012) DVDScr NTSC DD5.1 NL Subs	4550
Mees Kees (2012) DVDRip NL gesproken DutchReleaseTeam	13499
The Hobbit (2012) DVDSCR NL subs DutchReleaseTeam	10656
The Hobbit An Unexpected Journey (2012) DVDSCr NL Subs	7465
TOTAL	**98807**

Acknowledgements

The survey presented here was part of a larger research project conducted at the initiative and under the authority of IViR and CentERdata, with partial financial support from the Netherlands Ministry of Education, Culture and Science, Ziggo, KPN, XS4ALL, DELTA, CAIW, the Royal Dutch Book Trade Association (KVB) and SOS Internet. Funding sources had no involvement in the analysis presented here.

References

Adermon, A., & Liang, C. (2011). Piracy, music, and movies: A natural experiment. *IFN Working Paper no. 854,* (January 31, 2011)

Bauer, K., Mccoy, D., Grunwald, D., & Sicker, D. (2009). Bitstalker: Accurately and efficiently monitoring bittorrent traffic. *Information Forensics and Security, 2009. WIFS 2009. First IEEE International Workshop on*. IEEE, 2009.

Bhattacharjee, S., Gopal, R. D., Lertwachara, K., & Marsden, J. R. (2006). Impact of legal threats on online music sharing activity: An analysis of music industry legal actions. *Journal of Law and Economics, 49*(1), 91-114. doi:http://www.journals.uchicago.edu/JLE/home.html

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.

Chothia, T., Cova, M., Novakovic, C., & Toro, C. (2013). The Unbearable Lightness of Monitoring: Direct Monitoring in BitTorrent. *Security and Privacy in Communication Networks*. Springer Berlin Heidelberg, 2013. 185-202. Retrieved from http://link.springer.com/chapter/10.1007/978-3-642-36883-7_12

Christin, N., Weigend, A. S., & Chuang, J. (2005). Content availability, pollution and poisoning in file sharing peer-to-peer networks. *Proc. 6th ACM Conf. Electronic Commerce,* New York. 68-69-77.

Danaher, B., & Smith, M. D. (2013). Gone in 60 seconds: The impact of the megaupload shutdown on movie sales.(March 6, 2013)

Danaher, B., Dhanasobhon, S., Smith, M. D., & Telang, R. (2010). Converting pirates without cannibalizing purchasers: The impact of digital distribution on physical sales and internet piracy. *Marketing Science, 29*(6), 1138-1151. doi:http://mktsci.journal.informs.org/archive/

Danaher, B., Smith, M. D., Telang, R., & Chen, S. (2012). The effect of graduated response anti-piracy laws on music sales: Evidence from a natural experiment in france. *Journal of Industrial Economics, Forthcoming*

Hennig-Thurau, T., Henning, V., & Sattler, H. (2007). Consumer file sharing of motion pictures. *Journal of Marketing, 71*(October), 1-18.

Hoßfeld, T., Hock, D., Oechsner, S., Lehrieder, F., Despotovic, Z., & Kellerer, W. (2010). University of Würzburg Institute of Computer Science Research Report Series Measurement of BitTorrent Swarms and their AS Topologies.

Junemann, K., & Andelfinger, P. (2010). Bitmon: A tool for automated monitoring of the bittorrent dht. Peer-to-Peer …, 6–7. Retrieved from http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=5569978

Kryczka, M., Cuevas, R., Guerrero, C., Azcorra, A., & Cuevas, A. (2011). Measuring the bittorrent ecosystem: Techniques, tips, and tricks. *IEEE Communications Magazine*, 49(9), 144–152. doi:10.1109/MCOM.2011.6011746

Lauinger, T., Szydlowski, M., Onarlioglu, K., Wondracek, G., Kirda, E., & Kruegel, C. (2013). Clickonomics: Determining the effect of anti-piracy measures for one-click hosting. *NDSS Symposium 2013,* San Diego, CA.

Liebowitz, S. J. (2006). File sharing: Creative distruction of just plain destruction. *Journal of Law and Economics, XLIX*(April 2006), 1-27.

LJN: BV0549; 374634 / HA ZA 10-3184, 2012, January 11).

LJN: BW5387; 413085 / KG ZA 12-156, 2012, May 10).

Oberholzer-Gee, F., & Strumpf, K. (2007). The effect of file sharing on record sales: An emperical analysis. *Journal of Political Economy, 115*(1), 1-42.

Peitz, M., & Waelbroeck, P. (2004). The effect of internet piracy on music sales: Cross-section evidence. *Review of Economic Research on Copyright Issues, 1*(2), 71-79.

Peukert, C., Claussen, J., & Kretschmer, T. (2013). Piracy and movie revenues: Evidence from megaupload. A tale of a long tail?(August 12, 2013 (Preliminary))

Piatek, M., Kohno, T., & Krishnamurthy, A. (2008). Challenges and Directions for Monitoring P2P File Sharing Networks, Or, Why My Printer Received a DMCA Takedown Notice (pp. 1–7). Retrieved from http://www.usenix.org/event/hotsec08/tech/full_papers/piatek/piatek_html/

Rob, R., & Waldfogel, J. (2006). Piracy on the high C's: Music downloading, sales displacement, and social welfare in a sample of college students. *Journal of Law and Economics, XLIX*(April 2006), 29-62.

Rob, R., & Waltfogel, J. (2007). Piracy on the silver screen. *The Journal of Industrial Economics, LV*(3), 379-395.

Siganos, G., Pujol, J., & Rodriguez, P. (2009). Monitoring the bittorrent monitors: A bird's eye view. *Passive and Active Network Measurement*. Springer Berlin Heidelberg, 2009. 175-184. Retrieved from http://link.springer.com/chapter/10.1007/978-3-642-00975-4_18

Sinha, R. K., Machado, F. S., & Sellman, C. (2010). Don't think twice, it's all right: Music piracy and pricing in a DRM-free environment. *Journal of Marketing, 74*(2), 40-54. doi:10.1509/jmkg.74.2.40

Smith, M. D., & Telang, R. (2012). Assessing the academic literature regarding the impact of media piracy on sales. [http://ssrn.com/abstract=2132153] *Available at SSRN,* oi:http://dx.doi.org/10.2139/ssrn.2132153

Toro, C. A. G., & Chothia, T. (2009). Analysis of BitTorrent Peers' Behavior and Monitoring Trends (Category: Law and security). http://www.kaspersky.com/images/camilo_andrys_gonzalez_toro-10-75858.pdf

Van der Ham, J., Rood, H., Dumitru, C., Koning, R., Sijm, N. & De Laat, C. (2012). Review en Herhaling BREIN steekproeven 7 - 9 april 2012, Technical report UVA-SNE-2012-01, http://staff.science.uva.nl/~vdham/research/publications/dutchpirate.pdf

Vernik, D. A., Purohit, D., & Desai, P. S. (2011). Music downloads and the flip side of digital rights management. *Marketing Science, 30*(6), 1011-1027. doi:http://mktsci.journal.informs.org/archive/

Wolchok, S., & Halderman, J. (2010). Crawling BitTorrent DHTs for fun and profit."b *Proc. of WOOT (Washington, DC, USA, 2010)* (2010). Retrieved from http://www.usenix.org/event/woot10/tech/full_papers/Wolchok.pdf

Zentner, A. (2006). Measuring the effect of file sharing on music purchases. *Journal of Law and Economics, XLIX*(April 2006), 63-90.