

The Economics of Digital Piracy and
CustosTech

custostech

Executive Summary

Custos Media Technologies (CustosTech) provides a novel approach to fighting digital piracy. While the technology itself is cutting edge, the true innovation of the technology is a behavioural one: the incentive structure of the pirating community is warped, leading to a discontinuation of piracy. To understand the innovation, this white paper sets out to explain the piracy ecosystem within which the technology will be effective.

The consumer and producer welfare functions are considered from a theoretical point of view. These functions explain the incentive of consumers to choose to pirate movies: consumers who expect a larger net-gain to their utility from piracy will opt to do so. This net gain is determined by the relative valuations of legal to illegal copies, and the relative cost of use. Staying with theoretical considerations, the options facing producers to limit piracy are investigated: pricing, protection, and value-adding.

This theoretical framework is then used to understand the incentive structures governing the players in the ecosystem: hosts, uploaders and downloaders. Hosts are found to be almost exclusively profit-motivated, with uploaders motivated by profit or altruism. Downloaders are split into four categories, depending on their main motivation or justification for pirating. An analysis of incumbent anti-piracy technologies shows that these technologies are almost all ineffective, sometimes even acting to increase the preference for piracy.

With this background, the need for a new solution becomes all too apparent. The CustosTech technology is considered within the piracy framework, and the technological and economic effects explained.

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The Economics of Digital Piracy

Welfare

The economics of digital piracy presents some intriguing questions that have been illuminated by an abundance of theoretical and empirical studies that will be studied here. The most fundamental question in this field is the welfare effects of said piracy. While academic studies frequently focus on the effects of digital piracy on society, a more tangible approach is to analyse the welfare effects on the consumer and producer directly.

A consumer's welfare increases when he or she is entertained or enjoys something, and decreases with inconvenience or effort. While modern companies focus on a variety of very important goals, such as their effect on the environment, brand management and being an employer of choice, these goals are all instrumental in the essential objective of any company: increasing and maintaining the profitability of the company to increase its value to shareholders. In a free-market system, a firm accrues profit by being paid for increasing the welfare of the consumer, hence these two welfare effects are undeniably interconnected.

Consumer Welfare

Given two options, a consumer will typically choose to buy the option that is expected to increase his or her net welfare the most. Both options will give the consumer some utility from use or consumption, and some disutility from paying for it and from inconvenience of use. A consumer will know the listed price of a good before the purchase, but will make extrapolations about the utility and disutility of use, based on previous experience and various external signals. These signals include things such as marketing, signals about the previous experience of others and sampling.

Illegal copies of movies typically have lower listed prices than legal copies. The following question then arises: why would anyone opt to buy the legal copy? To a law-abiding citizen,

this might seem like a nonsensical question, but most people do break the law on a regular basis - whether by pirating movies, speeding, jaywalking or littering. Even singing "Happy Birthday" in public without permission from Time Warner is copyright infringement¹. From an economics point of view, people choose to abide by the law because the expected net utility from breaking the law is seen as less than from not breaking it. If a person is in a hurry on an empty road, the perceived benefit of exceeding the speed limit slightly might be deemed higher than the expected disutility of being caught, given the low probability thereof.

If there was perfect anti-piracy enforcement and the fine for infringing was more than the total cost of a legal movie, it is reasonable to assume that there would be no piracy. If there was no enforcement, however, it would not mean that everyone would only opt for illegal copies. The disutility from feeling guilty about doing something wrong or unfair is very real. The morality of an individual is influenced by experience - anti-piracy media campaigns attempt to instil the idea that piracy is wrong, but it is hard to compete with the 'everyone is doing it'-argument.

On the other side of the equation, the value of a legal copy might be perceived to be higher than that of the illegal one. Consumers who weight quality heavily will value the higher quality legal copy more. Legal copies can also have value-added benefits, such as access to online content or free merchandise. Timeliness of access is also important to consumers, as discussed below.

Producer Welfare

While short-term profits are good to have, the main focus for a company is maximising long-term profit. For any producer, profit is a function of selling-price per product, number of products sold, fixed input cost and variable input cost. Digital goods, such as movies, are a specific case where the cost of reproducing each movie, which constitutes the variable input cost (sometimes called the marginal cost of production), is close to zero. An economic analysis of this situation presents an interesting case: in a perfectly competitive economy, the market price for a good is

typically forced down to the marginal cost of production, which means profits approach zero.

Since there is no natural cost to copying digital goods, the artificial protection of monopoly rights of production becomes critical. The production of movies is risky in terms of returns on investment. Some expected economic profit is needed to compensate for this risk, therefore, so the investments to cover the fixed input costs can be procured. This is the role of copyright and other intellectual property rights: by creating an artificial monopoly of production, the producer can ask a price higher than the marginal cost of production.

Piracy is the infringement of this right. In the short term, this only affects the producer in the form of reduced income. In the long term, the consumer can be affected if investment to create new movies is reduced.

Positive Effects of Piracy

Any discussion about the economics of digital piracy will not be complete without an analysis of the reported positive effects of piracy. The two main channels typically discussed are network externalities and sampling. Both of these effects are hypothesised to increase the value of the legal copies.

Network Effect

Demand-side economies of scale, such as network externalities, are positive feedback loops associated with the size of a network. Social networks, such as Twitter, Facebook or even the landline network, are prime cases where network externalities play a major role: the more people you can contact via landline, for example, the more value it has as a communications device.

In terms of piracy, the effect works a bit less directly. People that have seen a movie and liked it can add to its marketing hype. For the network externality to be realised, a critical mass is needed: when a movie has enough fans they can drive the online recommendations up; people discussing the movie on forums and social media add to the

buzz, which can be identified as a form of earned marketing.

King and Lampe² show that this network effect can be implemented far more effectively using price discrimination. While some positive network externalities might exist, piracy remains a very blunt instrument to achieve it.

Frequently, online streaming services, such as Netflix, are not accessible in developing countries. Typically, the market in these countries is not developed enough to be expected to make the business model profitable. While the bandwidth in these countries is not always suitable for streaming services, it is sufficient for torrenting movies. Individuals without access to legal copies of movies opt to download pirated copies and distribute it within their local networks, therefore. These individuals are then added to the global network, thereby increasing the buzz.

Sampling

More directly, pirated copies can help potential consumers to get a clearer signal about the value of the movie to them. It is often argued that individuals who have downloaded an illegal copy would buy a legal copy if they enjoy it. This conjecture is problematic for the movie industry specifically, since movies are typically only watched once. That said, a recent study³ by Kantar Media found that there was a positive correlation between the consumption of illegal content and the consumption of legal content. Once again, there are specific cases where this channel is more relevant, typically where the value of the legal copy is notably higher than the value of the illegal one.

Time-Value in Piracy

Movie releases are windowed to ensure that different instances of a movie do not compete with each other. The marketing of a new movie is focused on the first window, called the theatrical window. The first weekend of release is not only critical for immediate revenues, but also to establish earned marketing through the network effect, once paid marketing diminishes. The biggest box office opening weekend earners are usually from known

franchises, as can be seen below⁴ in the list of top opening weekends.

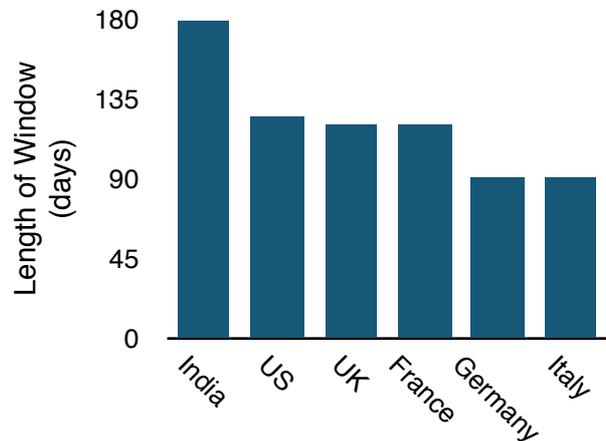
The income received while on the cinema circuit diminishes sharply over time, with 95%⁵ of all cinema revenue being accrued within the first 17 days after release for all but 2% of movies. The cinema window continues shrinking (more than 25% between 2000 and 2011⁶), to the dismay of cinema owners.

After the cinema circuit, the movie will go through various other release windows. Typically, the movie will enter the airline viewing window, then home video, pay-per-view/VOD, pay-TV, and eventually free broadcast.

Movie	Year	Opening Weekend Box Office	% of Total
Marvel's The Avengers	2012	\$207M	33.3
Iron Man	2013	\$174M	42.6
Harry Potter and the Deathly Hallows Part 2	2011	\$169M	44.4
The Dark Knight Rises	2012	\$160M	35.9
The Dark Knight	2008	\$158M	29.7
The Hunger Games: Catching Fire	2013	\$158M	37.2
The Hunger Games	2013	\$152M	37.4
Spider-Man	2007	\$151M	44.9
The Twilight Saga: New Moon	2009	\$142M	48.2
The Twilight Saga: Breaking Dawn Part 2	2012	\$141M	48.3

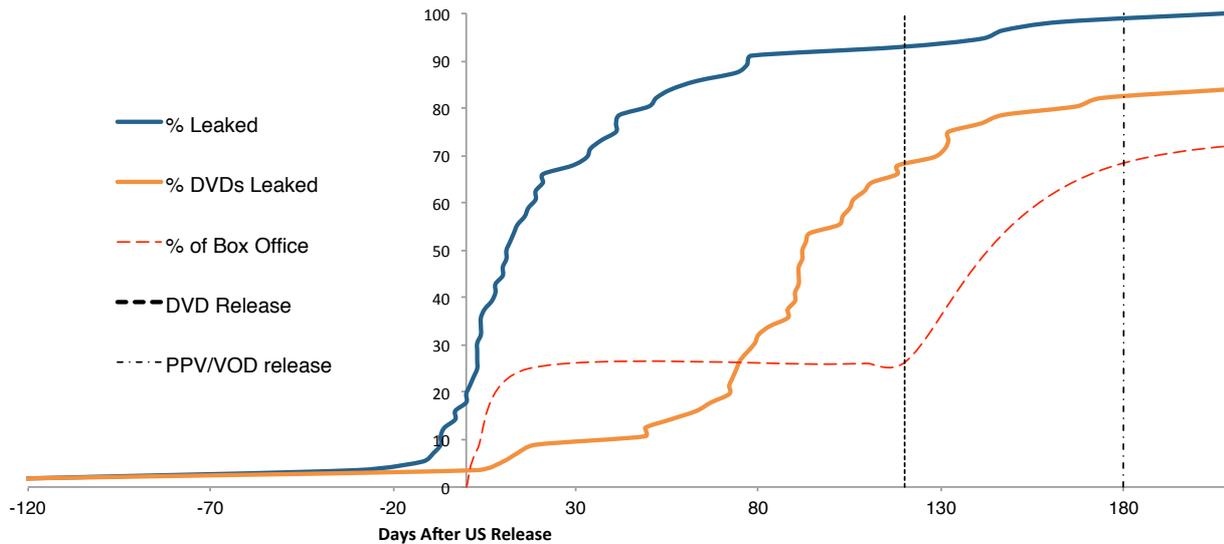
Window	Window Length
Theatrical	0-3 Months
Airlines	3-4 Months
Home Video	3-6 Months
PPV/VOD	6-8 Months
Pay TV	12+ Months
Free TV	27+ Months

This windowing becomes even more complicated when international releases are also taken into account. Countries have varying window-lengths, as shown below⁷, and different release dates, which means that pirated content can frequently cut into the high-profit windows in certain countries.



Following the marketing of the movie, the perceived value of both the legal and illegal copies of movies increases. This means that there is a high demand for pirated content by the consumers who opt for it.

All Oscar-nominated films⁸ from 2013 and 2014 were leaked in less than 208 days after their release. Some, such as The Grandmaster (-122 days), Les Miserables (-30 days), Zero Dark Thirty (-7 days), and Marvel's The Avengers (-7 days) were available before the official US release date. On average, the movies were leaked within 27 days after release, and the ripped DVD, on average, within 88 days after release. Within 11 days after release, a full half of the movies were leaked. By day 42, 75% of all the movies were leaked.



With the studios relying on more than 74% of the revenue per movie to be captured after this date, piracy can have very detrimental effects on the bottom-line.

Pricing, Protection and Value

Dual-Market View

In the dual-market view of piracy, consumers of movies are considered to be distributed on a spectrum with regards to how they value legal copies in relation to illegal copies. On the one end, there are individuals who do not attach any weight to the legality or quality of legal copies or who do not have access to legal copies. On the other end are the individuals who attach a great weight to having the legal copies; for the increased quality, and/or for moral or legal reasons.

The producer has some control over three variables, which it can manipulate in order to achieve maximum profitability: the price of the legal good, the 'price' of the illegal good and the value of the legal good. It has little or no control over the value of the illegal good. The producer affects the aforementioned three variables through the listed price of legal copies, protection against illegal copies and value-adding to legal copies.

Price

With the current revenue model, setting the price to zero would mean a loss to the producer. Setting the price too high, however, will also not maximise profits, since less people will choose to buy the product. The producers face what is called a Laffer Curve:



At the lowest price, everyone will buy the product. As the price increases, some individuals will opt for the illegal copy. At some point, the price times quantity sold is at a maximum, which means that profit is maximised.

Protection

There are various techniques being used in an attempt to increase the price of illegal copies, the main categories being: perceived prosecution, cost-of-search and time delay.

Perceived prosecution is the probability-weighted expected disutility from being caught, as discussed above. Media attention of the persecution of infringers can make possible infringers overestimate their chances of being caught, due to the availability bias.

Take-down notices act to increase the cost of search of illegal content. If content is taken down from popular sites, the potential pirate needs invest time and effort to find an available copy.

Digital Rights Management (DRM) typically acts to increase the time delay between legal release and illegal availability. Making it hard to create an illegal copy of a movie potentially increases this delay.

Value-Adding

Artists, such as Trent Reznor from Nine Inch Nails, have used value-adding as the sole piracy mitigation technique. Nine Inch Nails released two albums for free download under a Creative Commons licence. The production cost was covered by the sale of deluxe, limited edition CD's and vinyls as well as merchandise.

Recently, production companies have attempted to add value to DVD's by giving free access to online content. Other examples include bonus features, subtitles, and better quality video; but pirated copies can have these additions if the demand exists.

Incentive Structures

In the pirating community, there are three possibly overlapping roles that a person can fulfil: uploader, downloader and host. The advertising side of the ecosystem is not studied here. Each of these roles has goals that it acts to maximise.

Portals and Hosts

There are three types of hosting sites: BitTorrent trackers, file hosting sites and streaming services. For each of these categories, services that aggregate content from various sites exist⁹.

Type	Page-views per year	Example	Example Aggregator
BitTorrent Tracker	7,4B, 30.6% increase	The Pirate Bay	Kickass-torrent
File Hosting	2.3B, 40.6% increase	Mega-Upload	BeeMP3
Streaming	4.2B, 34.3% increase	Click to view	Alluc

There are legal alternatives to all of these categories, and content on these sites are not necessarily illegal. There are also some cases of infringing content being distributed on the Usenet, but the volumes here are extremely small.

Most of these sites have ad-based revenue models. Typically, these sites rely on community uploaders for content. The almost ubiquitous argument defending their role in infringement is that they merely host the content or trackers to the content, and hence cannot be held responsible for the infringement.

While sites like The Pirate Bay claim to be non-profit, most of the hosts are profit-driven. With the ad-based model, their goal is site traffic. Some hosts ask for donations from users, or also have paid premium accounts and/or affiliate programs. Having more hosted media on their sites drives traffic. This creates a large barrier to entry for new hosts, making most new hosts opt for aggregation models.

New, popular content drives traffic to hosting sites, but gets the most attention from anti-piracy groups. Having the first copy of a movie drives traffic to a site, as does hosting the first non-camera rip copy and the first HD copy. Hosting sites are therefore forced to protect uploaders from prosecution by ensuring uploaders' anonymity and by not cooperating with authorities. The Pirate Bay has a specific page¹⁰ to ridicule legal attempts to prosecute them and to explain that no torrent has ever or will ever be taken down. The same site

Reason for Piracy	Justifying	Digital	Free	Ambiguous
I've already paid to see it\them at the cinema\in concert etc	84%	14%	2%	3%
It's easier\convenient	74%	75%	51%	39%
It means I can try something before I buy it	73%	58%	21%	19%
It's free	71%	80%	100%	3%
It's quick	68%	69%	55%	28%
I already owned content in another format	64%	18%	4%	14%
I think legal content is too expensive	55%	53%	14%	6%
I can't afford to pay	47%	50%	17%	8%
I already spend enough on content	44%	21%	6%	9%
The Industry makes too much money	37%	32%	6%	9%
Because I can	33%	63%	17%	14%
The files I want are not available on legal services	28%	15%	9%	11%
I don't think I should have to pay for content online?	21%	26%	5%	3%
I don't want to wait for content to become available on legal services	18%	27%	9%	8%
No one ever gets caught	13%	27%	2%	4%
It's what my friends or family do	9%	88%	1%	1%
No one suffers	2%	29%	0%	2%

created a custom web browser¹¹ to circumvent the blocking of the site. The sites also give suggestions to downloaders on how not to get caught, such as downloading from a good torrent client, using anonymous downloads and tips about VPN and Tor servers.

Downloaders

The downloaders are the customers discussed above who opted for the illegal copies. They therefore made a choice to maximise their utility by downloading a pirated copy. Typically downloaders are motivated to get the content they desire with the least effort. The downloader further wants to minimise cost by not being prosecuted for downloading the illegal movie.

A recent report¹² by Kantar Media segments infringers into four categories:

Justifying Infringers (9% of infringers, 24% of infringed volume, 2% of total digital consumers): This group had the highest levels of infringement. They felt they had spent

enough on content already, and this sentiment was confirmed by their high total spending offline. Most of their digital consumption was streamed and primarily related to music, though they also consumed the highest proportion of illegal books across the segments. Generally, they like to try before they buy (related to their willingness to spend) and appear to be the most receptive to good/well-priced legal alternatives.

Digital Transgressors (9% of infringers, 22% of infringed volume, 2% of total digital consumers): This was the youngest infringing group, with the majority in education. They had the highest levels of downloading behaviour and had higher consumption of films and TV programmes than the other high infringing group (Justifying Infringers, mentioned above). This group showed the least remorse for infringing material, but also had the highest fear of getting caught. In fact, they appeared to be the most receptive to receiving letters from ISPs alleging infringement.

Free Infringers (42% of infringers, 35% of infringed volume, 10% of total digital consumers): This was the largest group and was chiefly defined by the fact that they infringed because it was free. They paid for a low proportion of the content they consumed and, as such, had the lowest total content spending among the infringing segments. They were responsible for the majority of illegal consumption of video games and computer software.

Ambiguous Infringers (39% of infringers, 20% of infringed volume, 9% of total digital consumers): This group had the lowest levels of digital consumption and the highest proportion of paid and legal content. They generally offered fewer justifications for infringing and for stopping infringing. This appears to be linked to their lower levels of infringing activity and a lack of confidence in their knowledge of what is legal.

This study lists the three biggest reasons for infringement as the fact that the content is free, the speed of obtaining digital goods and the convenience factor, as shown in the table below.

Another study¹³, done by NetNames, estimates that almost 26% of all internet users have sought infringing content, and that this number is rising.

Uploaders

File Hosting Uploaders

In 2011, the MPAA published a report¹⁴ on the business model of cyberlockers, which are sites that host files. The report specifically focused on the incentive schemes provided to uploaders by these sites for uploading larger file sizes and content that will be shared widely. The report postulated that these schemes were created to encourage uploaders to upload popular movies to their sites and circulate links as widely as possible. These controversial affiliate programs were prominently cited in the criminal indictment that led to the shutdown of Megaupload.

Following the MPAA report, researchers from Northeastern University and Eurecom investigated¹⁵ the earning potential on such affiliate programs, and found that for most

uploaders, these amounts are “so low that they cannot rationally explain profit orientated behaviour”.

This debate became irrelevant after the shutdown of MegaUpload in January 2012, whereafter all cyberlockers were faced with the fear of becoming the focus of a similar trial. Affiliate programs were discontinued and even third-party sharing was discontinued by various cyberlockers, forcing some to shut down completely due to lack of business¹⁶. Others were able to stay afloat by providing legitimate services and adhering to DMCA safe haven best practices. A study¹⁷ from the Swinburne University of Technology concluded that “the future viability of cyberlockers that employ affiliate programmes and do not respond promptly to rights-holder complaints appear rather dim”.

BitTorrent Uploaders

A study¹⁸ by Ruben Cuevas et al. analysed uploader behaviour in BitTorrent networks. They found that over 30% of available content was from fake uploaders. These fake uploaders are anti-piracy agencies or malicious users attempting a systematic poisoning index attack. Only 25% of downloads were of fake content.

Non-fake uploaders are divided into three categories: private uploaders that offer certain services and receive financial gain through ads, donations and fees; users that use uploads to drive traffic to their own websites; and altruistic uploaders. Private uploaders constitute 25% of top uploaders, promoters make up 23% and altruistic uploaders 52%.

The profit-driven uploaders are responsible for roughly 26% of the uploads. The distribution of uploaders to uploaded content is extremely skewed, reflecting the fact that a handful of uploader-accounts do the majority of uploads. Various IP's are reported to use an uploading account, reflecting some manner of collusion. The top 100 non-fake uploaders from the study, which followed more than 55 000 torrents, were responsible for 37% of all uploads. Downloads of their content made up 50% of all downloads.

Based on typical ad-revenue and website traffic, the researchers estimate the following daily income for the top 100 profit-motivated uploaders:

Daily Income (US\$)	Min	Median	Avg	Max
Private	1	55	440	3,7k
Promotor	1	51	205	1.9k

This, however, is merely the possible income generated from these sites, not the profit. Hosting costs typically scales with use, which means that the larger sites will have higher overhead costs. The Pirate Bay claims¹⁹ to be operating with a very thin margin, with equipment and hosting barely covered by advertising income.

Altruistic uploaders only uploaded 11.5% of the content and are responsible for about the same fraction of downloads. A disproportionately large amount of content shared by these users was smaller files, such as music and e-books.

Incumbent Approaches

The three traditional approaches to fighting piracy are technological, legal/moral and pricing. All three of these approaches have succeeded to some extent, but it is evident from the ongoing pervasiveness of piracy that no method has been sufficiently effective. The limited successes and ongoing strategies of these approaches are interesting to take note of in the context of our new technology. These approaches are accompanied by survey data regarding the attitudes of the top 20% and bottom 80% of infringers²⁰.

Technology

29% of top infringers would stop pirating if legal services were more convenient and flexible.

The technological approaches to anti-piracy can be grouped into preventative and reactive technologies. Preventative technologies include the widely unpopular, but still present, Digital Rights Management (DRM). These technologies typically place restrictions on media items in an attempt to make it harder to pirate the content. While this is cited as

necessary to protect the rights of copyright holders, critics see the restrictions on fair-use as anti-competitive behaviour and an infringement of consumer rights.

In the economic model of digital piracy, as discussed above, these restrictions would decrease the value of the legal copy relative to the illegal one. While legal content remains under the restrictions placed by the DRM, illegal copies are unrestricted. Even DRM that is touted as uncrackable, such as the Cinavia system, is eventually cracked²¹.

Bergemann et al.²² showed that an increase in the flexibility of use of a media product leads to

Factors that would encourage infringers to stop	Top 20%	Bottom 80%
If legal services were cheaper	46%	31%
If everything I wanted was available legally	34%	26%
If a subscription service I was interested in became available	31%	14%
If legal services were more convenient/flexible	29%	14%
If everything I wanted was available legally online as soon as released elsewhere	29%	20%
If my ISP sent me a letter saying they would suspend my internet access	28%	18%
If legal services were better	27%	16%
If it is clearer what is legal and what isn't	27%	26%
If I thought I might be sued	25%	19%
If I thought I might be caught	23%	15%
If friends or family were caught	23%	12%
If my ISP sent me a letter saying they would restrict my internet speed	18%	12%
If my ISP sent me a letter informing me my account had been used to infringe	16%	12%
If everyone else stopped doing it	15%	11%
If I knew where to go to see if something was illegal or not	12%	14%
If there were articles in the media about people being caught	10%	6%
Nothing would make me stop	5%	6%
Other reason	1%	2%

a higher value, which has a positive effect on demand. This idea is expanded on by Vernik, Purohit and Desai²³ who concluded that DRM restrictions can reduce the profits of the copyright holders, consistent with the model above.

Reactive technologies include identification technologies, searching technologies and response technologies. Fingerprints identify any copy of a specific media item, while watermarks are meant to identify an individual copy of a media item²⁴.

Searching technologies can be either passive, or active. Passive technologies block or restrict content that passes through a checkpoint and is identified as infringing. Legitimate file hosting services, like Dropbox, use this type of technology to restrict piracy while keeping content private²⁵. Web crawlers fall under the active category. This technology searches through the internet, identifying infringing content. The biggest limitation to this technology (other than cost) is unsearchable content, such as encrypted or non-indexable content. File hosting sites encrypt the content that they host, while private BitTorrent trackers and Tor-network sites are hard to access.

Even when infringing content is identified, there is little recourse from a technological point of view. One popular approach is to work through internet service providers (ISPs) to firstly inform infringing users of their misdeed and, if required, throttle the bandwidth of the infringing user. Under certain conditions, infringing content can be taken down by anti-piracy systems, although the most common response is to use law-based options to handle it.

Legal/Moral

28% of top infringers would stop pirating if their ISPs threaten action. 25% would stop if they thought they might be sued and 23% if they thought they would be caught.

As previously explained, prosecuting digital pirates publicly increases the perceived price of illegal alternatives. Any action that increases the perception of the probability of being caught increases the cost of the illegal content. Frequently, however, legal action is seen as a non-credible threat, in the language of game

theory. Arresting all movie downloaders is a non-credible threat, given that the downloader knows that law enforcement does not have the capacity to do so.

As mentioned above, the Pirate Bay has a whole page²⁶ thwarting the non-credible threats from around the world. Actions that change this view have been shown to be effective. The very public arrest of Kim Dotcom and the subsequent shutdown of the file hosting site, Megaupload.com, is one prominent example²⁷. While various file hosting sites took drastic measures in reaction to the case, users merely shifted from file hosting sites to BitTorrent sites²⁸.

The most visible legal tactic is DMCA takedown notices, where content owners, or their representatives, ask sites hosting infringing content to take it down. The issuing of these takedown notices is often automated, sometimes with embarrassing results. Microsoft, for example, has asked Google to censor BBC, CBC, CNN, Wikipedia, the US government and even Bing²⁹; HBO, as another example, has asked Google to takedown links to HBO.com³⁰; Zuffa, the owner of the UFC franchise, and has sent takedown notices for everything from movies to software to very lewd pornography³¹.

Graduated-response laws, such as the Copyright Alert System in the US and the revoked HADOPI law of France, attempts to educate casual infringers and punish repeat offenders³². Research³³ on the HADOPI law found that while the number of casual uploaders (predominantly altruistic uploaders) dropped, the overall publishing rate actually increased. In the US, it is clear³⁴ that the six-strike system has not halted the growth in piracy. Users are increasingly opting for Virtual Private Networks (VPN) and anonymous proxies that shield them from detection³⁵. A report³⁶ by the Centre for Copyright Information found that there was a 30% repeat warning rate, which is quite high considering the low detection rate and the protective measures users can take.

Price Discrimination and Freemium

46% of top infringers would stop pirating if legal services were cheaper. 29% of top infringers would stop pirating if desired content was available online at the same time as it is released everywhere else.

A very effective model for curbing piracy is to lower the price of the legal product below that of the illegal copy. Services that monetize large audiences with a low willingness to pay, like Pandora, Spotify and 8-tracks, deter piracy by using a “Freemium” model. Users get access to basic services, while more access or less ads requires a paid account. Subscription-based on-demand services like Netflix fulfil this role in the movie industry.

Research³⁷ has shown that these models do not only deter piracy, but can also increase net profits for producers in some cases.

Another form of price discrimination happens though the windowing process, discussed above. This schedule, meant to capture more monopoly profits from sales, might be seen as a leading cause of piracy. An ongoing study³⁸ by George Mason University’s Mercatus Centre looks at this question. The study finds that less than half of the most-pirated movies are available legally in some form, with less than 2% available on a legal streaming service.

The self-evident solution to this is to reduce the window lengths. This has been happening steadily, as shown above, but not at a pace that follows the demand of consumers using new technologies.

The Economics of CustosTech

CustosTech brings a unique solution to the piracy environment, which can easily be understood within the economic model of piracy discussed above. While the CustosTech product is based on cutting edge technology, the true innovation is a behavioural one.

The Technology

The basic concept is that the key to a Bitcoin wallet is embedded into the watermark of a media item, such as a movie. This key can be read from the movie with relative ease, but is extremely hard to destroy. When the movie is distributed, a specific Bitcoin wallet is associated with the individual owner of the movie. The owner of the movie is free to use the movie, and even to copy and distribute it to people he or she trusts. If, however, the movie is leaked to untrusted parties, anyone with access to it will have an incentive to extract the Bitcoin from the wallet. The CustosTech system is immediately notified when the Bitcoin has been extracted, and who the infringing uploader is.

Steps can then be taken against the owner of the infringing content, as required by the owner of the copyright. This can include, but is not limited to, legal action, cancellation of accounts and black-listing. The only requirement of the reaction is that the cost of persecution should be strictly higher than the value of Bitcoin in the wallet, for obvious reasons.

From a technological point of view, CustosTech has three great advantages compared to most available alternatives: flexibility, remote bounty management and the distributed nature of detection. CustosTech is proudly free of any restricting DRM. No technical restrictions are placed on the protected content. Users can make multiple copies of the media they own, use it on any device they wish and even share it with trusted family and friends, as one would with a physical copy. That said, the technology works seamlessly with DRM products.

The implementation of the Bitcoin-based wallets allows CustosTech to manage the size of the bounties remotely. This enables the content owner to increase the detection incentive when the most is at stake and to decrease the size later on. A low quality cinema camera rip is worthless the moment a DVD copy is available online, so the bounty can be revoked at this point. When very little revenue can still be extracted from a movie, the rewards can all be revoked remotely.

The crowdsourcing of detection is not a new idea: a British anti-piracy firm is building a browser plugin³⁹ that allows users to add links to infringing content to the firm's database. This enables the firm to access unsearchable sites, such as cyberlockers. Unlike CustosTech, however, this technology merely relies on "industry workers" who, they argue, would use the technology "in a show of support for the music business". This means that the scope for detection is limited, and limited to the wrong end of the industry. Industry workers will probably not be hanging out on private BitTorrent or cyberlocker sites.

Their technology relies on the handful of individuals who have a pre-existing incentive to take down piracy. CustosTech changes the incentives of anyone and everyone with access to pirated content to report infringing content.

The Economics

CustosTech misaligns the incentive-structure between the uploaders and downloaders that is discussed above. Both uploaders and downloaders aim to increase their utility when they decide to participate in piracy. Whether motivated by profits or altruism, the uploader means to gain from uploading the video. The downloader maximises utility by enjoying the movie and paying as little as possible.

What CustosTech does, is to give the downloader an incentive to take an action that will reduce the utility of the uploader. The downloaders, being half of the market, are necessarily present where there is piracy, which makes them the perfect agents for fighting piracy. The economic effect of the technology works both directly and indirectly, as will be explained below.

Direct Effect

The direct economic effect of the technology is the incentivisation of the downloader to inform the CustosTech system of infringing content. As discussed above, technologies that merely rely on intrinsic motives are limited in scope and efficacy. While individuals can be employed to identify content, it will not be cost effective solution. The CustosTech technology relies on the incentive of the downloaders to

download the illegal content and places a non-related incentive in their path.

A distributed detection system like this has two prerequisites: it has to be able to transfer the value to the claimant and it needs to be profitable to the claimant. Using Bitcoin makes meeting these criteria a lot simpler. Bitcoin is costlessly global, which means that the value can be transferred as easily to a bounty hunter in India as it can be to a casual downloader in the US.

The profitability criteria becomes a balancing act. If the claimant expects to be prosecuted for the download, he or she will require a large bounty to claim it. While Bitcoin is not necessarily anonymous, steps can be taken to ensure the anonymity of a transaction. Without a fear of getting caught, the claimant will be willing to accept a smaller amount. Given the global nature of the internet and Bitcoin, the competition for the bounty will be global. While a \$5 bounty, for example, will mean little to an American, it can be more than two days' wages for a bounty hunter in India. The balancing act then becomes bounty size to expected time to claim. As mentioned above, the upper limit to the bounty is the expected cost of prosecution; anything above this amount and legal owners will claim their own bounties.

Indirect Effect

The indirect effect is on the incentive structure of the uploader. Once the infringing content is identified, action can be taken against the owner of the content. Legal action is an option, but owners can also be blacklisted, fined or lose a deposit. Such an action will be costly to the infringer, and this cost will now be priced into his or her incentive structure. As discussed above, the motives for uploading can either be altruistic or profit-driven. CustosTech influences the incentive structure regardless of what drives the uploader. If the uploader is profit-driven, the extra cost will diminish the already thin margins. If the uploader is driven by a misplaced sense of community or some other altruistic drive, having the downloaders act to incriminate him or her will lead to disillusionment.

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