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Government-sanctioned and market-based anti-piracy measures can both mitigate economic harm from piracy.

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Copyright Enforcement in the Digital Age: Empirical Evidence and Policy Implications

THE CORRELATION BETWEEN the rise of Internet-based piracy^a and drops in revenue from media sales has made online copyright infringement a hotly debated topic in the media and technology industries. In the 10 years following Napster's introduction in 1999, global recorded music sales decreased 50%, despite having previously been on an upward trend.¹⁶ Likewise, while DVD/VHS sales increased from 2000 to 2003, sales fell 27% in the four years after the widespread adoption of the BitTorrent protocol 2004.

a Throughout this article, when we use the term "piracy" in the context of digital media consumption, we follow the *Oxford English Dictionary* definition of "the unauthorized use or reproduction of another's work."

Although many industry observers approach this topic with strong, and fundamentally philosophical, viewpoints, a community of academic researchers has aimed to bring objective and robust empirical analysis to the measurement and analysis of illegal online filesharing. The first phase of this research focused primarily on the impact of digital piracy on legal sales. We are aware of 26 peer-reviewed journal articles studying the economic harm caused by piracy, with 23 of them finding piracy causes significant harm to legal sales. In short, "the dust has settled in that literature," as Joel Waldfogel of the University of Minnesota observed at a 2015 meeting of the World Intellectual Property Organization, "...and most people believe that, indeed, unpaid consumption reduces the ability of sellers to generate revenues."^{b,c}

With the harm from piracy well established in the literature, our goal

b See <https://www.youtube.com/watch?v=D0gwM2WRjGE#t=9m20s>. See also Robert Hammond's observation in his 2014 peer-reviewed paper in the *Southern Economic Journal* that it is a "well-documented fact that file sharing is harmful to the music industry." Literature reviews by Danaher et al.,⁷ Liebowitz,¹⁶ and Oberholzer-Gee and Strumpf¹⁷ all draw similar conclusions.

c There is also a small but inconclusive literature on whether and how revenue lost due to piracy affect the supply of creative works, as in Telang and Waldfogel²³ and Waldfogel.²⁴

» key insights

- The empirical evidence shows the best way to reduce the economic harm caused by digital piracy is through combined anti-piracy efforts from rightsholders, technology firms, and governments.
- Rightsholders can reduce piracy and increase legal sales by making legal content more easily accessible in digital channels and by synchronizing international release dates; technology firms can respond by making pirated content more difficult to find on digital platforms.
- Governments can respond to piracy by introducing well-known and well-enforced legal penalties against individual pirates, by taking legal action to shut down or otherwise block Internet access to prominent pirate sites.

here is to synthesize the findings in the more recent literature that analyzes the effectiveness of various approaches for reducing the economic harm from piracy. Some reviews in the literature explore the underlying determinants of a consumer's decision to acquire content legally or illegally; see, for example, Watson et al.²⁵ Other papers explore the question through a laboratory experiment, as in, for example Fleming et al.¹² Unlike this work, we focus specifically on evaluating the effectiveness of a number of strategies rightsholders can use to respond to piracy, including making legal content more available or convenient, prioritizing links to legal sites in search results, and removing title-specific copies of media files from the Internet. We then analyze the results from various studies of specific government anti-piracy interventions, synthesizing these results to provide insights into the determinants of the effectiveness of such interventions.

We show that firm strategies and government interventions can both have meaningful effects on consumer behavior, reducing piracy and increasing legal sales. However, we also find that no single action is a panacea for the problem posed by piracy. We conclude that the most effective response to piracy involves combined efforts from both rightsholders and governments.

Business Strategies

Rightsholders have adopted a number of strategies in an attempt to persuade pirates to consume their goods through legal channels. Such strategies often come at a cost to the firm, and measuring the effectiveness of these strategies is thus of great importance.

Increasing the availability and convenience of legal distribution channels appears to be a significant factor in reducing piracy. For example, Danaher et al.¹⁰ showed that NBC's decision to remove its television content from the iTunes video store on December 1, 2007 caused piracy of that content to increase by 11% relative to a control group of content from other television networks.¹⁰ Figure 1 displays piracy of NBC vs. non-NBC content before and after NBC removed its content from iTunes. Furthermore, when NBC later restored its content to the iTunes store, piracy diminished. Danaher et al.¹⁰

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also found that neither of these events caused any statistically significant change in physical DVD sales of that content, a notable observation given that the desire not to cannibalize physical sales is a common reason firms give for delaying adoption of digital distribution channels.

In a related paper, Danaher et al.⁵ showed that ABC's decision to add some of its television programs to Hulu caused a 20% decrease in piracy of that content, implying that offering content in a convenient way (on a digital-subscription or ad-supported service) can convert a significant number of pirates to legal consumption.

Zhang²⁶ examined the removal of digital rights management (DRM) protection from the catalog of EMI Music—one of the four major music labels at the time—and found it was associated with an increase in EMI's digital music sales relative to changes in the other labels' sales, and that the increase in sales was larger for less-popular content than for more-popular content. Given the consistent finding in the literature that piracy diminishes sales of copyrighted works, a reasonable interpretation of this result is that the increased appeal and utility of DRM-free content convinced some pirates to purchase legally.

Other studies have shown that reducing the time between the U.S. release of a film and its international release in theaters (Danaher and Waldfogel⁹) or on DVD (Smith and Telang²²) can decrease piracy and increase sales.

In addition to making legal content more available, rightsholders can also make pirated content less appealing or less available. Christin et al.³ showed that “poisoning” filesharing networks with replaced decoy files can manipulate consumer perceptions of content availability on a piracy network, but recent piracy technologies have included safeguards against such actions, and this strategy is no longer commonly used. Reimers²⁰ documented that when publishers employed a third-party organization to selectively increase copyright enforcement on a specific set of book titles by having Google de-list the sites offering the copyright-infringing files and by sending takedown notices to those sites, this action caused ebook sales of those

titles to increase by 11%.^d However, such private enforcement of public copyright policy is controversial and the subject of much legal debate; see, for example, The Takedown Project (<http://takedownproject.org/projects>) and Kuczerawy.¹⁴

Beyond strategies individual firms can pursue, there may be opportunities to protect content through industry cooperation. One example on the demand side is the Copyright Alert System in the U.S. in which many ISPs have voluntarily agreed to a graduated response system of warnings and penalties when they detect copyright infringement by their users. We are aware of no academic evidence as to whether this system has had any impact. On the supply side, however, we have studied search behavior in relation to piracy and found that demoting search results that link to piracy websites can shift user behavior toward legal consumption, implying search engines may be useful partners in the effort to reduce piracy's impact.²¹

In summary, there is strong evidence that rightsholders can reduce piracy and increase legal consumption by offering their content in more convenient channels and by reducing de-

lays in availability between countries and among distribution channels. There is also evidence that cooperation from firms outside the entertainment industry can help protect copyrighted content. However, each of these strategies is costly to the firms involved, and none of them can fully mitigate the impact of piracy on sales. It is thus worth considering whether government enforcement might also serve to mitigate the impact of piracy on legal consumption.

Enforcement

The digitization of media goods effectively weakened copyright laws across the globe by making it easy for ordinary consumers to illegally share media files from computer to computer. Many industry observers have called for reform of existing copyright policy to address issues particular to digitization, and governments have tried a variety of policies to mitigate the impact piracy has had on sales. By analyzing the effectiveness of these diverse efforts at copyright

Figure 1. NBC vs. non-NBC piracy before and after NBC removed its content from iTunes, December 1, 2007; source: Danaher et al.¹⁰

d Although this is an example of private copyright enforcement, it is worth noting that such private enforcement is possible only in a policy environment where copyright infringement is illegal.

Figure 2. iTunes music sales before and after HADOPI was introduced.

enforcement we can identify and understand the principles behind which policies are most effective. We start by dividing anti-piracy policies as either having a demand-side or supply-side focus.

Demand-side anti-piracy. Demand-side anti-piracy policies focus on enforcement by targeting individuals engaged in illegal downloading of copyrighted works, either with penalties for said illegal behavior or with positive incentives for legal consumption.

HADOPI. The HADOPI law, or Creation and Internet law, a graduated-response anti-piracy law passed in by the French government in 2009, was one of the first demand-side policies enacted in response to piracy. The law empowered the French HADOPI authority (in English, the High Authority for Transmission of Creative Works and Copyright Protection on the Internet) to send warnings to identified copyright infringers and, after repeated infringement, refer the case to courts to impose penalties. HADOPI also provided for a number of positive educational efforts aimed at informing consumers of and steering them toward legal options.

HADOPI went through a great deal of political debate in France from March 2009 until being passed into law in September 2009. In Danaher et al.,⁸ we used the event of the law's enactment to measure the effectiveness of the law in migrating music pirates toward legal digital downloads on the iTunes music store. Specifically, we identified a group of countries that had digital

music sales trends similar to France's before HADOPI^e and compared their sales trends before and after HADOPI to the French sales trend.

Figure 2 plots iTunes music sales trends for music sales in France (red) and for the “control group” countries (blue), demonstrating that from July 2008 until March 2009 France's trend was statistically indistinguishable from the control group. The green dashed line indicates French Google searches for the term “HADOPI” and is our measure of French awareness of the law. From March to June 2009, while the law was still under political debate, public awareness of the law rose and spiked. During this period, French music sales began to rise above sales in the control group, and the gap widened as awareness grew. Notably, the increase in French sales began before the law was actually in effect and being enforced but at the same time as the public became aware of the law and the potential penalties it involved. The study showed that HADOPI caused digital music sales to increase approximately 25% relative to the control group, with larger increases for the most-heavily pirated genres, and smaller increases for the least-pirated genres.^f Danaher et al.⁸ also found that the effect of the law appears to have

been maintained for more than two years after the public's initial awareness, although it may have diminished slightly during the last few months of the study. The HADOPI agency sent out many infringement warnings from 2010 to 2012 that may have contributed to continued awareness of the law and its continued effectiveness.^g

IPRED. In April 2009, Sweden implemented a copyright reform policy based on the European Union's Intellectual Property Rights Enforcement Directive (IPRED) that made it significantly easier for rightsholders to detect and identify filsharers, increasing the risk of punishment for online piracy. Adermon and Liang⁴ compared piracy levels and total music sales in Sweden before and after the law to those in two other Scandinavian countries—Norway and Finland. They found the law directly led to a 16% decrease in Internet traffic during the first six months, which they attributed to a 32% decrease in piracy. They also found that total music sales increased 36% during this time relative to the control group, with a larger increase for digital sales and a smaller increase for physical sales. They thus found that awareness of IPRED effectively migrated many music pirates to legal channels.

However, Adermon and Liang⁴ also noted that law was enforced very weakly, with only a few cases making it to the courts. After the first six months, piracy levels and music sales both returned to near their original levels, and Adermon and Liang suggest that the transitory effectiveness of the law might be attributed to waning public belief in its level of active enforcement.

Demand-side policies. France and Sweden are not the only countries with demand-side anti-piracy policies. Various forms of demand-side anti-piracy laws exist in Ireland, New Zealand, the Republic of Korea, and the U.K., among others, but we are not aware of peer-reviewed empirical studies on their effectiveness. However, the two aforementioned studies, Adermon and Liang⁴ and Danaher et al.,⁸ do share several themes. First, the measured increase in

e Belgium, Germany, Italy, Spain, and the U.K., the five largest iTunes music markets in Europe at the time, other than France.
f As discussed here, this result is robust to de-trending the data by country.

Figure 3. Post-shutdown change in digital movie sales vs. pre-shutdown MPR.

g This effect is robust to controlling for French iOS—iPhone, iPod, and iPad—sales; see Danaher et al.⁸ and the blog InfoJustice.org (<http://infojustice.org/archives/8891>) for a detailed discussion.

legal consumption was relatively similar (25% vs. 36%) despite the laws being passed at different times and in different countries.^h Second, HADOPI affected behavior when the public became aware of its existence and before it actually took effect, while IPRED's effect diminished after the public observed a lack of enforcement. With demand-side anti-piracy enforcement, awareness of the policy and an expectation of its enforcement appear to be necessary conditions for effectiveness. When these conditions are met, it appears that demand-side policies significantly reduce piracy and increase legal consumption and revenues. However, we cannot say whether the effects of such policies are sustained in the long run. In addition to the IPRED effect disappearing due to weak enforcement, the HADOPI effect appeared to diminish somewhat after the first 18 months, although this decrease was not statistically significant.

Supply-Side Anti-Piracy

Supply-side anti-piracy policies involve targeting sites or protocols that supply access to pirated content. Sources of copyright-infringing files can be either shut down entirely or blocked in a given region in cases where ISPs are ordered to block access to piracy websites. The effectiveness of such policies appears to depend on how inconvenient they make further piracy.

Megaupload shutdown. Cyberlockers, one of the primary means of sharing copyright-infringing files on the Internet, are simply cloud storage space where people can house their data on remote servers. However, some cyberlockers have policies that heavily promote illegal filesharing (such as a lack of passwords to protect account access or cash payments to incentivize individuals who upload popular files). In 2011, the most popular piracy cyberlocker worldwide was <http://www.megaupload.com>, which provided more than 25 petabytes of user uploaded—and largely copyright-infringing—content and accounted for 4% of all Internet traffic.¹⁸ In January 2012, the U.S. Department

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of Justice shut down Megaupload.com, seizing all of its servers and computer assets, effectively removing its content from the Internet. Many other piracy sites, including its sibling streaming site Megavideo.com (<http://www.megavideo.com>) had linked to the content on this site. Lauinger et al.¹⁵ showed the Megaupload shutdown did not change the set of content available to pirate on the Internet, because the content that existed on Megaupload was also available on other piracy sites, and new piracy sites emerged in its wake.¹⁴

But even though the Megaupload shutdown may not have altered the range of pirated content available, it may still have affected consumer behavior if the remaining content was lower quality or less trustworthy (in terms of being safe and virus free) or if it increased consumer search costs by causing consumers to need to identify and learn to use other sites. In Danaher and Smith,⁶ we asked whether the shutdown of Megaupload increased digital movie sales and rentals. We noted that the Megaupload penetration rate (MPR), or the percent of all Internet users who visited Megaupload in the months before the shutdown, varied significantly across countries. This means the shutdown delivered a larger “shock” to high-MPR countries than to low-MPR countries. To determine the causal effect of the shutdown, we had to determine whether digital movie sales increased more in high-MPR countries than in low-MPR countries after the site was shut down.

Figure 3 demonstrates that countries with high MPR (such as Belgium and Spain) had greater increases in digital movie sales after the shutdown than did countries with lower MPR (such as Australia and Canada).ⁱ We observed a similar pattern for rentals and also that in the months before the shutdown a similar pattern did not exist; that is, there was no relationship between sales trends and MPR until

ⁱ Note the shutdown of Megaupload took place in January 2012, so sales were at the time naturally declining from their holiday peaks. But in countries where the Megaupload shutdown created a larger shock, sales did not decrease by as much as they did in other countries, and in the countries where Megaupload was used the most, sales actually increased after the holidays despite the fact that in other years these countries experienced declines over the same period.

^h Both studies involved counterfactual exercises, using a control group to simulate what would have happened in the treated countries if not for the treatments; such difference-in-difference exercises are naturally reliant on the quality of the control group.

Causal increase in paid legal streaming resulting from U.K. site blocks, November 2013.

Consumer Segment	Pre-block Visits/User to Blocked Sites	Causal Increase in Visits to Legal Sites
0	0	0.0%
1	1.0	2.2%
2	2.0	4.4%
3	3.0	6.5%
4	4.0	8.7%
5	5.4	11.7%
6	8.2	17.5%
7	13.2	26.8%
8	23.8	42.4%
9	66.4	14.8%

the shutdown occurred. We concluded that the shutdown of Megaupload thus caused global revenues from digital movie sales and rentals to increase by 6.5% to 8.5%. However, our data extended only 18 weeks after the shutdown, so it was unclear how long the effect lasted after this 18-week period.

U.K. site blocking. Unlike the Megaupload shutdown, which shut down the entire site worldwide, site blocking involves requiring ISPs in a given country to block access to infringing sites. As a result, the content on these sites is still available on the Internet; it just cannot be accessed through an ISP's service without some additional measures (such as accessing proxy sites dedicated to providing unblocked access or by using virtual private networks that make it appear a user is accessing a site from a different country).

In May 2012, the U.K. courts ordered ISPs to block access to The Pirate Bay, a major indexing site for BitTorrent tracker files. To study the effectiveness of this program, we obtained data from an Internet consumer panel tracking company on monthly visits to piracy sites and visits to paid legal video streaming sites.⁴ We divided consumers into 10 different segments, with the first segment being non-users of The Pirate Bay, the second being the lightest users of The Pirate Bay, proceeding all the way up to the 10th segment, the heaviest users of The Pirate Bay. Presumably, the block had no effect on non-users of the site (making them a control group) and had an incrementally stronger effect on groups with heavier users of the blocked site than groups

with lighter users. We asked how these groups changed their downloading behavior relative to the control group after The Pirate Bay was blocked.^j

We found when the Pirate Bay was the only site blocked, former users generally increased use of other piracy sites and VPNs, thus causing only a small decrease in total piracy. This finding is consistent with Poort et al.¹⁹ who found only small decreases in total piracy when Dutch ISPs blocked access to The Pirate Bay. Not surprisingly, we found no causal increase in use of paid legal streaming sites from this block; that is, in spite of its popularity, when U.K. ISPs blocked only The Pirate Bay there was no statistical increase in legal consumption. It appears that users simply found other ways to access the same pirated content on other popular sites. A study by Aguiar et al.² using similar methods found similar results in that the shutdown of a single video-linking site Kino.to (now defunct) in Germany did not cause a meaningful increase in legal consumption. Notably, this shutdown was more like a website block than an actual site shutdown, because Kino.to linked to content only on other sites and did not host content; shutting down Kino.to simply removed, or "blocked," a means

^j Results from this 2015 study were therefore generated by 20 data points, an observation for each of 10 segments both before and after the blocks. However, each of these data points actually represents a sample mean based on the behavior of hundreds or thousands of individuals in the segment, and the resulting tests thus had much greater statistical precision than if the results were based on only the before-and-after behaviors of 10 individuals.

of accessing the content without actually removing the content itself from the Internet. This finding is thus similar to our findings regarding the blocking of The Pirate Bay.

The fact that shutting down a single site apparently has no significant impact on the consumption of piracy could mean either that website blocking is inherently ineffective or that blocking only a small number of sites is insufficient to cause consumers to change their behavior. To test these hypotheses, we analyzed whether a larger number of blocks would have a different impact on consumer behavior than a single block would have. We did this using an event in November 2013 whereby courts in the U.K. ordered the near-simultaneous blocking of 28 piracy sites, with 19 hosting video content. We applied the same methodology to study the effect of these 19 blocks as we used to study the blocking of The Pirate Bay and found a different result: When 19 sites were blocked by ISPs in the U.K. there was a significant reduction in overall piracy, and segments with greater usage of the blocked sites before their blocks exhibited a greater increase in use of legal sites after the blocks occurred,^k a correlation that did not exist prior to the blocks (see the accompanying table).

These results suggest that blocking 19 sites in the U.K. caused average treated consumers to increase their visits to legal sites by 12%. The large decrease in total piracy and the 12% increase in legal site visits demonstrate that, in spite of the fact that some users chose at the time to use VPN services to circumvent the blocks,^l the blocking of 19 major sites did indeed cause a significant shift from illegal to legal consumption.

Supply-side policies. These results suggest that the success of supply-side anti-piracy interventions rests on how inconvenient they make piracy, a view also espoused in a 2015 theory paper by Dey et al.¹¹ Opponents of supply-side

^k The one exception to this is segment 9, as in the Table 6, the heaviest users of the blocked sites, and is discussed further in Danaher et al.⁴

^l The 19-site block resulted in a large-percent-age increase in visits to VPN sites. However, on a unit basis the increase in use of legal sites was much greater than the increase in VPN usage. As noted in Danaher et al.,⁴ this difference is because VPN usage was much less than legal usage prior to the block.

piracy interventions argue that targeting piracy websites cannot be effective, as pirates will always find other sites on which to illegally acquire media, but the empirical research suggests a more nuanced view. Multiple studies document that shutting down or blocking websites may not reduce the range of content available to pirate and that weaker supply-side interventions (such as blocking only one site or shutting down a linking site) cause only small reductions in piracy and do not increase legal activity.

However, several studies show that significant supply-side actions (such as the simultaneous blocking of many sites or the complete shutdown of a large, international piracy site that hosted content) can both reduce total piracy levels and increase consumption through legal channels. This happens even if the blocked content is available on other less-well-known sites, as in Lauinger,¹⁵ or if the actions can be circumvented by technologically savvy consumers, as in the case of increased VPN use among individuals affected by the U.K. blocks. In short, the effectiveness of supply-side anti-piracy interventions rests on whether they sufficiently increase consumers' search and transactions costs of finding alternate sources of pirated content.

Conclusion

The literature on copyright enforcement demonstrates that rightsholders have many options for mitigating the impact of piracy on sales, although these strategies often come at a cost to the firms in terms of undermining the effectiveness of their existing marketing strategies.

The literature also shows that government interventions can mitigate the impact of piracy on sales. Although there is little evidence that government action reduces the overall range of content available through piracy channels, there is evidence that government anti-piracy interventions can be effective at changing user behavior if they sufficiently increase the search and transactions costs associated with finding piracy content. Specifically, government actions that only weakly increase the inconvenience of piracy or that are weakly enforced have only transient effects on piracy and legal consumption. However, government actions that meaningfully increase the disutility associated with

illegal filesharing can cause consumers to shift their consumption from illegal channels to legal channels. In light of the empirical evidence, it is clear that anti-piracy actions initiated by both rightsholders and governments can mitigate the economic impact of piracy on legal sales.

However, whether government-sanctioned anti-piracy efforts *can* be effective is a different question from whether government-sanctioned anti-piracy efforts *should* be adopted. The latter involves analyzing the social-welfare impacts of various interventions, as well as a better understanding of the long-run effects of piracy—whether reduced revenues from piracy affect the supply of creative works. As countries continue to evaluate and change their copyright policy over time, and as rightsholders continue to experiment with new strategies in the digital era of copyright, further research is needed to analyze whether these changes affect not just industry revenue but also creative output and social welfare. **C**

Additional background information appears in an online appendix available with this article in the ACM Digital Library; <http://dl.acm.org/citation.cfm?doid=2979673&pi cked=formats>

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