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Catch Me if You Can: Effectiveness and Consequences of Online Copyright Enforcement*

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Abstract

We evaluate the unexpected shutdown of `kino.to`, a major platform for unlicensed video streaming in the German market. Using highly disaggregated clickstream data in a difference-in-differences setting, we compare the web behavior of 20,000 consumers in Germany and three control countries. We find that this intervention was not very effective in reducing unlicensed consumption or encouraging licensed consumption, mainly because users quickly switch to alternative unlicensed sites. We highlight that the shutdown additionally had important unintended externalities. Individuals who never visited `kino.to` and who additionally clicked on news articles that covered the shutdown increased their visits to piracy websites substantially. We show that this effect largely comes from articles that explicitly mention alternative websites or suggest that users do not have to fear legal consequences from unlicensed streaming. Finally, we document that the unlicensed video streaming market is much more fragmented after the shutdown, potentially affecting future interventions, at least in the short run. We argue that our results can be helpful to understand why online piracy rates are still high, despite a plethora of enforcement efforts.

Keywords: Anti-Piracy Policy, Copyright, Movie Industry, Clickstream, Natural Experiment
JEL classification: K42, L82, O34, O38

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1 Introduction

With the advent of file-sharing networks and, more recently, unlicensed online streaming, copyright infringing content has become easily available to consumers. This raises concerns about sales displacement, continued investment in entertainment products, and overall welfare. Governments have reacted with different actions to enforce copyright on the Internet, such as stricter legislation, DNS blocking, and crackdowns of platforms that host or provide access to infringing content. Despite the many enforcement efforts carried out in the last decade or so, online piracy rates are still substantially high (UK Intellectual Property Office, 2016) and have even increased regarding video content (Poort and Weda, 2015). Additionally, the available evidence on the effectiveness of individual policies is mixed. Studies suggest that announcements and introduction of stricter laws did not have a lasting effect on box office movie revenues in the US, France, New Zealand, South Korea, Taiwan, and the UK (Orme, 2014; McKenzie, 2017). In the context of digital music, new laws in France and Sweden led to an increase in sales of about 25%, but this effect diminished after 6 months (Adermon and Liang, 2014; Danaher et al., 2014). Studies that look at the effect of DNS blocking find limited reductions in overall piracy consumption (Poort et al., 2014; Danaher et al., 2015b). Finally, the shutdown of the major hosting platform *Megaupload* was associated with an average increase in licensed digital and theatrical revenues of movie content of less than 10% (Danaher and Smith, 2014). Box office revenues of narrow-release movies even declined, probably due to word-of-mouth effects of piracy (Peukert et al., 2017).

The fact that online copyright enforcement policies have been rather unsuccessful in lowering piracy rates or increasing producer surplus remains a puzzle. Drawing on a large body of work across disciplines, we argue that the deterrence effect of online copyright enforcement efforts is likely to be challenged by adaptive behavior on both the demand and the supply side. In addition, we highlight that unintended externalities can be an important factor in policy implementations. Despite their importance for policy and management, the empirical significance of these effects has not yet been documented.[1] Our paper is the first to provide individual-level evidence on the effects of a copyright enforcement intervention on consumer behavior.

[1] Theoretical work highlights strategic reasons why too strong enforcement may be suboptimal for the firm (e.g. Conner and Rumelt, 1991; Peitz and Waelbroeck, 2006; Jain, 2008; Tunca and Wu, 2013).

The literature shows that increased enforcement efforts can deter unlawful or unethical behavior, both directly and indirectly (Levitt, 1997; Ayres and Levitt, 1998; DiTella and Schargrodsky, 2004; Draca et al., 2011; Bertoni et al., 2013). Shutting down one supplier of infringing content could convince other piracy websites to voluntarily step down and deter new entry.[2] Because consumers' intentions to pirate and willingness to pay for licensed content are correlated with the perceived risk of prosecution (Chiou et al., 2005; Chiang and Assane, 2009; Liao et al., 2010), one could similarly expect enforcement efforts, either targeted at consumers or suppliers, to have some kind of externalities. On the other hand, theoretical insights from the economics of crime literature suggest that the effectiveness of law enforcement may be undermined by displacement effects, adaptive behavior, and the industry's supply behavior (Cameron, 1988). Stronger enforcement sometimes simply shifts criminal activity to a different time or place (Angrist and Kugler, 2008; Adda et al., 2014; Dobkin et al., 2014), or even induces market entry after crackdowns have weakened incumbent criminals (Dell, 2015). Recent evidence shows that international cooperation in law enforcement can reduce cybercrime, but also diverts hacker attacks to non-enforcing countries (Hui et al., forthcoming). Similarly, studies suggest that consumers simply switch the modus operandi of accessing and distributing unlicensed content as a response to stricter enforcement (Lauinger et al., 2013; Arnold et al., 2014; Poort et al., 2014). Such results are in line with the literature on search and switching costs on the Internet (Chen and Hitt, 2002; Goldfarb, 2006a,b). For example, Goldfarb (2006b) shows that consumers easily switch to a competing website when their preferred website is temporarily unavailable because of denial of service attacks.

An important source of (intended or unintended) externalities could result from the fact that piracy and copyright enforcement actions regularly trigger substantial media coverage.[3] Authors have frequently articulated the idea that media coverage may reinforce the intended effects of enforcement, leading consumers to reduce piracy consumption and switch to licensed offerings (Al-Rafee and Cronan, 2006; Hennig-Thurau et al., 2007; Sinha and Mandel, 2008; Danaher et al., 2010;

[2] A few days after *Megaupload* was closed down, its competitors *Filesonic* and *Fileserve* restricted downloads to the person who uploaded the file, rendering the platform useless for the distribution of pirated content. Many other competitors followed subsequently. See http://tinyurl.com/75of8j6.

[3] A keyword search for prominent examples in the news database *Factiva* lists 37,597 articles related to "Napster" (period 1999–2002), 13,301 articles related to "Pirate Bay" (2003–2016), 13,760 articles related to "Megaupload" (2007–2013), 11,362 articles related to "HADOPI" (2009–2013), 6,277 articles related to "PIPA" and "SOPA".

Cox and Collins, 2014).[4] However, not all news articles contain a clear-cut anti-piracy message. Zamoon and Curley (2008) study the contents of US newspaper articles about software piracy, and document that around the same number of articles condemn and condone piracy. Further, in situations where the legal status of downloading and streaming is ambiguous, news articles may provide legal information – for example by citing lawyers – that can affect consumption choices in different ways.[5] Indeed, there is some evidence that consumers use arguments put forward in the mass media to rationalize their piracy behavior (Vida et al., 2012). Regardless of their tone, news articles may also simply inform consumers about the existence of unlicensed content on the Internet. This information can facilitate switching to alternative unlicensed offerings for consumers already in the market, and it may lead previously uninformed consumers to start pirating following news reports.

While we are not aware of any systematical evidence of media-induced externalities of copyright enforcement, findings from a variety of empirical contexts show that information in mass media can have direct and indirect effects on individuals' behavior. For example, Goh et al. (2011) show that newspaper reports affected how many consumers opt-in for a consumer protection policy. Media coverage of suicides is also known to be related to subsequent increases in suicide rates (Gould, 2001), and there is robust evidence of a link between media and violent behavior against others. For example, Yanagizawa-Drott (2014) and Adena et al. (2015) show that radio broadcasts increased participation in violence in the Rwandan genocide and Nazi Germany. Esser and Brosius (1996) document that the number of right-wing violent offenses increases with the intensity of TV news coverage of previous right-wing violent offenses. Finally, exposure to public health campaigns aiming at establishing social norms for issues such as smoking, drinking, unsafe sex, and cancer pre-

[4] For example, Al-Rafee and Cronan (2006, p. 247) state that "one approach [to reduce piracy] would be to expand the media coverage on [...] digital piracy busts." Cox and Collins (2014, p. 75) conclude that "public awareness campaigns may prove a more worthwhile investment of time and resources for the movie industry." Hennig-Thurau et al. (2007, p. 15) argue that "stressing the unethical element of appropriating copyrighted content [...] in marketing campaigns could increase the moral costs of illegal file sharing and lower file-sharing activities" and Danaher et al. (2010, p. 1150) speculate that "large part of antipiracy efforts in the future may need to rely on the consumer's 'moral' cost associated with piracy". Experimental evidence in Sinha and Mandel (2008) shows that reading (made-up) news articles about piracy lawsuits can affect the perceived risk of getting caught and increase the willingness to pay for licensed content.

[5] In representative surveys among 10,000 Germans, only 39% stated that they find it easy to judge whether movie and TV content offerings on the Internet are legal or illegal. 86% stated that they know about legal consequences of up-and downloads of copyrighted material from news reports. See DCN-Studie 2013, available at https://drive.google.com/open?id=0Bxe11iVXrXgsd0dKeFExWU9vWlE.

vention, can be negatively correlated to people's attitudes and intentions of use (Cho and Salmon, 2007).

We examine the extent of the intended and unintended consequences of online copyright enforcement using URL-level clickstream data that allow us to observe all web browsing of 5,000 individuals each in Germany, France, Italy, and the UK throughout 2011. We exploit the exogenous timing of the shutdown of the then dominant German streaming website `kino.to` in June 2011 as a natural experiment. In a difference-in-differences setting, we compare licensed and unlicensed video consumption of consumers in Germany to a control group of consumers in three other countries, before and after the shutdown.

Our aggregate results show that the effectiveness of the shutdown of `kino.to` was limited, confirming previous findings regarding other copyright enforcement cases and different data. Comparing German users to international users, we see a moderate reduction in visits to piracy sites of 4.5%. We also fail to find much evidence for substitution into consumption of licensed video content as German users do not differentially change their visits to movie theaters' websites, licensed online video services (such as *Maxdome*, *Lovefilm*, and *iTunes*), or DVD/Blu-ray-related pages on *Amazon*.

Our individual-level data allow us to go far beyond a simple aggregate analysis. Distinguishing different types of users, we find that individuals who were using `kino.to` before its shutdown decreased their piracy consumption by about 27%. Because consumers substitute towards existing and newly entering alternative unlicensed websites, this decrease is, however, much lower than what could have been expected given `kino.to`'s 79% market share. Most interestingly, we find evidence of unintended externalities. On average, individuals who never visited `kino.to` increased their visits to other piracy websites by 0.8%. We show that this effect is driven by individuals who clicked on news articles that discussed the shutdown of `kino.to`. Those users increase their visits to piracy websites by about 35%. Looking at the content of these news articles, we find that this effect mainly comes from articles that directly mention alternative piracy websites, or indicate that consumers do not have to fear prosecution when using streaming sites.

Finally, we assess the post-shutdown structure of the market for unlicensed video streaming in Germany. While the market was initially largely dominated by `kino.to`, it ends up being much

more fragmented after its shutdown. In the observed six-month period after the shutdown, the market was evenly split between `movie2k.to` (the second largest player at the time of the shutdown), `kinoX.to` (a new entrant), and a remainder of 17 websites which cumulatively accounted for one third of the market. Future interventions in the German market may therefore be potentially more costly and potentially less effective after the shutdown of `kino.to`, at least in the short run.

Our paper makes an important contribution to an emerging literature documenting the importance of public policy externalities for both policy and management (e.g. Goh et al., 2015). Our key contribution to the piracy literature is to highlight that not only direct, but also indirect effects need to be taken into account when evaluating the effectiveness and consequences of copyright enforcement efforts. This can help understand why we still observe high piracy rates despite the abundance of enforcement efforts that have been carried out in the past.

Our results generate at least two important and novel implications. First, we provide evidence that consumers find it easy to switch to alternative unlicensed services, which substantially reduces the effectiveness of the enforcement effort. Second, an enforcement effort that creates publicity can backfire if some consumers that were previously uninformed start using unlicensed offerings. This challenges the idea – often put forward in the piracy literature, but never tested in observational data – that the media can be helpful in educating consumers about possible consequences of unlicensed consumption, and in persuading them to stop pirating and switch to licensed offerings. With this in mind, we discuss implications for future anti-piracy policy. From a managerial perspective, opening the "black box" of consumer behavior can be helpful to design private copyright enforcement strategies, as well as to understand the competition between licensed and unlicensed services.

We recognize that while our analysis provides rich insights, it remains a case study with context-specific results. Based on a careful discussion of the available evidence and established results in the literature, we conclude that it is unlikely that a similar experiment in a different institutional and geographic setting would yield very different results. The historical context, however, is likely to affect our results on substitution towards licensed consumption. We speculate that better availability and lower prices of licensed content can convince consumers to switch to licensed offerings (Danaher et al., 2010, 2015a; Poort and Weda, 2015; Aguiar and Waldfogel, forthcoming).

2 Movie Piracy and the Shutdown of kino.to

Consumption patterns of entertainment products have drastically changed since the beginning of the 21st century. Ever since the advent of Napster in 1999 and the creation of subsequent file-sharing networks, individuals are able to freely share and access vast amounts of digital media files. The primary mode of access to unlicensed content in recent times is the system of cyberlockers and linking sites.[6] In their simplest form, cyberlockers are online services that allow Internet users to upload and store large files. While this type of service can be used to back up any type of personal data, it can also be used to share copyright protected files such as movies and episodes of TV series (Antoniades et al., 2009; Liu et al., 2013). Once a file is uploaded, the uploader receives a download URL, which can be shared with other individuals, e.g. by posting the link on a website where anyone can get direct access. These linking sites, or sometimes called streaming sites, would typically do more than simply providing access to these links, as they would also categorize content, make it searchable, and provide meta-information (such as credits and ratings).[7] Like many licensed services, this ecosystem essentially runs on advertising revenues.[8] The more visits a cyberlocker gets, the higher the advertising revenue. In order to generate traffic to its website, a cyberlocker would sometimes pay uploaders a share of the advertising revenue generated by their uploaded content. Linking sites also show third-party ads to final consumers, generating revenue for their owner. Therefore, an individual who visits the linking website and clicks on the link enjoys free content and generates revenue for the cyberlocker, the initial uploader, and the linking site. Of course, the content creator or rightsholder is usually not compensated at all. This is why we refer to this type of consumption as "unlicensed" throughout the paper. Overall, this whole process has enabled cyberlockers to store huge amounts of movies, episodes of TV series, e-books, and recorded music. Linking websites play a crucial role in the unlawful sharing of copyright protected content by acting as platforms for uploaders and final consumers.

[6] According to a representative survey among German consumers conducted in 2011, 80% of the consumers that use unlicensed services for movie and TV series consumption do so mainly via cyberlockers and streaming sites. Only 2% use mainly *BitTorrent*. See DCN-Studie 2011, available at https://drive.google.com/open?id=0Bxe11iVXrXgsSjBGRFpqR2txVFk.

[7] The name streaming site relates to the fact that the links provided on the websites often allow for the immediate consumption of the movie, without having to download the complete file. We will use the terms linking and streaming interchangeably in the remainder of the text.

[8] According to a joint report of the music and advertising industry in 2012, more than two thirds of infringing websites are predominately financed by advertising. See Google and PRS, available at https://docs.google.com/file/d/0Bw8Krj_Q8UaENDhEOG1LVFRhVkU/view.

The German market for unlicensed video content had a substantial size in 2010, with at least one million people (more than 1% of Germany's entire population) using cyberlockers and linking sites to stream or download 54 million movies and 23 million TV show episodes (GfK et al., 2011, p. 17).[9] While a significant number of linking sites were active in the German market, `kino.to` was – as will be detailed below – the dominant platform providing access to unlicensed video streaming in 2011. Following a complaint filed by movie industry representatives, a joint raid involving police, computer specialists, and tax officers led to the seizure of `kino.to` on June 8, 2011, effectively removing access to copyright infringing content. In the couple of months following the intervention, visitors of `www.kino.to` were shown a police notice stating that the domain had been seized, owners had been arrested, and users that had created or distributed unlawful copies of copyrighted material may be facing prosecution. As a result of various court decisions between December 2011 and June 2012, 6 members of `kino.to`'s management team were sentenced to prison for up to four and a half years (Spiegel Online, 2012).

Given the massive popularity of `kino.to`, its shutdown generated tremendous media attention, published in all kinds of outlets, including major ones such as *Bild* (Germany's largest tabloid) or *Süddeutsche Zeitung* (Germany's largest national daily newspaper). As we detail below, we observe 1,835 distinct URLs of news articles or blog posts covering or following up on the shutdown, collected using several databases including *Google News*, *Factiva* and *LexisNexis*.

A verdict from a German court sheds some light on the contents of `kino.to` and the revenues it generated (Amtsgericht Leipzig, 2011). Users of `kino.to` had clicked 1.74 billion times on links to movies and TV episodes between September 1, 2010 and June 8, 2011 alone, an average of some 7 million clicks per day. The district court considered that the website offered at least 1.3 million links to some 21,000 motion pictures, 7,000 documentaries, and 106,000 TV episodes. `Kino.to` provided about ten alternative links for each movie, about two for each documentary and about eight for each TV episode. Content was not directly hosted by `kino.to`, but mostly by external

[9] A total of 4.3 million consumers accessed movies and 5.8 million accessed TV episodes online in 2010. Most commonly (47%), survey participants indicated that legal streaming sites (such as MyVideo) and TV station websites (many German TV stations have large online archives) were the primary source to consume TV episodes. However, only 22% considered those services as the primary source of movie consumption. The majority of consumers (38%) reported cyberlockers and streaming sites (such as `kino.to`) as their main source of movie consumption, while 18% indicated that they mainly used cyberlockers and streaming sites for consuming TV episodes. For movies, 17% of the consumers mainly used paid download services, while only 9% mainly used such services for TV episodes.

cyberlockers. Interestingly enough, `kino.to` owned some of these cyberlockers (`freeload.to` and `ebays.to`). The district court considered that at least 12,970 links (less than 1% of the total number of links) pointed to content hosted on vertically integrated cyberlockers. The owners of `kino.to` assumed an active role in obtaining links to video files, setting incentives for uploaders, and enforcing minimum quality standards. Monthly advertising revenues are estimated at €150,000, which amounts to almost €6 million over the period from March 2008 to June 2011. During the same period, revenues from integrated cyberlockers were some additional €634,000.

3 Data and Methodology

3.1 Data Source and Structure

We have access to clickstream data from *Nielsen*'s Internet audience measurement service *NetView*. This service monitors the online activity of a large number of Internet users by recording all of their URL visits via an application that is installed on the consumer's device (desktop PC or Mac) and operates in the background. Consumers are incentivized to take part and stay in the panel by a rewards program, in which they can exchange credit points for retail and travel vouchers. Consumers earn a fixed amount of credit points every month, and take part in a lottery every quarter.[10] Upon signing up, *Nielsen* requires participants to fill out a survey about basic demographics, such as household size, net household income, age, gender, education, and employment status.[11]

Our sample consists of the browsing history of 5,000 individuals each in Germany, France, Italy and the UK throughout 2011, totaling 20,000 users. We observe the URL of every website an individual has visited together with a timestamp, the referral URL, and the amount of time spent on that URL.[12] The URL information lets us distinguish different kinds of online activities. Most importantly, it allows us to identify visits to webpages linking to copyright infringing content – such as unlicensed video streaming – as well as domains related to licensed video consumption. The great

[10] See https://digitalvoice.nielsen.com/us/en/home.html.

[11] To check whether our sample is representative of the population of Internet users, we compare key demographic variables to a representative sample of Internet users in Germany, which we construct using data from the representative German Socioeconomic Panel (SOEP, Wagner et al., 2007). We find that differences in household income, education, and age are significantly different from zero, but small in size. We note, however, that representativeness is not crucial for the purpose of our study, because we are interested in across- and within-group comparisons in the same sample. In an analysis not detailed here, we investigate whether the effects found below differ across demographic groups. Results don't provide much evidence that this is the case.

[12] Nielsen measures time spent on a given URL while it is in focus (tab and browser window), see http://en-us.nielsen.com/sitelets/cls/digital/Online-NetView-FAQ.pdf.

level of detail in this data even allows us to go beyond the website level. For example, we distinguish different product categories users are browsing on *Amazon*, or identify whether users are accessing news articles related to the shutdown of `kino.to`. We aggregate the data from the clickstream level to the user-week-level, so that the unit of observation for most of our analyses is the weekly sum of clicks per user in a specific content category, e.g. unlicensed video streaming websites. With 52 weeks, 5,000 users per country, and four countries, we have 1,040,000 observations.

3.2 Variables

All variables are defined briefly in Table 1 and introduced in more detail below. Descriptive statistics are reported in Table 2.

3.2.1 Piracy Consumption

Measuring the consumption of unlicensed video content requires the identification of websites providing access to such content. We both manually went through the top-1000 domains classified by *Nielsen* as entertainment-related websites and used available lists of piracy websites in 2011.[13] This led us to a total of 20 websites offering unlicensed video streaming content, which defines our unlicensed video streaming market in Germany. By far, the most popular site in this set is `kino.to`, which was visited around 6,000 times per week between January and June 2011 in our sample. This is more than 8 times the traffic received by the second most visited website in our data, `movie2K.to`, which had an average of 730 weekly visits over the same period of time. The 20$^{\text{th}}$ and last website included in the definition of the German movie streaming piracy market, `streams.to`, received an average of less than 1 weekly click between January and June 2011. With a weekly average of 79% market share, `kino.to` was clearly the dominant unlicensed movie streaming platform in the German market at the time of its shutdown. We perform a similar exercise to define the corresponding unlicensed video streaming markets in Italy, France, and the UK.

Piracy: Visits Our preferred measure of piracy usage is the weekly number of visits to the piracy websites described above.

[13] See for example http://tinyurl.com/lvaunh6 and http://repat.de/2011/06/alternativen-zu-kino-to.

One may be worried that visits to those types of sites do not provide a perfect measure of video content consumption. Before being able to stream a movie, a user would need to make a number of navigational clicks, for instance searching or browsing through content, or selecting a server that provides the video stream. A potential concern would therefore be that the unlicensed websites in our sample differ in their design. This may, for example, lead to a smaller number of necessary clicks to consume content on `kino.to` compared to alternative websites. It may be possible that some websites do not offer the desired content, and that the observed clicks to that domain only reflect search as opposed to consumption. To address these issues we re-run our regressions using three alternative measures of unlicensed video consumption, which we present below.

Piracy: Streams We exploit the fact that a website like `kino.to` doesn't directly host video content, but only provides links to cyberlockers (external servers that operate under a different domain name, e.g. `megavideo.com`). Using historical information available online, we compile a list of 34 cyberlocker services. In our raw clickstream data, we flag a streaming session whenever we observe a click to a linking site that is directly followed by a click to a cyberlocker site, or clicks to cyberlocker sites where a linking site is listed as the referral.

Piracy: Days This is a measure of the extensive margin of piracy consumption, making use of daily variation within users. We count the number of days on which a given individual uses an unlicensed video streaming website in a given week. A piracy day is flagged as such if we observe at least one visit to a unlicensed website. In this way, we address the concern that some platforms may require more clicks than others to reach content.

Piracy: Duration Our third alternative measure is provided by *Nielsen* and gives the time spent on each URL (in seconds). While video consumption should result in much higher values compared to navigational clicks, a few practical issues challenge the accuracy. For example, *Nielsen* only records time spent on pages in focus and time stops being recorded once the user switches to another tab. While this implies that the duration provided by *Nielsen* will potentially underestimate

the time spent on each URL, this measure is still strongly correlated with the true time spent on each URL.[14]

3.2.2 Licensed Consumption

Our data provide us with good proxies for several licensed video consumption channels. In particular, we can observe visits to websites related to movie theaters, licensed online video services, and DVD/Blu-ray purchases.

Licensed: Cinema We proxy for movie theater visits by measuring clicks on the main movie portals that include showing times (e.g. `kino.de`, `mymovies.it`) as well as the websites of the major movie theater companies in a given country.[15]

Licensed: Online We track visits to paid licensed video services. While European consumers could not subscribe to flat-rate services that were already popular in the U.S. (e.g. *Netflix*) and the number of digital pay-per-view services was limited in 2011, we are still able to measure the visits to platforms such as *Canalplay*, *Mediaset Premium*, *CinemaNow*, *Lovefilm*, and *iTunes*.[16]

Licensed: DVD We proxy for DVD and Blu-ray sales by measuring visits to pages in the DVD and Blu-ray categories on *Amazon*.[17] The home video market was dominated by DVD and Blu-ray in 2011, with a market share of more than 96%, leaving less than 4% to digital channels in Germany (GfK and Bundesverband Audiovisuelle Medien, 2013), similarly so in other European countries.[18]

[14] We randomly selected 500,000 URLs on `youtube.com` that were visited by users in our data and collected information about the duration of according videos via the YouTube API. The correlation between *Nielsen*'s measure of visit duration and the actual video duration is 0.79 (and 0.91 for YouTube videos shorter than 120 seconds, which are more likely to be watched completely).

[15] A representative survey among 8,639 German consumers estimates that 16.21 million people have bought cinema, concerts or theater tickets online in 2011. Around 30.5 million Germans went to a movie theater in 2011. This implies that almost every second cinema visitor purchased tickets online. See `http://tinyurl.com/nhur74u` and GfK and German Federal Film Board (2012).

[16] We cannot observe purchases on *iTunes*, because the *Nielsen NetView* application only captures traffic within the browser and *iTunes* is a standalone software. We are therefore only able to observe the visits to the *iTunes* webpage, which is a proxy of individuals signing up of the service and downloading the *iTunes* application to make purchases later. Market shares for 2011 are not available, but data in the first half of 2014 show that *Maxdome* dominates the German market with a share of 35%, followed by *iTunes* with 18%, *Lovefilm* (12%) and *Videoload* (10%). See `http://tinyurl.com/qb3jjsw`.

[17] We did this by crawling all *Amazon* URLs in our data to check the product category of items. *Amazon* is by far the dominant online retailer in the German market with a revenue of €4.8 billion in 2012. The second biggest online retailer is *Otto* with €1.7 billion in revenues. *Amazon*'s market position is similarly dominant in other European countries. See `http://tinyurl.com/pq9vyvf` and `http://tinyurl.com/jwvhbpo`.

[18] See `http://tinyurl.com/lzu6488` and `http://tinyurl.com/guqwkya`.

3.2.3 User Types

Because individuals may be affected differently by the shutdown of `kino.to`, it is useful to define groups according to their characteristics. In the German sample, 16.9% of the users have visited the `kino.to` website at least once between January 1st and June 8th 2011. We refer to these individuals as the **Kino** users, and to the individuals who never visited `kino.to` before its shutdown as **Non-Kino** users. We observe effectively zero visits to `kino.to` from users located in other countries.

For an additional analysis, we also construct a more granular distinction of user types. We distinguish between users of `kino.to` that did not visit any other piracy websites before the shutdown (**Kino: Singlehoming**) and those that did (**Kino: Multihoming**). Similarly, we distinguish between non-users of `kino.to` who visited unlicensed streaming sites before the shutdown (**Non-Kino: Pirate**) and those who did not (**Non-Kino: Non-Pirate**). Finally, for the purpose of analyzing aggregate effects, we group all German users in a variable named **Germany**.

3.2.4 News Consumption

To measure news readership, we collected news articles and blog posts covering or following up on the shutdown of `kino.to`. We pulled search results for the term "kino.to" from *Google*, *Google News*, and the proprietary news databases *Factiva* and *LexisNexis* and went through all 112.7 million URLs accessed by German users in our data to identify those that included some version of "kino.to."[19] After careful manual cleaning, we arrived at 1,835 distinct URLs of news articles. When matching these URLs back to our clickstream data, we obtained 170 news articles that were actually visited by the individuals in our sample. We then created the dummy variable **News** that turns one once a user clicks a corresponding URL for the first time.

In a next step, we classified the content of news articles (Zamoon and Curley, 2008; Goh et al., 2011) into one the four following categories: *Background*, *Illegal*, *Legal* and *Alternative Websites*. About a third of the articles cover topics in multiple categories. Examples of background stories (**News: Background**, 44%) include "Polizei schaltet kino.to ab (Police takes down kino.to)" in *Zeit Online* and "Millionenkonten bei kino.to entdeckt (Millions found in kino.to bank accounts)" in

[19] See e.g. http://www.zeit.de/digital/internet/2011-06/kinotto-razzia-streaming.

Süddeutsche Zeitung, which summarize key facts about `kino.to` and the procedure and surrounding events of the takedown.[20] Articles like "Millionen Nutzer haben Angst (Millions of users fear legal action)" and "Kino.to: GVU will Nutzer verfolgen und bestrafen (GVU wants to prosecute and punish users)" quote industry representatives or lawyers saying that consumers may face criminal and civil prosecution. We include articles featuring such claims in the category **News: Illegal** (11%).[21] Typical claims in the **News: Legal** (7%) category are that streaming may not count as copying in the sense of German copyright law, and consumers therefore do not need to fear legal consequences.[22] The last category of media coverage – referring to unlicensed alternative websites (**News: Alternatives**, 46% of the articles) – includes stories such as "Kino.to-Nachfolger bereits online: Video2k.tv (Kino.to successor already online)" in *Gulli*, and "Illegales Filmportal ist zurück – Kino.to-Piraten verhöhnen Ermittler (Illegal movieportal is back – Kino.to-pirates mock investigators)" in *Bild*.[23]

The different types of stories published in news outlets following the shutdown of `kino.to` illustrate the idea that media coverage may generate externalities going in several directions. On the one hand, coverage may deter consumers from using alternative websites out of fear of legal action. On the other hand, media coverage may inform users of the seized platform about the existence of alternative websites and therefore lower search and entry costs. Similarly, it may also inform individuals who were initially unaware of the existence of such websites, causing them to start consuming unlicensed content online.

3.3 Estimation Strategy

3.3.1 The Shutdown of kino.to as a Natural Experiment

The main goal of this paper is contribute to the understanding of the effectiveness and consequences of online copyright enforcement. The richness of our highly disaggregated data allows us to not only investigate direct effects, but also provide evidence for potentially confounding or reinforcing indirect effects. Like many recent studies that are interested in evaluating anti-piracy or cybercrime enforcement policy (e.g. Adermon and Liang, 2014; Danaher and Smith, 2014; Reimers, 2016;

[20] See `http://tinyurl.com/6bjxxo2` and `http://tinyurl.com/mam4sx9`.
[21] See `http://tinyurl.com/3mfm9tq` and `http://tinyurl.com/635vgcl`.
[22] See `http://tinyurl.com/6ad5dus` and `http://tinyurl.com/lhx8ub8`.
[23] See `http://tinyurl.com/kkj3bbb` and `http://tinyurl.com/5usgxsu`.

Peukert et al., 2017; Hui et al., forthcoming; Zhang, forthcoming), we focus on a specific empirical setting, and interpret the shutdown of kino.to as a natural experiment that removes an important option from the consumers' entertainment choice set, suddenly and unexpectedly.

A number of facts indicate that the timing of the shutdown was indeed exogenous to all parties involved – the movie industry, consumers, and the owners of kino.to. First, the management team did not seem to know about the intervention of kino.to as they did not relocate to a third country before their arrest.[24] We therefore do not expect them to have carried out any type of strategic action, e.g. removing links, in anticipation of a crackdown. Second, our data shows no evidence of consumers changing their visits to kino.to shortly before the domain went offline. Finally, although industry representatives were seemingly involved in the investigations, it is very unlikely that they could have affected the exact timing of the operation in a way that would affect the dependent variables in our analysis. We could not find any evidence that movie theaters, or offline or online retailers (including licensed video platforms) strategically changed contents or prices – neither in anticipation of the precise date of the shutdown, nor afterwards.

3.3.2 Econometric Model

Following the policy evaluation literature (e.g. Card and Krueger, 1994), we use a difference-in-differences approach, in which we compare the behavior of consumers that were affected by the policy to the behavior of consumers that remained unaffected. Under some moderate assumptions, this allows to establish a plausibly causal estimate of the impact of the shutdown of kino.to on the consumption of both unlicensed and licensed video content.

Individuals located outside of the German-speaking countries constitute a good control group because they are very unlikely to be affected by the shutdown of kino.to, neither directly nor indirectly. First, we observe essentially zero clicks to kino.to from users located in Italy, France, and the UK. Second, media coverage of the shutdown was almost exclusively limited to news articles in German outlets and written in German.[25] Because we are interested in testing for externalities

[24] According to news articles, 13 suspects were immediately arrested. See for example http://www.spiegel.de/netzwelt/netzpolitik/kino-to-ermittler-verhaften-mutmassliche-betreiber-von-raubkopie-seite-a-767375.html.

[25] Less than 2.5% of the news articles and blog posts covering and following up on the shutdown of kino.to we observe are written in English, 85% of the URLs have the German top-level domain .de.

caused by the intervention, we distinguish between two different treatment groups within Germany. The first group, which includes individuals that visited `kino.to` before its shutdown (Kino users), was directly affected by the intervention. The second group of consumers includes German individuals that never visited `kino.to` (Non-Kino users). By definition, these individuals could only have been indirectly affected by the shutdown.

The identifying assumption in any difference-in-differences setting is that the dependent variable would have followed a similar trend in the treatment and control groups had the policy shock not happened. A necessary condition for this assumption to hold is that trends of treatment and control groups do not differ before the intervention. Using the long time dimension of our data, we provide some statistical insights that support this assumption, and therefore address the concern that changes in the dependent variable would have occurred in the absence of the policy shock.

The baseline specification of our difference-in-differences model is defined as follows:

$$\begin{aligned}\ln(Clicks_{it}+1) = \alpha &+ \delta_1\left(After_t \times Kino_i\right) + \delta_2\left(After_t \times \textit{Non-Kino}_i\right) + \sum_c \beta_c(t \times C_c) \\ &+ \beta_1\left(t \times Kino_i\right) + \beta_2\left(t \times \textit{Non-Kino}_i\right) + w_t + \mu_i + \varepsilon_{it}, \end{aligned} \tag{1}$$

where $Clicks_{it}$ refers to the number of visits to either unlicensed or licensed video consumption websites of individual i in week t, t is a linear time trend, $Kino_i$ and $\textit{Non-Kino}_i$ indicate whether individual i is a Kino user or a German Non-User of Kino, $After_t$ is a dummy variable equal to one during the weeks after the shutdown, the β coefficients capture country- and group-specific time trends and ε_{it} is an individual-time specific error term. The δ coefficients correspond to the effects of the shutdown on the two treatment groups. Specification (1) also includes week fixed effects and individual fixed effects, which allow us to control for any unobserved week-specific and cross-sectional-invariant factors as well as individual-specific and time-invariant factors. Note that the terms corresponding to $After_t$, $Kino_i$, and $\textit{Non-Kino}_i$ are not included in the specification as they are implicitly controlled for by the week and individual fixed effects. Following the literature, we estimate equation (1) using OLS and cluster standard errors at the individual level (Bertrand

et al., 2004). As the individual-level data tends to be dispersed and as we are interested in relative changes, we use the logarithm of the number of clicks as a dependent variable.[26]

4 Results

In what follows, we first show how the shutdown affected the consumption of unlicensed video content, both directly and indirectly. We then provide evidence that exposure to news articles that discuss the shutdown can explain the externalities we observe and show how this varies across categories of news articles. We go on to examine how the shutdown affected the consumption of licensed alternatives. We provide additional evidence that indirect effects and externalities are driven by how much knowledge individuals have about unlicensed alternatives, by distinguishing between single and multihoming users. We then "zoom out" and discuss what our results imply on the aggregate and speculate about welfare effects. Finally, we discuss the changes in the overall structure of the market for unlicensed video consumption after the enforcement effort. Throughout, we present a range of robustness checks regarding the identifying assumption of the difference-in-differences model and potential measurement error in the dependent variable.

4.1 Effects on Unlicensed Video Consumption

4.1.1 Descriptive Evidence and Parallel Trends

We start our analysis with a descriptive look at how the consumption of unlicensed content changed with the shutdown. The plot of average overall piracy levels in Figure 1 shows that the overall number of visits to unlicensed video streaming sites declined substantially right after `kino.to` was removed from the market. However, this decline is clearly not as strong as the decline in visits to `kino.to`. Furthermore, visits to piracy websites quickly increase again following the 5^{th} week after the shutdown and almost return to pre-intervention levels towards the end of the observed period.

Figure 2 plots the average total clicks to piracy websites separately for Kino users, Non-Kino users and users in France, Italy and the UK (termed "international users" in the remainder of the text). For Kino users, we observe a strong decline in piracy consumption directly after the shutdown, which quickly recovers and then stagnates from the 5^{th} week after the shutdown onwards. The post-

[26] As we have many zeros in the dependent variable and want to avoid losing those observations, we follow the prior literature and take the log over $Clicks_{it} + 1$. We show below that results remain robust when we exclude outliers.

shutdown levels of Kino users stay below the pre-shutdown levels for the entire period of observation. Looking at Non-Kino users, we first observe that their average piracy levels are substantially lower than the piracy levels of Kino users. However, we see a sharp increase directly after the shutdown, which still remains much lower than the piracy levels of Kino users. The group of international users shows fairly stable levels of piracy consumption throughout the observed period. Most importantly, Figure 2 provides evidence that the necessary condition of the parallel trends assumption seems to hold. Average piracy levels of Kino users, Non-Kino users and international users follow very similar trends before the shutdown. Furthermore, the fact that overall piracy levels of international users remain stable throughout the entire year, and especially do not markedly change with the shutdown, strongly suggests that these individuals constitute a valid control group.

We now go beyond this simple visual inspection and provide more detailed evidence supporting the validity of our parallel trends assumption. We estimate the following specification to test, week by week, whether the number of visits to piracy websites of Kino and Non-Kino users differ from the number of visits to piracy websites of international users:

$$\ln(Clicks_{it}+1) = \alpha + \sum_t \beta_0^t w_t + \sum_t \beta_1^t \left(w_t \times Kino_i\right) + \sum_t \beta_2^t \left(w_t \times Non\text{-}Kino\right) + \mu_i + \varepsilon_{it}. \quad (2)$$

We define the week before the shutdown as the left-out reference week. Testing that $\beta_1^t = 0$ and $\beta_2^t = 0$ (no difference between treatment group users and international users) for all t in pre-shutdown period therefore provides a more direct test in support of our parallel trends assumption. Estimates of β_1^t and β_2^t for all t, along with 90% confidence bands are reported in Figure 3. Overall, most of the pre-shutdown coefficients appear to be statistically indistinguishable from zero prior to the intervention and we do not observe a systematic trend.[27]

[27] An alternative way of checking for the validity of our identification assumption is to perform a placebo test, where we focus on the pre-shutdown period only and define a "placebo" shutdown at the middle point of that time period. Estimating our difference-in-differences model (1) on this subset of the data should provide statistically insignificant results if the identification assumption is valid. Performing such an exercise indeed leads to non-significant estimates for the corresponding coefficients δ_1 (coeff= -0.044, s.e.= 0.032) and δ_2 (coeff= -0.002, s.e.= 0.004) in equation (1). One might also be worried that some of the pre-shutdown coefficients are significantly different from zero (see Figure 3). If we exclude those weeks from the sample, the results, which are not presented here but available upon request, are again very similar to our main results presented below.

4.1.2 Econometric Evidence

We now turn to the results of estimating equation (1). Those baseline results are reported in column (1) of Table 3. The estimate for the average effect of the intervention on Kino users is significant and equal to -0.317 (s.e.= 0.033), indicating that the intervention was successful in reducing piracy consumption levels by 27.2%.[28] If we put these results in relation to the average 79% market share of `kino.to` in the pre-shutdown period, the decline is much smaller than what we would expect if consumers did not switch to alternative piracy websites. Instead of only distinguishing between two time periods (before and after the shutdown) with the $After_t$ interactions in equation (1), we can also look at the post-shutdown coefficients from the regression of equation (2) in Figure 3. Confirming what we already saw in the descriptive statistics, we find the strongest decline in piracy levels for Kino users in the first five weeks after the shutdown, with some uptake afterwards. This result indicates that the existence of alternative unlicensed platforms challenged the effectiveness of `kino.to`'s shutdown in deterring consumers from online piracy.

The estimated coefficient on the $After \times Non\text{-}Kino$ variable in column (1) of Table 3 is positive and significant at the 10% level.[29] This indicates that shutting down `kino.to` did not only affect Kino users directly, but also individuals that never visited `kino.to`. On average, those individuals increase their visits to piracy websites by 0.8%. Again, estimates for the post-shutdown period from the flexible form regression in equation (2), reported in Figure 3, show how the effect of the shutdown changed over time. We find that the effects on Non-Kino users did not immediately materialize, but became pronounced following the first five weeks after the shutdown. Note that this timing is symmetric to the timing of the increase in piracy usage we find for Kino users.

Before exploring the mechanism behind this externality in more detail, we report results of various additional specifications that provide further support to our identification strategy and address concerns regarding a potential measurement error in the dependent variable.

As a first robustness check, we construct an alternative control group by means of a propensity score matching based on observables, i.e. gender, age, income, education and overall news consumption.

[28] Point estimates are transformed to percentage values as follows: $PercentageChange = (exp(Coefficient) - 1) * 100$.

[29] As shown in Table 4 and discussed below, the net effect is driven by two opposing effects. This explains that the coefficient is small in magnitude and relatively imprecisely estimated.

For each individual in the treatment group, we find a control individual using one-to-one matching without replacement. Following Lechner (2002), we use binary probit models to estimate propensity scores for the two treatment groups Kino users and Non-Kino users. The results in column (2) are very similar to those results obtained with the control group of international users in Table 3.

As a second robustness check, we consider three alternative measures of piracy. We first proxy for the number of streams of unlicensed content by measuring subsequent visits to cyberlockers. A second alternative measure involves the weekly number of days an individual visited websites offering unlicensed content. The third proxy measures the weekly duration spent on piracy websites. Results are reported in columns (3), (4) and (5) of Table 3 and are in line with our preferred specification. This alleviates the concern that our baseline results could be driven by measurement error, for example caused by differences in the design of alternative piracy websites that would make more clicks necessary to search for and consume content compared to `kino.to`.

Finally, because of the dispersed distribution of the dependent variable, a concern could be that our results are driven by outliers. We check the robustness of our results to outliers by dropping observations with the 1% smallest and largest residuals and 1% smallest and largest predicted values after running the baseline regression. Re-running the regression on this new sample generates the results presented in column (6), which remain similar to column (1).

4.2 Externalities from News Coverage

Our results above indicate that Non-Kino users increased their consumption of unlicensed content following the intervention. We now test if the media coverage surrounding the shutdown of `kino.to` can explain these unintended externalities.

Using visits to URLs of news articles and blog posts that cover and follow up on the shutdown of `kino.to`, we define the dummy variable $News_{it}$ equal to one starting in the week where we observe the individual's first visit to one of those URLs. To test whether the shutdown effect varies

conditional on reading news about `kino.to`, we add the following interactions to our baseline model in equation (1): $After_t \times Kino_i \times News_{it}$ and $After_t \times Non\text{-}Kino_i \times News_{it}$.[30]

The results are reported in Table 4.[31] To ease comparison with our baseline results, column (1) of Table 3 is included in the first column of the table. Column (2) reports estimates of the augmented model with three-way interaction terms comparing users that have read news about `kino.to` to those that did not. While there is no significant difference for Kino users, we observe a large and significant difference for Non-Kino users: their consumption of pirated consumption increases 35% more than the insignificant baseline increase of 0.5%. We observe 100 Non-Kino users that read news, which represents 2.4% of the total number of Non-Kino users, and 11.9% of the total number of Kino users, making this an effect of substantial economic significance.

In column (3), we further distinguish the content of the news articles to identify possible mechanisms. As before, we do not find any significant difference within Kino users. For Non-Kino users, we see that the strong positive effect of reading about the shutdown on piracy consumption is driven mainly by reading news articles that conclude that using streaming services would not lead to legal consequences for consumers, but also by reading news articles that mention unlicensed alternatives to `kino.to`. Much in line with theory, the effect of reading articles that conclude that using unlicensed streaming sites would be illegal is negative, yet not significant (p-value 0.104).

4.3 Effects on Licensed Video Consumption

While we have shown that shutting down `kino.to` led to a decrease in overall piracy levels, it could only have benefited content creators and copyright holders if consumption of licensed content also increased as a result from the intervention. We analyze the effects of the shutdown on licensed video consumption proxied by clicks on movie theater websites, licensed video streaming services, and DVD/Blu-ray pages on *Amazon*.

[30] We also add group-specific time trends of the $News$ variable. Note that we cannot separately identify coefficients for lower-order interaction variables in this model. By definition, users cannot read news about the shutdown before it happened, and therefore $News_{it} = 0$ if $After_t = 0$. This makes $After_t$ and $News_{it}$ collinear, and therefore also any interaction with each.

[31] In results not reported here, but available upon request, we can show that the effects are very similar when we use a control group generated from a propensity score model that matches individuals based on observable characteristics.

The identifying assumption here is again that clicks to licensed content of treatment and control groups would have followed similar trends had the shutdown not happened. We can again partially test this assumption by looking at cross-group differences in trends prior to the intervention. Figures 4, 5, and 6 plot the interactions of week dummies and user type from a regression of equation (2).[32]

Results are reported in Table 5.[33] Columns (1), (3), and (5) report the overall effects on Kino and Non-Kino users. These specifications present no evidence of Kino users substituting into any of the licensed alternatives. For Non-Kino users, we observe a slight reduction in paid licensed streaming services of 0.6%.

When we again include the news interactions in columns (2), (4) and (6), we get positive and significant coefficients for the news interactions regarding visits to cinema websites. The $News$ interactions are significant for both the Kino and Non-Kino users, suggesting that both groups increase their visits to movie theaters after they read news about the shutdown. The decrease in consuming streamed licensed content for Non-Kino users that we observed for the overall effects is not significantly moderated by reading news about the shutdown.

4.4 Effects on Different Levels of Aggregation

We now assess the effect of the shutdown on alternative levels of aggregation. Speculating somewhat beyond what our analysis allows us to show in a causal manner, we first provide suggestive evidence that indirect effects and externalities are driven by the amount of knowledge individuals have about unlicensed alternatives. We then run a country-level analysis to assess the overall effect and speculate about the size of welfare effects.

[32] As discussed in footnote 27, we can also conduct placebo tests to check for the validity of our identification assumption. Performing such exercise for our different dependent variables leads to non-significant estimates for the corresponding coefficients δ_1 and δ_2 in equation (1) for all but one case (the δ_2 coefficient when using clicks on $Amazon$ DVD pages as a dependent variable, which turns out to be marginally significant: coeff$= -0.007$, s.e.$= 0.004$). We additionally perform our estimations by focusing on a shorter time window around the shutdown, which essentially removes weeks that are significantly different from zero (see Figures 3-6). Those results, which are not presented but available upon request, are again very similar to our main results presented in Table 5.

[33] The effects reported in Table 5 can be replicated to a large extent by using an alternative control group generated from a propensity score model that matches individuals based on observable characteristics. The results, which are not reported here but available on request, show a small positive coefficients (significant at the 10% level) for $After \times Kino$ and $After \times Non-Kino$ regarding visits to movie theaters. All other coefficients are very similar to those in Table 5.

4.4.1 The Effect of Knowing about Unlicensed Alternatives

Our definition of Kino users includes users that only visit `kino.to` and no other unlicensed video streaming website (Kino: Singlehoming, 57%), as well as users that visit `kino.to` along with other services (Kino: Multihoming, 43%). Similarly, our definition of Non-Kino users includes users that did visit other piracy websites before the shutdown (Non-Kino: Pirate, 6%) as well as those that did not visit any piracy websites before the shutdown (Non-Kino: Non-Pirate, 94%). We split each of the two treatment groups into two subgroups to get a more nuanced view of how existing knowledge about other piracy sites could influence the reaction to the shutdown.[34] Knowing about unlicensed alternatives could play out in two ways. First, because Kino multihomers already knew about alternative unlicensed video streaming websites before the removal of `kino.to`, they should perhaps find it easier to switch to those websites (Chen and Hitt, 2002; Goldfarb, 2006a,b). Second, because Non-Kino pirates were already exclusively using alternative platforms before the shutdown of `kino.to`, we should not expect their usage of alternative piracy websites to be affected by the intervention.

We estimate our difference-in-differences model using visits to alternative unlicensed video streaming websites (i.e. visits to all unlicensed streaming websites except `kino.to`) as well as visits to licensed video consumption as the dependent variable. Results are presented in Table 6. Column (1) shows that Kino users that visited alternative piracy websites before (multihomers) increase their visits to those sites more than singlehomers. Additionally, we observe no significant effect for the Non-Kino users that visited alternative piracy websites before the shutdown (Non-Kino Pirate). Taken together, these results provide evidence that prior knowledge about unlicensed alternatives triggers switching, not an unobserved trend that makes those sites more attractive per se. The effect for users that never visited piracy websites is positive and significant. This provides some additional evidence of unintended externalities and supports the results discussed above.

Regarding licensed consumption, we first find that singlehoming Kino users increase their visits to movie theater websites in column (2). The effect size is 2.6%. This suggest that the intervention was

[34] Note that any measure of prior knowledge about alternative piracy websites, including the multihoming status we use below, may be correlated to unobservables. For example, young and tech-savvy Internet users may be more interested in consuming contents online, and therefore also in multihoming on different piracy websites. The following results therefore need to be interpreted with caution.

at least somewhat effective in convincing some individuals to substitute towards licensed offerings. Intuitively, it makes sense to see this uptake only for singlehoming users since they do not readily know about alternative unlicensed websites. Regarding licensed online video content in column (3), we observe no effect for Kino users and find that users that never pirated before the shutdown decrease their clicks to licensed offerings. Again, this provides further supporting evidence of our main results. The unintended externalities only affect users that never pirated before the shutdown. Finally, we do not observe any effects when it comes to visiting DVD/Blu-Ray pages on *Amazon* in column (4).

4.4.2 The Aggregate Effect and Implications for Welfare

A necessary condition for the enforcement effort to be welfare enhancing – net of any enforcement costs – is that the resulting producer surplus exceeds the reduction in consumer surplus that results from lower piracy levels. To speculate about the welfare implications of the shutdown of `kino.to`, we assess the aggregate effect of the intervention by combining Kino users and Non-Kino users into a single treatment group, labeled **Germany**. The results of this analysis are presented in Table 7. Compared to France, Italy and the UK, we find an overall reduction in piracy levels in the German market of 4.5%, but do not observe any significant changes in any type of licensed consumption. We conclude that the shutdown reduced overall welfare as consumer surplus is reduced and there is no evidence of an uptake in licensed consumption.[35]

We try to quantify the welfare loss in a back-of-the-envelope calculation. A 4.5% decrease in clicks to piracy sites is equivalent to 0.17 streams per capita (using our **Piracy Streams** measure). Based on estimates of sales displacement rates in the literature (Hui and Png, 2003; Rob and Waldfogel, 2006, 2007; Bai and Waldfogel, 2012; Danaher et al., 2010), we can assume that the monetary equivalent of the utility of streaming a movie via an unlicensed websites is somewhere between 3.5–20% of the price of the licensed version. The average price on *iTunes* in Germany is 3.00 Euro for rentals and 7.99 Euro for purchases, the average movie ticket price in 2011 in

[35] One should also take into account the potential effect of the intervention on prices. As mentioned in section 3.3.1, we do not find any evidence that movie theaters or offline and online retailers changed their content or prices as a result of the `kino.to` shutdown.

Germany is 7.39 Euro, and the average price of DVDs and Blu-rays at *Amazon* is 16.57 Euro.[36] Let's consider one scenario where consumers displace sales at the lowest displacement rate and always prefer the cheapest option (*iTunes* rentals) and another scenario where consumers have the highest displacement rate and prefer the most expensive option (DVD/Blu-ray). The resulting estimate of per capita change in consumer surplus is in the range of 2–56 cents.[37] Using census and ITU data for the number of Internet users in Germany (65.21 million in 2011), our estimate of total loss in consumer surplus (and therefore overall welfare) is somewhere between 1.16 and 36.74 million Euro per week.[38]

4.5 Post-Shutdown Market Structure

We now turn to the analysis of the overall structure of the market for unlicensed video streaming following the shutdown of `kino.to`. The raid on June 8, 2011 involved the seizure of servers, databases of the linking site itself, and integrated cyberlocker services. However, the shutdown only resulted in a shock to part of the whole piracy ecosystem. Because content hosted on other cyberlockers remained online, it was relatively easy for existing competitors or even new entrants to supply similar content as the one initially offered by `kino.to`. Shutting down the major platform may therefore simply result in some existing or new website capturing most of the market. However, it is a priori not clear whether a new dominant platform would emerge to take `kino.to`'s place, or if a more fragmented market should be expected as a result of the intervention.

We look at the evolution of unlicensed platforms' weekly market shares to assess how the streaming piracy market was affected by the shutdown of `kino.to`. Figure 7 presents the evolution of market shares for the different platforms defining our market, distinguishing between `kino.to`, `kinoX.to`, `movie2k.to`, and the 17 remaining websites included in our market definition. The figure shows remarkable changes in the structure of the streaming piracy market after the intervention. Before the shutdown, `kino.to` (dashed blue line) clearly dominated the market with an average market share of about 80%. The second largest player `movie2k.to` had a market share of about 10%, and

[36] Price information about purchase and rental prices on *iTunes* comes from the meta search site `werstreamt.es` (in 2014), cinema ticket prices from the German Federal Film Board (FFA), and we calculate average DVD/Blu-ray prices directly from the *Amazon* pages that individuals visited in our data.

[37] $0.17 * 0.035 * 3 * 100 = 1.79$ and $0.17 * 0.20 * 16.57 * 100 = 56.34$

[38] If we were to take the enforcement costs into consideration, which are probably largely borne by tax-payers, the estimated loss in consumer surplus would of course be higher.

the remaining websites jointly accounted for an average market share of 10%. During the first four weeks after the intervention, `movie2k.to`'s market share increased to about 55%, and the market share of all other streaming sites increased to about 45%. After four weeks `kinoX.to` entered and immediately gained 20% market share, while `movie2k.to`'s market share decreased to about 30%.[39] Eight weeks after the shutdown, the market shares changed to about one third each.

The changes in market shares imply changes in market concentration. Figure 8 shows the weekly evolution of the Herfindahl-Hirschman Index (HHI) of the unlicensed video streaming market.[40] This adds additional insights since we do not aggregate the "long tail" of websites in the HHI measure. Before the shutdown of `kino.to`, the HHI was around 6,500. It decreased sharply to 3,000 during the week of the shutdown, but immediately increased to about 4,000 after two weeks. After four weeks, and following the entry of `kinoX.to`, the HHI decreased again sharply to about 2,000, where it remains for six weeks before increasing slightly to about 3,000 at the end of the year.

While the shutdown of `kino.to` had important effects on the market structure of the German piracy market, it is important to note that these effects are also likely to be context-specific. One should therefore interpret and generalize our results with caution. First, we only observe six months of data after the shutdown of `kino.to` and therefore cannot test whether the observed market structure will remain stable in the longer run. For instance, it is possible for one of the remaining platforms to increase its market share to the point of having a market structure similar to the one preceding the intervention. Second, market-specific characteristics could influence the impact of the shutdown on the structure of the piracy market.[41]

We note that these changes in market structure, while context-specific, can have important policy implications. In the case of the German market for unlicensed video streaming, our results suggest

[39] Note that the decrease in `movie2k.to`'s market share is not due to a decrease in traffic to the platform, but by an expansion of the overall piracy market driven by the entry of `kinoX.to`.

[40] The HHI is calculated by summing up the squared market shares of all active unlicensed platforms. Using percentages to express market shares leads to values of the HHI ranging from 0 to 10,000, the latter corresponding to the case where a single platform has a market share of 100%.

[41] For instance, the initial level of market concentration, the substitutability of content across existing sites, or even the severity of the punishment imposed on the platform's owners, could all affect the impact of the shutdown on the structure of the market. Such market specificities may also influence the entry decision of a new platform, which may in turn affect the effects of such intervention on the structure of the piracy market.

that the shutdown of `kino.to` made, in the short term at least, future interventions potentially more costly – as there would not be a single dominant platform to shutdown anymore – and potentially less effective if only a single website is targeted by the intervention.

5 Discussion

The robustness checks detailed above have helped to address concerns regarding the internal validity of our findings, discussing the choice of measures and control group. External validity of our results may nevertheless remain a concern. While our analysis provides insightful results, it is essentially a case study, with certain limits to generalizability. In particular, one may wonder whether similar results could be expected from a similar enforcement carried out in a different country or at a different point in time. Guided by the literature on threats to external validity in quasi-experimental research (Cook and Campbell, 1979; Howell, 2005) and the available evidence, we carefully discuss the boundaries of our research regarding its geographic, institutional, and historical context. Finally, we discuss alternative private and public enforcement policies and their potential to reduce piracy levels and increase licensed consumption.

5.1 External Validity Regarding Geography

A first concern is related to a potential interaction of setting and treatment, i.e. that the effect may differ across institutional and geographic settings.

How representative are German consumers? Evidence suggests that cross-country differences in piracy rates can be explained by the strength of enforcement and aggregate demographics such as income and education (van Kranenburg and Hogenbirk, 2005; Proserpio et al., 2005; Walls, 2008). Reflecting such differences, the piracy rate in Germany in 2011 is lower than in other European countries, but higher than in the US.[42] The per-capita propensity to pirate alone, however, is not enough to draw conclusions about potential cross-country differences regarding the displacement of licensed content. Although willingness to pay is clearly correlated with intentions to pirate (see the extensive review in Watson et al., 2015), we are not aware of systematic evidence showing that the willingness to pay for licensed content varies across countries.

[42] Germany's piracy rate in 2011 is about two-thirds of a standard deviation below the European average, and 40% above the piracy rate of the US. Calculations are based on data from Table 1 in Danaher and Smith (2014) and page 9 in Business Software Alliance (2012).

How representative is the German market for unlicensed video streaming? A concern could be that our results crucially depend on the structure of the piracy market and the relative quality of different unlicensed streaming options. Consider a scenario where, after the shutdown of a high appeal website, consumers can only access low appeal alternatives. Licensed options may consequently gain in relative attractiveness. Evidence suggests that such a scenario is probably not very realistic. Lauinger et al. (2013) show that it is fairly easy to replicate the content of a linking site, because the underlying video files are stored elsewhere, and multiple copies exist.[43] As a consequence, what we document in the German case – that other websites (including new entrants) quickly gain traffic – is likely to happen in other markets as well. Anecdotal evidence from recent examples is consistent with this idea. Within a few weeks following the shutdown of the hugely popular unlicensed sites `kat.cr` (global Alexa rank 69) and `zone-telechargement.com` (French Alexa rank 11) by legal authorities in late 2016, multiple new platforms entered the market.[44] In general, Germany is no exception when it comes to anti-piracy interventions. A variety of other countries have introduced policies targeted at consumers and suppliers of unlicensed content, some of which are thoroughly documented in the literature (Danaher et al., 2014; Adermon and Liang, 2014; Danaher and Smith, 2014; Poort et al., 2014; Peukert et al., 2017; McKenzie, 2017).

How representative is the German market for licensed video consumption? A growing literature shows that availability of licensed content can reduce piracy (Danaher et al., 2010, 2013; Aguiar and Waldfogel, forthcoming). Accordingly, a potential explanation for why we don't observe more substitution towards licensed consumption may be found in the relative quality of licensed online alternatives in the German market in 2011 (Poort and Weda, 2015).[45] Compared to other (European) countries, there is not much reason to believe that Germany was an exception when it comes to the availability and attractiveness of licensed content, neither online nor offline. To date, in 2017, Apple doesn't offer movies in 45 (24%) and TV shows in 149 (79%) of 189 markets

[43] Looking at all links listed on `rlslog.net`, a linking site that is very similar to `kino.to`, Lauinger et al. (2013) show that the median number of alternative links to the same content (hosted on a variety of cyberlockers) is 48.

[44] see `https://venturebeat.com/2016/07/31/kickasstorrents-mirrors-go-down-but-new-kat-sites-quickly-spring-up/` and `http://www.lemonde.fr/pixels/article/2016/12/15/zone-telechargement-est-il-vraiment-de-retour_5049581_4408996.html`.

[45] We do not have access to reliable data on the catalogues of licensed services in 2011. However, according to the comparison website `www.werstreamt.es`, still in November 2014, the licensed German market offers less content than `kino.to`, with 11,600 movies on `iTunes`, 8,500 on `Maxdome`, 5,800 on `Videoload`, and 1,000 on `Netflix` compared to 20,000 movies on `kino.to`.

where they operate an *iTunes Store*.[46] Data from 2013 suggests that the vast majority of movies in a country-specific *iTunes Store* in Europe are only available in one language (Gomez-Herrera and Martens, 2015). The streaming service *Netflix* had not started to roll out in Europe before 2012, arriving in Germany and France in 2014 and in Italy in 2015.

In addition, it also seems that prices of licensed offerings in Germany were not very different compared to other countries. Gomez-Herrera and Martens (2015) show that cross-country price differences of digital content can be largely explained by overall price levels, which is essentially the same regarding cinema ticket prices.[47] Finally, in a study that looks at an entirely different experiment, analyzing very different data from the US, Danaher et al. (2010) arrive at results very similar to ours. After the removal of content on *iTunes*, piracy rates for the same content increased, yet there is no effect on sales of respective DVDs at *Amazon*.

5.2 External Validity Regarding History

We now discuss the potential concern that the effects identified in our analysis may differ across time periods.

How will digital piracy and licensed offerings change? According to a joint report of the music and advertising industry in 2012, infringing websites are predominately financed by advertising or subscription models.[48] Hence, as long as there is demand for unlicensed content that can be monetized, the incentives to operate large-scale piracy websites are likely to remain strong. An emerging literature suggests that the appeal of piracy may decrease over time, mainly due to improvements in licensed alternatives. Theoretical work shows that content services where consumers can choose between fee based or free and ad-supported subscriptions (a model that is mostly offered in the music market, much less in the video market) can reduce the demand for piracy (Thomes, 2013). Recent evidence in Aguiar and Waldfogel (forthcoming) suggests that the licensed streaming platform Spotify – which operates a freemium business model – has had a negative and significant impact on recorded music piracy. Data from the Netherlands in Poort

[46] See https://en.wikipedia.org/wiki/ITunes_Store.

[47] To look into this, we collected yearly average cinema ticket prices for Germany (FFA), Italy (SIAE), France (CNC) and the UK (UK Cinema Association) and consumer price index data (OECD) for 2010–2014. Regressing consumer price index data on an index of cinema ticket prices (both base 2010) yields a coefficient of 0.9

[48] Google and PRS (2012), "The six business models for copyright infringement", https://docs.google.com/file/d/0Bw8Krj_Q8UaENDhEOG1LVFRhVkU/view.

and Weda (2015) shows that piracy levels of music have declined from 35% to 23% between 2008 and 2012, while piracy levels of video content increased from 11% to 18% during the same time. Relying on survey data, the authors conclude that this difference can be explained by differences in how consumers perceive availability and price of licensed music vs. video offers. The idea that consumers do not switch to licensed platforms because their preferred content is not available can be partly tested with our data. Looking at the URLs of visited pages on `kino.to`, we see whether users were watching movies or TV shows. This allows us to categorize users based on their content preferences. Distinguishing between the effects of the shutdown on users who mainly watched TV series on `kino.to` and users who mainly watched movies, shows that the former group reacted to the shutdown to a larger extent. Usage of alternative piracy websites is similar for both types of users before the shutdown, and increased 50% more for users that mainly watched TV shows thereafter.[49] This suggests that it is mainly a preference for TV shows that convinces consumers to switch to alternative websites. An implication could be that firms might be able to strategically react to differences in user preferences and offer specialized products. However – in line with the results above – we do not find evidence that either type of Kino user increases visits to licensed video streaming services.

In conclusion, if availability and pricing of licensed offerings becomes more attractive, it is likely that more consumers switch to licensed offerings.[50] Yet, according to anecdotal evidence, the most significant changes towards full digital availability of movies are yet to come – more than five years after the enforcement effort we study. Recent news reports suggest that movie studios are negotiating with cinema owners about reducing the window between theatrical release and video on-demand in exchange for a share of streaming revenues.[51] Reportedly, movies would become available for streaming three weekends after the theatrical release at a price of $30–50 per movie.

5.3 Alternative Policy Levers

Based on suggestive evidence and established results in the literature, we conclude that the effects we document are not very likely to differ across institutional and geographic settings. However, we

[49] Results are not reported here but are available upon request.

[50] Note, however, that the mere availability of licensed offerings may not be enough to curtail piracy. Godinho de Matos et al. (forthcoming) show that reducing piracy also requires offering licensed content much earlier and at much lower prices than those currently offered in the marketplace.

[51] See `http://tinyurl.com/lm8r5vt`.

have reasons to speculate that our findings are specific to the historical timing of the shutdown. Better availability and lower prices of licensed consumption options introduced in the recent years could help to convince more consumers to use legitimate offerings if further developed. Looking ahead, we discuss whether alternative policy levers could be more effective.

Public enforcement There are reasons to expect stronger effects from greater enforcement efforts on the supply-side. In the model of Dey et al. (2016), stronger supply-side enforcement leads to higher entry costs for unlicensed websites, which in turn reduces the content available for consumers. The authors show that supply-side enforcement can lead to desirable welfare outcomes (which is similar to the result in Tsai and Chiou, 2012). In the light of this model, an interpretation of our results could be that the enforcement intensity was not high enough, in particular because the intervention affected only one unlicensed website. The implication could be that shutting down multiple websites at a time would be more effective at decreasing piracy levels and increasing welfare.[52] Nevertheless, from a practical perspective, achieving a level of enforcement that is sufficiently broad to be sustainable in the long run seems very hard. For example, evidence shows that the rate of new cyberlockers entering the market increased after the shutdown of Megaupload (Lauinger et al., 2013) and consumers use VPN services to circumvent the blocking of the PirateBay and a number of similar websites (Danaher et al., 2015b). Putting aside country-specific legal issues – which may make a large scale international raid difficult – the associated costs of physically raiding multiple websites hosted on geographically dispersed servers would also have to be taken into account. This could naturally reduce the welfare enhancing effect of supply-side enforcement (Tsai and Chiou, 2012; Dey et al., 2016). A relatively recent regulatory approach is to reduce the advertising revenues that piracy websites receive. Initiatives towards a self-regulation of the online advertising industry have been implemented in 2013 the UK and are on the agenda of the European Commission since 2015.[53] Although economically appealing, except for a recent

[52] A recent working paper by Danaher et al. (2015b) looks at this question and uses highly aggregated clickstream data to compare the effects of two policy experiments in the UK – court decisions that ordered Internet service providers to block one piracy website versus the blocking multiple piracy websites. While they don't find evidence of an increase in visits to paid streaming services when one website is blocked, they find a positive effect in the case of the wide blockade. For both interventions, their analysis suggests that a change in the number of clicks to other torrent sites or cyberlockers is small or not significant, but the results also show that consumers increase clicks to VPN services that allow to circumvent the blockade.

[53] See http://ec.europa.eu/growth/tools-databases/newsroom/cf/itemdetail.cfm?item_id=8974

working paper by Batikas et al. (2017), we are not aware of an academic literature that provides evidence on the overall effectiveness of such efforts.

Taxes and subsidies Theoretical work in Becker et al. (2006), using a model that is applied to illegal drugs, shows that a tax on legalized production is better able to reduce the quantity of drugs in the market than quantity-restricting enforcement efforts. This is in line with what Chen and Png (2003) find in their theoretical analysis of digital piracy. They compare the welfare implications of government policies and conclude that taxing copying is superior to fining on consumers, and that a subsidy for legal producers is optimal. Evidence from a discrete choice experiment carried out in the Netherlands shows that a tax of less than two Euro on Internet subscriptions would keep revenues of music rights holders at the current level while simultaneously increasing consumer surplus (Handke et al., 2016).

Private enforcement Theory suggests that firms find it optimal to invest in private enforcement to deter piracy when public enforcement is too weak (Banerjee, 2003; Sundararajan, 2004; Kiema, 2008; Ahn and Shin, 2010; Lu and Poddar, 2012). This is backed by evidence showing that private enforcement can be effective in settling infringement cases regarding digital images (Luo and Mortimer, 2016), and increase sales of e-books (Reimers, 2016). However, when copy protection reduces consumer utility, private enforcement can have negative implications for firm profits and social welfare (Ahn and Shin, 2010). This idea is mirrored in evidence showing that music sales increase due to the removal of digital rights management technology (Zhang, forthcoming).

6 Conclusion

In this paper we address the puzzle that online piracy rates remain high, despite an abundance of enforcement efforts that involve large amounts of public resources. We study the unexpected shutdown of `kino.to`, the largest unlicensed video streaming site in the German market in 2011, using highly disaggregated clickstream data for a set of 20,000 Internet users in Germany, Italy, France and the UK to provide detailed evidence on the effects of this intervention on consumer behavior and on the structure of the unlicensed video streaming market.

We show that the shutdown was rather ineffective in reducing unlicensed consumption and moving consumers to licensed offerings. We highlight that indirect effects – consumers quickly switching to alternative unlicensed websites – and unintended externalities that operate via the type of story news articles tell about piracy, are important factors driving our results. The latter is quite surprising in light of the previous literature. Awareness about legal consequences of online piracy – in the form of the anticipation of stricter laws – has been causally linked to higher sales of licensed content (Adermon and Liang, 2014; Danaher et al., 2014) and media and press coverage has often been presented as a potential mechanism to raise awareness about the negative consequences of piracy (Al-Rafee and Cronan, 2006; Hennig-Thurau et al., 2007; Sinha and Mandel, 2008; Danaher et al., 2010; Cox and Collins, 2014). Our study shows that media coverage of copyright enforcement – which has happened regularly in the past – implies a trade-off for content creators and copyright holders, depending on the content of news articles. In the case of `kino.to`, only about 11% of news articles that individuals in our data read were discussing legal aspects that could have had deterring effects. Our results suggest that if that fraction had been higher, we would have seen less switching to alternative piracy websites and fewer consumers entering the market. In other settings, the introduction of journalistic standards have been shown to be effective in reducing unintended effects of news coverage. For example, Etzersdorfer and Sonneck (1998) show that the number of copycat suicides (or suicide attempts) decreased after newspapers adopted specific guidelines for journalists. From a policy perspective, it goes without saying that benefits from such efforts must be traded off against freedom of the press.

We also show that the structure of the piracy market changed after the shutdown of `kino.to` in a way that may make future interventions more costly and potentially even less effective, at least in the short run. An interesting avenue for future research could be to evaluate whether broader public enforcement efforts, targeting multiple websites at the same time, or reducing the monetary incentives from advertising revenues could be more effective. From a managerial perspective, we get important insights into consumer behavior that can be helpful to design effective private copyright enforcement strategies, as well as to understand competition between licensed and unlicensed services. Although our study is specific to its historical context, we speculate that better availability and lower prices of licensed content can convince consumers to switch to licensed offerings.

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Table 1: Variable Definition

Variable	Definition
Dependent Variables	
Piracy (ln+1)	Weekly visits to piracy websites
Piracy: Stream (ln+1)	Weekly number of downloads from piracy websites
Piracy: Days (ln+1)	Weekly number of weekdays where the user visited piracy websites
Piracy: Duration (ln+1)	Weekly duration of visiting piracy websites
Alt. Piracy (ln+1)	Weekly visits to alternative piracy websites, i.e. all sites excluding kino.to
Licensed: Cinema (ln+1)	Weekly visits to cinema websites
Licensed: Online (ln+1)	Weekly visits to licensed streaming websites
Licensed: DVD (ln+1)	Weekly visits to the DVD section of Amazon
Independent Variables	
After (0/1)	One after the shutdown of kino.to in week 23 of 2011
Kino (0/1)	One if a German user visited kino.to before the shutdown
Non-Kino (0/1)	One if a German user never visited kino.to
News (0/1)	One after a German user read news about the shutdown of kino.to
News: Background (0/1)	One after a German user read news on the kino.to shutdown that includes a background report
News: Alternatives (0/1)	One after a German user read news on the kino.to shutdown that mentions illegal alternatives
News: Legal (0/1)	One after a German user read news on the kino.to shutdown that considers streaming from kino.to as legal
News: Illegal (0/1)	One after a German user read news on the kino.to shutdown that considers streaming from kino.to as illegal
Kino: Singlehoming	One if a German user visited kino.to and visited no other piracy websites before the shutdown
Kino: Multihoming	One if a German user visited kino.to and at least one other piracy website before the shutdown
Non-Kino: Pirate	One if a German user never visited kino.to and visited at least one other piracy website before the shutdown
Non-Kino: Non-Pirate	One if a German user never visited kino.to and visited no other piracy websites before the shutdown
Germany	One for German users

Table 2: Descriptive Statistics

	Kino (N=843), Non-Kino (N=4157), Control (N=15000)											
	Kino Before		Kino After		Non-Kino Before		Non-Kino After		Control Before		Control After	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Piracy	8.566	26.327	7.805	35.030	0.105	2.898	0.383	9.164	0.915	9.225	1.053	14.487
Ln(Piracy + 1)	0.798	1.400	0.604	1.296	0.014	0.189	0.035	0.319	0.103	0.535	0.108	0.558
Piracy: Streams	0.986	4.458	0.687	4.389	0.004	0.150	0.022	0.711	0.172	1.900	0.195	2.679
Piracy: Ln(Streams + 1)	0.255	0.654	0.169	0.549	0.001	0.045	0.007	0.105	0.043	0.289	0.044	0.299
Piracy: Days	0.697	1.445	0.530	1.314	0.012	0.179	0.027	0.274	0.096	0.557	0.099	0.572
Piracy: Ln(Days + 1)	0.322	0.562	0.241	0.512	0.006	0.083	0.015	0.124	0.047	0.234	0.048	0.238
Piracy: Duration	143.802	447.674	152.198	835.740	2.578	68.715	9.852	272.952	31.950	364.358	27.629	371.705
Piracy: Ln(Duration + 1)	1.567	2.567	1.185	2.383	0.033	0.413	0.079	0.656	0.240	1.161	0.237	1.140
Licensed: Cinema	0.505	3.050	0.426	3.095	0.194	2.013	0.190	1.986	0.599	6.416	0.539	4.459
Licensed: Ln(Cinema + 1)	0.122	0.491	0.100	0.451	0.044	0.307	0.043	0.303	0.121	0.503	0.114	0.485
Licensed: Online	0.468	4.899	0.470	4.957	0.276	4.636	0.224	3.213	0.111	2.541	0.136	2.786
Licensed: Ln(Online + 1)	0.079	0.421	0.074	0.417	0.044	0.316	0.041	0.301	0.022	0.216	0.025	0.233
Licensed: DVD	0.425	3.644	0.484	4.800	0.215	2.537	0.255	3.230	0.124	1.989	0.172	2.981
Licensed: Ln(DVD + 1)	0.095	0.427	0.093	0.435	0.052	0.312	0.059	0.335	0.030	0.238	0.037	0.269

Table 3: Piracy, Baseline Results and Robustness Checks[†]

	(1) (Piracy) Coef./s.e.	(2) (PSM) Coef./s.e.	(3) (Streams) Coef./s.e.	(4) (Days) Coef./s.e.	(5) (Duration) Coef./s.e.	(6) (Outliers) Coef./s.e.
After × Kino	-0.317***	-0.296***	-0.161***	-0.119***	-0.546***	-0.321***
	(0.033)	(0.034)	(0.017)	(0.013)	(0.058)	(0.028)
After × Non-Kino	0.008*	0.012*	0.003*	0.003*	0.029***	0.008***
	(0.005)	(0.007)	(0.002)	(0.002)	(0.009)	(0.003)
Adjusted-R^2	0.456	0.453	0.365	0.477	0.432	0.290
No. of Ind.	20000	9017	20000	20000	20000	19808
No. of Obs.	1040000	468884	1040000	1040000	1040000	1021649

[†] Standard errors are in parenthesis and clustered at the individual level. All specifications include individual fixed effects, week fixed effects, and linear group-specific trends.

* Significant at the 10% level.

** Significant at the 5% level.

*** Significant at the 1% level.

Table 4: Piracy, Externalities[†]

	(1) Coef./s.e.	(2) Coef./s.e.	(3) Coef./s.e.
After × Kino	-0.317***	-0.317***	-0.318***
	(0.033)	(0.033)	(0.033)
After × Non-Kino	0.008*	0.005	0.007
	(0.005)	(0.005)	(0.005)
After × Kino × News		-0.013	
		(0.203)	
After × Non-Kino × News		0.300***	
		(0.107)	
After × Kino × News: Background			-0.054
			(0.181)
After × Kino × News: Alternatives			0.084
			(0.165)
After × Kino × News: Legal			-0.095
			(0.209)
After × Kino × News: Illegal			0.205
			(0.218)
After × Non-Kino × News: Background			0.004
			(0.064)
After × Non-Kino × News: Alternatives			0.163*
			(0.086)
After × Non-Kino × News: Legal			0.283**
			(0.115)
After × Non-Kino × News: Illegal			-0.185
			(0.114)
Adjusted-R^2	0.456	0.456	0.457
No. of Ind.	20000	20000	20000
No. of Obs.	1040000	1040000	1040000

[†] Standard errors are in parenthesis and clustered at the individual level. All specifications include individual fixed effects, week fixed effects, and linear group-specific trends.

* Significant at the 10% level.

** Significant at the 5% level.

*** Significant at the 1% level.

Table 5: Licensed Alternatives†

	(1) (Cinema) Coef./s.e.	(2) (Cinema) Coef./s.e.	(3) (Online) Coef./s.e.	(4) (Online) Coef./s.e.	(5) (DVD) Coef./s.e.	(6) (DVD) Coef./s.e.
After × Kino	0.004	-0.004	0.012	0.014	-0.002	-0.002
	(0.010)	(0.010)	(0.009)	(0.009)	(0.008)	(0.008)
After × Non-Kino	0.005	0.004	-0.006**	-0.005*	-0.004	-0.004
	(0.004)	(0.004)	(0.003)	(0.003)	(0.003)	(0.003)
After × Kino × News		0.134**		-0.043		0.006
		(0.059)		(0.049)		(0.057)
After × Non-Kino × News		0.123**		-0.045		-0.038
		(0.056)		(0.071)		(0.057)
Adjusted-R^2	0.284	0.284	0.261	0.261	0.316	0.316
No. of Ind.	20000	20000	20000	20000	20000	20000
No. of Obs.	1040000	1040000	1040000	1040000	1040000	1040000

† Standard errors are in parenthesis and clustered at the individual level. All specifications include individual fixed effects, week fixed effects, and linear group-specific trends.
* Significant at the 10% level.
** Significant at the 5% level.
*** Significant at the 1% level.

Table 6: Knowing About Unlicensed Alternatives†

	(1) (Alt. Piracy) Coef./s.e.	(2) (Cinema) Coef./s.e.	(3) (Online) Coef./s.e.	(4) (DVD) Coef./s.e.
After × Kino: Singlehoming	0.215***	0.026**	0.015	-0.003
	(0.028)	(0.012)	(0.011)	(0.010)
After × Kino: Multihoming	0.395***	-0.026	0.009	0.001
	(0.060)	(0.018)	(0.013)	(0.013)
After × Non-Kino: Pirate	0.000	0.007	-0.020	-0.004
	(0.041)	(0.018)	(0.014)	(0.017)
After × Non-Kino: Non-Pirate	0.009**	0.005	-0.005*	-0.004
	(0.004)	(0.003)	(0.003)	(0.003)
Adjusted-R^2	0.430	0.284	0.261	0.316
No. of Ind.	20000	20000	20000	20000
No. of Obs.	1040000	1040000	1040000	1040000

† Standard errors are in parenthesis and clustered at the individual level. All specifications include individual fixed effects, week fixed effects, and linear group-specific trends.
* Significant at the 10% level.
** Significant at the 5% level.
*** Significant at the 1% level.

Table 7: Aggregate[†]

	(1) (Piracy) Coef./s.e.	(2) (Cinema) Coef./s.e.	(3) (Online) Coef./s.e.	(4) (DVD) Coef./s.e.
After × Germany	-0.046***	0.005	-0.003	-0.004
	(0.007)	(0.004)	(0.003)	(0.003)
Adjusted-R^2	0.455	0.284	0.261	0.316
No. of Ind.	20000	20000	20000	20000
No. of Obs.	1040000	1040000	1040000	1040000

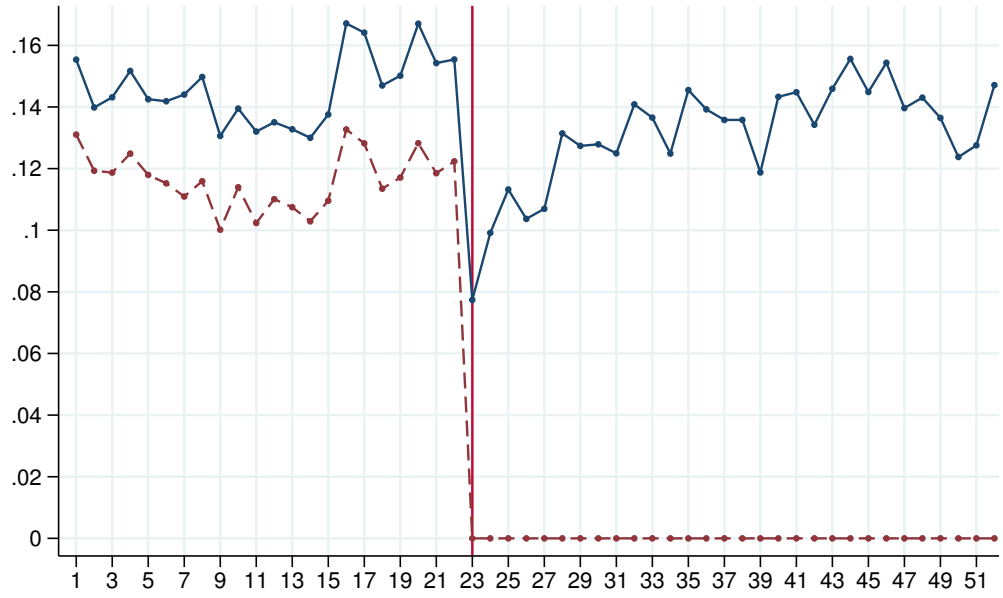
[†] Standard errors are in parenthesis and clustered at the individual level. All specifications include individual fixed effects, week fixed effects, and linear group-specific trends.

* Significant at the 10% level.

** Significant at the 5% level.

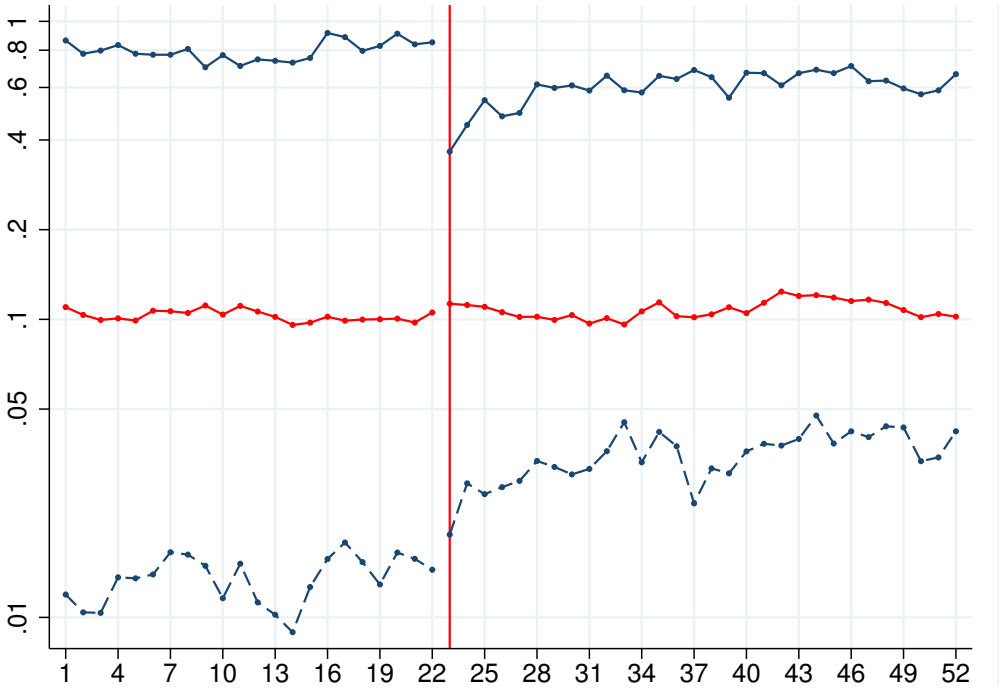
*** Significant at the 1% level.

Figure 1: Evolution of Online Movie Streaming Piracy



Vertical axis: Average log weekly clicks per user. Horizontal axis: Calendar weeks in 2011.
Solid blue: *Average log weekly clicks per user on all unlicensed streaming websites.*
Dashed red: *Average log weekly clicks per user on kino.to.*

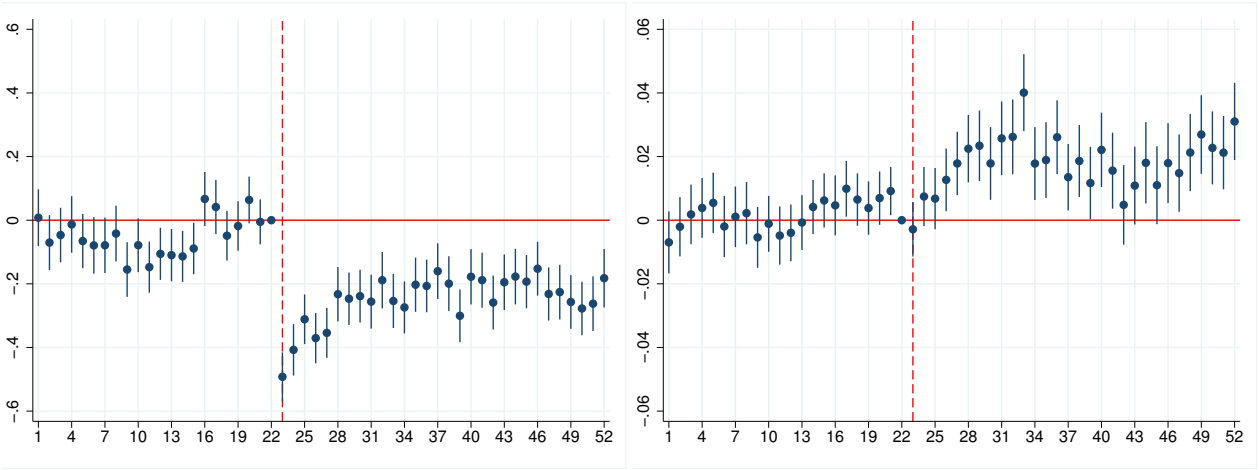
Figure 2: Evolution of Online Movie Streaming Piracy, by Group



Vertical axis: Average log weekly clicks per group. Horizontal axis: Calendar weeks in 2011.
Solid blue: *Kino users.* ***Dashed blue:*** *Non-Kino users.*
Solid red: *International users (control group).*

Figure 3: Group difference: Overall piracy

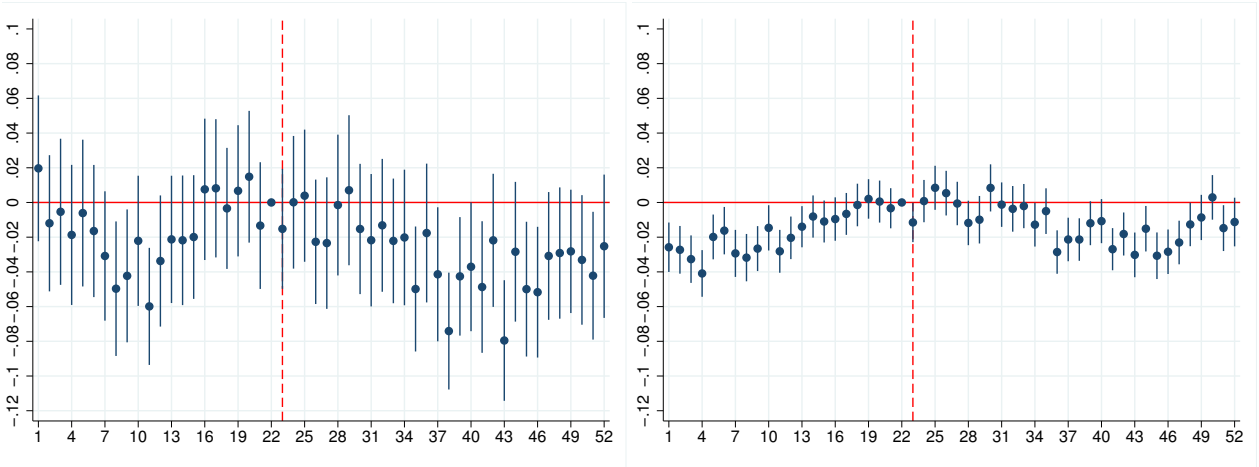
Kino vs. international *Non-Kino vs. international*



Vertical axis: OLS coefficients. Horizontal axis: Calendar weeks in 2011.
Weekly differences between the treatment group (Kino/Non-Kino) and the control group (users in FR, IT, UK).
Solid blue: *OLS estimates of the $\beta_1^t w_t$ (left panel) and $\beta_2^t w_t$ (right panel) coefficients obtained from a regression of:* $\ln(Clicks_{it}+1) = \alpha + \sum_t \beta_0^t w_t + \sum_t \beta_1^t (w_t \times Kino_i) + \sum_t \beta_2^t (w_t \times \text{Non-Kino}) + \mu_i + \varepsilon_{it}$.
Bars indicate 90% confidence bands.

Figure 4: Group difference: Cinema

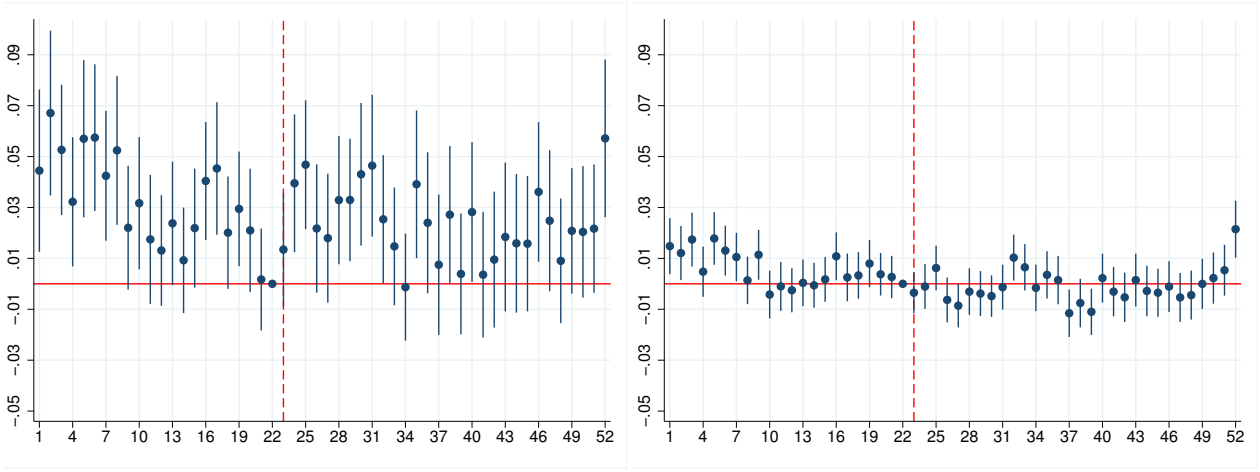
Kino vs. international *Non-Kino vs. international*



Vertical axis: OLS coefficients. Horizontal axis: Calendar weeks in 2011.
Weekly differences between the treatment group (Kino/Non-Kino) and the control group (users in FR, IT, UK).
Solid blue: *OLS estimates of the $\beta_1^t w_t$ (left panel) and $\beta_2^t w_t$ (right panel) coefficients obtained from a regression of:* $\ln(Clicks_{it}+1) = \alpha + \sum_t \beta_0^t w_t + \sum_t \beta_1^t (w_t \times Kino_i) + \sum_t \beta_2^t (w_t \times \text{Non-Kino}) + \mu_i + \varepsilon_{it}$.
Bars indicate 90% confidence bands.

Figure 5: Group difference: Online

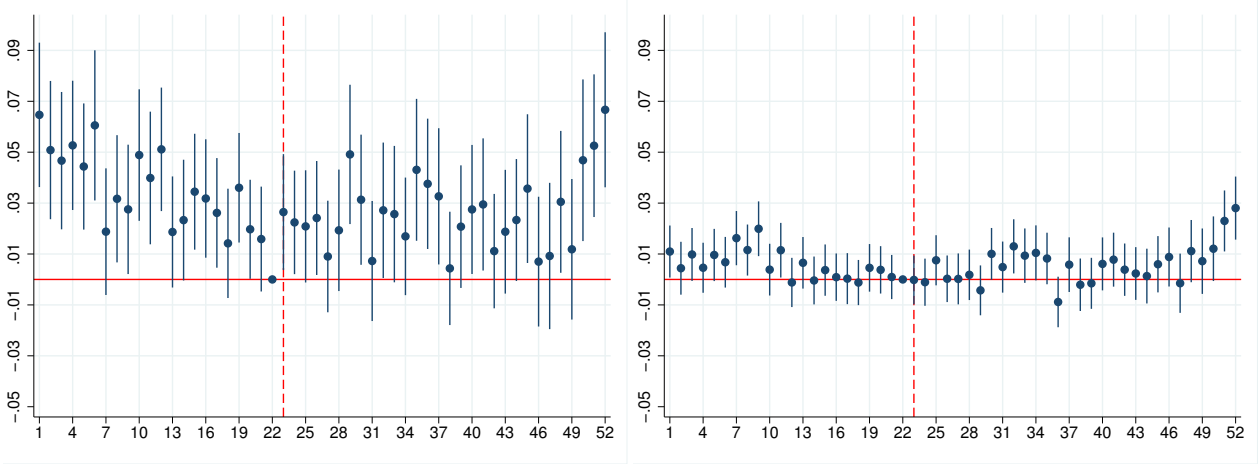
Kino vs. International *Non-Kino vs. International*



Vertical axis: OLS coefficients. Horizontal axis: Calendar weeks in 2011.
Weekly differences between the treatment group (Kino/Non-Kino) and the control group (users in FR, IT, UK).
Solid blue: *OLS estimates of the $\beta_1^t w_t$ (left panel) and $\beta_2^t w_t$ (right panel) coefficients obtained from a regression of:* $\ln(Clicks_{it}+1) = \alpha + \sum_t \beta_0^t w_t + \sum_t \beta_1^t (w_t \times Kino_i) + \sum_t \beta_2^t (w_t \times \text{Non-Kino}) + \mu_i + \varepsilon_{it}$.
Bars indicate 90% confidence bands.

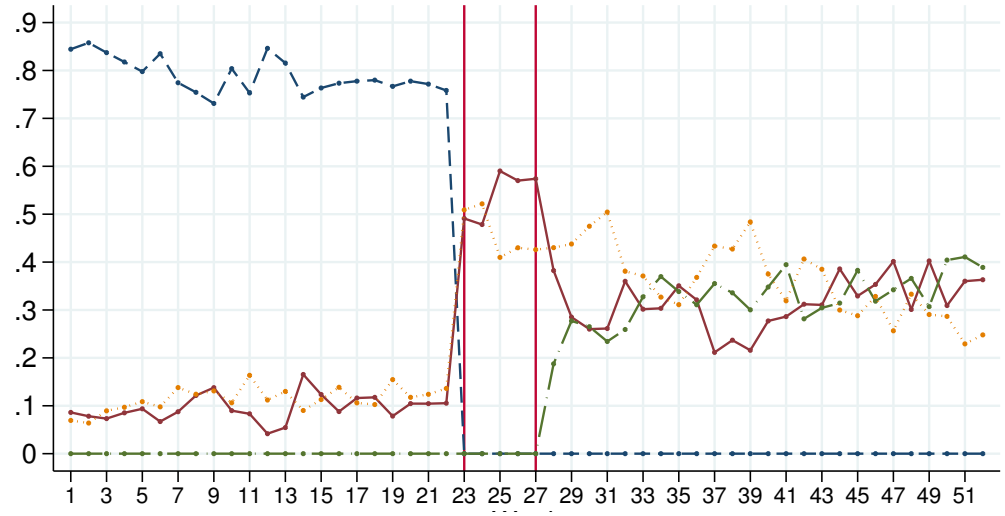
Figure 6: Group difference: DVD

Kino vs. International *Non-Kino vs. International*



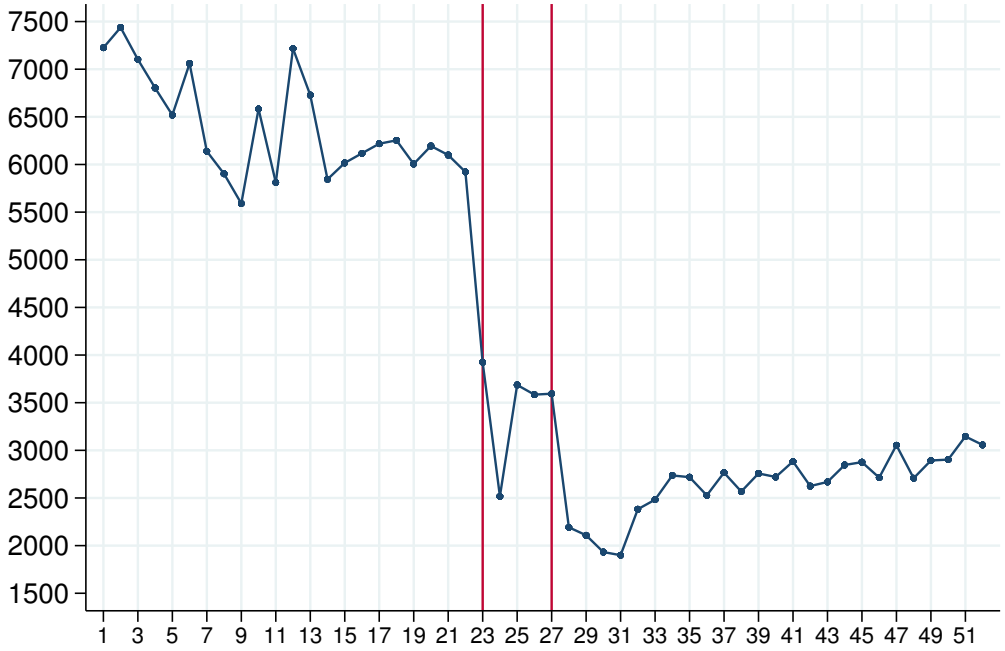
Vertical axis: OLS coefficients. Horizontal axis: Calendar weeks in 2011.
Weekly differences between the treatment group (Kino/Non-Kino) and the control group (users in FR, IT, UK).
Solid blue: *OLS estimates of the $\beta_1^t w_t$ (left panel) and $\beta_2^t w_t$ (right panel) coefficients obtained from a regression of:* $\ln(Clicks_{it}+1) = \alpha + \sum_t \beta_0^t w_t + \sum_t \beta_1^t (w_t \times Kino_i) + \sum_t \beta_2^t (w_t \times \text{Non-Kino}) + \mu_i + \varepsilon_{it}$.
Bars indicate 90% confidence bands.

Figure 7: Market Shares of Unlicensed Video Streaming Websites



Vertical axis: Weekly market share. Horizontal axis: Calendar weeks in 2011.
Dashed blue: *Weekly market share of kino.to.*
Solid red: *Weekly market share of movie2k.to.*
Dashed green: *Weekly market share of kinox.to.*
Dotted orange: *Weekly market share of all other unlicensed streaming websites.*

Figure 8: Concentration in the Unlicensed Video Streaming Market



Vertical axis: Weekly HHI in Germany. Horizontal axis: Calendar weeks in 2011.