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The effects of movie piracy on box-office revenue: an empirical analysis of the Chinese movie market

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ABSTRACT

I evaluate the substitution effects of pirated movies - the unlicensed online movies available on file-sharing websites - on their genuine counterparts, and explore the institutional and economic causes of China's high level of movie piracy. To do this, I build a dataset including information on online piracy, theater showings, and revenues. I use the level of availability of pirated products and the download intensity of pirated movies as proxies for the piracy level. By utilizing these proxies, I estimate that the average revenue loss caused by piracy is 64%. Protectionism and censorship systems, as well as a low theater coverage rate, contribute to China's high level of piracy. Counterfactual results show that minimizing release delays. which are mainly caused by protectionism and censorship, increases the box office returns of foreign movies by 43%.

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Copyright infringement; intellectual property protection; internet piracy; movie box office

1. Introduction

Internet copyright piracy is typically viewed as causing massive financial damage to the producers of media products. High rates of piracy are typically attributed to a lack of intellectual property protection and to the high price of licensed products relative to local income in developing countries (Karaganis, 2011). Neither policymakers nor academic researchers, however, have a good understanding of the reasons for the lack of "copyright culture" in these countries. In this article, I add to the discussion by evaluating the substitution effects of pirated movies on their genuine counterparts and by exploring the institutional and economic causes of the high piracy level in China.

Numerous studies examine the effects of pirated goods on sales of licensed products (Bhattacharjee, Gopal, Lertwachara, Marsden, & Telang, 2007; Danaher & Smith, 2014; McKenzie & Walls, 2016; Oberholzer-Gee & Strumpf, 2007; Rob & Waldfogel, 2006, 2007). Media industry professionals tend to believe that copyright infringement causes billions of dollars in losses. Academia has not yet reached consensus, however, on the economic effects of digital piracy on media industries. Some studies claim that piracy could have some positive effects on sales of licensed products through such channels as word-of-mouth effects (Lee, 2006; Liu, 2018), sampling effects (Kretschmer & Peukert, 2019; Peitz & Waelbroeck, 2006), and network effects (Bellefamme and Peitz, 2014).

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Other research shows that the availability of a pirated good reduces a firm's profit by substituting the sales of licensed products (Danaher & Smith, 2014; Leung, 2013; Yoon, 2007). The effects of piracy on the sales of media products are difficult to address given the difficulty of observing piracy behavior and the correlation between product sales and the intensity of piracy.

In this study, I build a unique dataset comprising information on 1,039 movies in wide release in China from 2006 to 2013. With detailed information about online piracy, theater showings, and revenues, I analyze both the effect of availability on piracy rates and an estimation of the displacement rates of piracy on box office sales. The difficulties of observing piracy activities present the most serious obstacles to being able to estimate losses due to piracy. Some empirical studies have used measures of the intensity of specific groups' piracy to estimate the displacement rates of piracy on licensed products' sales (Leung, 2013; Peukert, Claussen, & Kretschmer, 2017; Rob & Waldfogel, 2007). Rob and Waldfogel (2007), for example, conducted a survey of university students, confirming that each album download reduces purchases by nearly 0.2 units. Leung (2013) affirmed a high replacement rate of pirated products on licensed software using data from a survey of college students in Hong Kong. This estimation, which used survey samples and website tracking, has a potential problem of bias since, in the data, products that were pirated heavily also tend to be very popular and sell well in the genuine product market. Many papers use instrument variables to deal with the heterogeneity problems in estimation (Oberholzer-Gee & Strumpf, 2007; Rob & Waldfogel, 2007). In this study, I apply the download and search intensities of pirated movies as a first set of proxies for piracy level, and use the download intensities of television shows and movies unreleased in China as instrument variables to deal with the endogeneity problem in the OLS estimation.

To estimate the revenue lost to movie piracy, some studies use the availability of pirated products as a proxy for the extent or intensity of piracy (Danaher, Dhanasobhon, Smith, & Telang, 2010; Ma, Montgomery, Singh, & Smith, 2014; Strumpf, 2014). Yet surveys and website tracking can cover only a minimal segment of the population. The piracy intensity in such samples cannot represent the total intensity of piracy without complete knowledge of the products distributed to the population through both piracy and licensed consumption. Once a pirated movie is uploaded online, unauthorized DVD makers and pirate website owners will copy the movie or forward a link to the first available online resources (Yang, 2009), enabling the entire population to watch it inclusively and uncompetitively. The availability method may thus better represent the extent of online piracy and solve the generalizability problem. In this study, I apply the level of availability of pirated products and the download intensity of pirated movies on pirate websites as proxies for piracy level, and evaluate the substitution effects of pirated movies on their genuine counterparts by using both linear regression and structural estimation methods.

Another approach I take is to use the Chinese government's anti-piracy campaigns as a natural experiment for estimating revenue loss caused by piracy in both the short and long terms. Previous research has used these copyright protection actions as natural experiments to investigate the impact of intellectual property protection on the sale of licensed products (Aguiar et al., 2018; Adermon & Liang, 2014; Danaher & Smith, 2014; Danaher, Smith, Telang, & Chen, 2014; Orme, 2014). Following these examples, I also make use of several quasi-natural experiments to analyze the effects of copyright protection campaigns on theatrical box office sales in China. The Chinese government has introduced several campaigns to combat intellectual property rights infringement by blocking pirate websites, as well as by punishing the manufacture and sales of counterfeits. This kind of strict intellectual property protection campaign exerts a universal effect on the entire supply of online pirated products since most of the street DVDs are copied from online resources in China (Hu, 2010). This study contributes to the literature on the economics of piracy that investigates the impact of intellectual property protection enforcement on the sale of licensed products by investigating this specific type of policy intervention in both the short and long terms, finding that these campaigns can only shut down the major pirate websites temporarily but cannot always prevent the new pirate websites from occupying the vacuum created by these actions.

I then use a structural model to formulate counterfactual experiments to investigate the influences of government policies on online piracy and box office revenues. Since all screenplays in China must be approved by the Chinese government, strict censorship systems and protectionist policies in the film industry have played a significant role in the Chinese movie industry. The policies of import quotas, censorship, and targeted blackouts of foreign film screenings do not restrict the supply of pirated movies. Instead, they impede the distribution of licensed movies. In particular, these practices cause delays in theatrical release time and even prevent some movies from entering the market, which heavily affects the attractiveness of licensed products relative to piracy products. These policies represent the main barriers to the market entry of media products in developing countries.

I also explore the effects of the accessibility of licit products on the level of piracy. Before 2009, in particular, a widespread lack of movie theaters in China made pirated movies the only choice for the majority of the population. The lack of theaters constrains the ability to distribute licensed media products in developing countries. Since 2009, subsidies for screen building have increased the rate of theater coverage, making theaters more accessible to the population. I use this development as a quasi-natural experiment to evaluate the effects of theater accessibility on the formation of China's high piracy level. In addition to the dearth of cinemas, China's policies of strict censorship and protectionism also present significant obstacles in the way of access to licensed video products. This analysis can be used to demonstrate that the inaccessibility of legal products is one major factor driving the enormous appetite for unauthorized movies among consumers in emerging markets.

I present four principal findings in this article. First, my estimation affirms that the Chinese government's anti-piracy campaigns increase the average box office revenue rate by approximately 60% if the piracy supply is cut off and the government anti-piracy movements reduce box office losses – but only in the short term. Second, I find that the substitution elasticity of pirated movies on movies in theaters is about 0.31. Theaters that allocate fewer screens to movies being pirated increase their revenue loss due to piracy by 52%. Part of the revenue loss comes from the negative influence of online piracy on the supply of authentic products. Third, by removing the release delays caused by protectionism and censorship, I find that the rapid growth in the number of screens in the Chinese movie market has reduced the rate of piracy loss by 23%.

My focus on China makes a particularly useful contribution to the growing literature attempting to investigate the effect of pirated resources on the sale of licensed products by

using unbiased estimates of piracy levels. There are several advantages to using the Chinese movie market to quantify the impact of illicit movie downloads on sales of licensed products. First, I employ the Chinese government's interventions in the movie market as exogenous impacts to deal with the potential endogeneity problem caused by the correlation between movie quality and supply gap. These settings allow me to establish causality and provide more precise evaluations.

Another advantage is that my findings can facilitate the understanding of the institutional reasons for the high piracy level in developing countries. The existing literature has mainly focused on piracy problems in *developed* countries (Bai & Waldfogel,). Although the film industry projects high rates of piracy in countries with emerging markets, the effects of piracy and the causes of the high levels of piracy in these counties are not well understood. The Chinese movie market has experienced rapid growth and there have been great changes in intellectual property protection policies in recent decades. These changes enable me to explore the mechanism of revenue damage caused by online piracy and suggest policy options that will mitigate such damage in developing countries. The results indicate that lack of access to licensed products and obstacles to the entry of foreign media products, both very common in Third World countries, are the major reasons for the considerable substitution effects of piracy products on licensed product sales in these countries.

A third advantage of a China focus is that it adds the work done in several papers that estimate the impact of intellectual property protection on the sale of licensed products. The Chinese government has launched occasional campaigns against copyright infringement. Unlike in many developed countries, most of these actions are in response to pressure from foreign government and copyright owners. Using this exogenous impact on the movie market, I investigate not only the short-term effects but also the long-term effects of these actions. The results indicate that government anti-piracy campaigns can only shut down the supply of online piracy temporarily, in the short term. In the long term, without institutional changes for the protection of intellectual property, new piracy channels will always emerge to occupy the vacuum created by these actions.

A fourth advantage of using Chinese data is that I can use the dataset to explore supply-side reactions to online piracy and estimate the effects of these reactions on box office sales. Supply-side reactions to piracy may generate second-order effects on the sales of licensed products, which researchers have not sufficiently discussed. Each Chinese cinema has the freedom to set the price and number of screens allocated to a movie. I can thus identify the behavior response of cinemas to online piracy by checking prices and screen allocations. I find that a large part of revenue loss comes from the negative influence of online piracy on the supply of genuine products.

The article is organized in seven sections. Section II provides background information on the motion picture industry and online piracy in China. Section III describes the data. Section IV presents the estimation using both the reduced form method and the structural estimation method. Section V gives the results of the counterfactual experiments, and section VI concludes.

1.1. Background information

In this section, I discuss the essential background features of the Chinese motion picture market and online piracy. The discussion centers on three issues: (a) the different degrees of damage done to licensed products by pirated movies in various forms, (b) the types of pirate websites that operate in China and how pirated movies are supplied to these websites, and (c) the institutional background of the Chinese movie market and how policies may aggravate the damage piracy products do to box office sales. This information demonstrates the significant advantages of using the Chinese movie market to explore the substitution effects of online piracy on licensed product sales.

1.1.1. Types of pirated movie releases

Pirated movies are released in different formats, which are labeled Camcorder (Cam), Telesync (TS), Telecine (TC), PPVRip, SCReener (SCR), DVDscr, DVDRip, High Definition (HD), WEBRip, TVRipor, and Blu-Ray/BD/BRRipm depending on their quality and sources.¹ The substitution effects of pirated movies on movies legally consumed in theaters depend on the quality of the pirated resources.

Once the film is released in the theaters, the potential for camcorder capture and theater operator piracy (classified as Cam and TS, respectively), increases drastically (Bloom & Polyzois, 2004). The Cam version² is usually the first version to appear online on the same day as the first preview of the film. For example, Milot (2014) investigates the concept of sales lost at the box office in relation to the unauthorized downloading of Cam copies of widely released movies at a popular BitTorrent website and asserts that the effects of the unauthorized downloading of Cam movies on the box office sales of individual movies are insignificant. A Cam movie has very poor picture and sound quality, and the first Cam version is usually available on the day of a movie's world premiere, which means they are not a good substitute for high-quality movies in theaters (Chen et al., 2017). I thus estimate the box office sales loss caused by TS and DVD versions, which have better quality than Cam versions and usually come out several days or even weeks after a movie's world premiere.

TS versions³ are copies of films shot in empty cinemas from projection booths with professional cameras. They are directly connected to the sound source and their quality is better than Cam versions. They appear online several days after the first preview or premiere of the original film versions (Bloom & Polyzois, 2004). I define versions other than Cam and TS versions as DVD versions. Unlike Cam and TS versions, DVD versions are usually copied directly from formal channels such as licensed DVDs. Their quality is thus better than the TS versions, but usually appear online several weeks after the TS and

¹According to Sojitra, Savaliya, Varnagar, and Ghosh (2015), the definitions of these versions are as follows: DVDscr versions are copied from early DVD releases of the theatrical version of a film; R5 versions are from retail DVDs from the Indian subcontinent, Africa, North Korea, Russia, and/or Mongolia; HD and Blu-ray versions are from high-quality retail DVDs; PPVRip versions are copied from the movies shown to hotel clients; SCR versions are copied from the copies distributed to critics and special users; DVDRip versions are copied from DVDs distributed to the general public; TVRipor versions are copied from a capture source using an analog capture card; WEBRip versions are copied from internet streaming services; and Blu-Ray/BD/BRRip versions are copied directly from a Blu-ray disc.

²Cam versions are recorded with digital video cameras during projections in theaters, and have poor picture and sound quality.

³In this article, for the sake of simplicity, I group both "TC versions" and "TS versions" together as "TS versions." Strictly speaking, TC versions of a movie use the same sound source as TS versions, but copy the film digitally from the film reels, giving them better picture quality than TS versions (Schmidt et al., 2012).

Cam versions come out (Schmidt, Antunes, Barcellos, & Gaspary, 2012).⁴ Since the release times of these DVD versions are not in sequence – one version may be released first for one movie but not for others – I use the uploading time of the earliest DVD version as the available time of the DVD version of pirated movies.

1.1.2. Movie piracy in China

Thousands of unlicensed video websites and numerous peer-to-peer file-sharing networks make copyrighted works available for free to internet users in China (Priest, 2006), and most Chinese internet users turn to unlicensed online movies as their first choice for movie viewing. A 2009 survey by the EntGroup⁵ shows that nearly 98% of Chinese internet users have used the internet to access movies.

Such pirated resources are mainly found on pirate websites, which upload links to such resources on their web pages as soon as they get access to them. The websites check and label the various versions of each movie. As in any other market, movie distributors also distribute their movies through licensed digital channels and DVD sales when they are no longer being shown in theaters. During the period under study, however, the absence of licensed DVD sales⁶ and on-demand internet streaming media⁷ means that box office sales were practically the only source of revenue for producers and distributors (Huang, 2014), which makes it easier to measure direct losses to piracy in this market. In addition, most unlicensed DVDs are also copied directly from online pirated resources (Hu, 2010). The release of unlicensed DVD sales is therefore also affected by these pirate websites.

Fan subtitling (or "fansub") networks are also one of the crucial segments of online piracy in China. Many foreign films that are released in Chinese theaters are either shown in their original language with Chinese subtitles or are dubbed in Chinese. This work is done by professional translators in dubbing factories (Lv & Li, 2015). Pirated foreign movies, on the other hand, are generally shown in their original language with unofficial subtitles produced by fan subtitling groups. After a piracy resource is available online, fan subtitling groups will translate and produce Chinese subtitles for the movie. The unofficial subtitles of a movie usually become available online soon after the pirated version is uploaded. Despite the fact that the fan-made subtitles are unprofessional, most Chinese audiences prefer the fan versions to the official dubbed or subtitled versions for their unique features, including their slangy style, playful interpretations of the source text, and detailed annotations that help to bridge the cultural gap (Lv & Li, 2015).⁸

The Chinese government has launched occasional campaigns against infringers in response to pressure from foreign and domestic copyright owners (Priest, 2006). Its typical action is to shut down major pirate websites and fansub websites and to

⁴Pre-released DVD version resources are sometimes leaked by informal channels (Ma et al., 2014).

⁵EntGroup, Inc. is a consulting firm that specializes in the Chinese movie industry.

⁶Licensed DVD sales are negligible in the Chinese movie market because of the low price and easy accessibility of unlicensed DVDs (Wang, 2010).

⁷Before 2014, the Chinese video-streaming market also had serious piracy problems. In 2014, Chinese authorities launched a series of operations called "Sword Net" to stop copyright infringements of video-streaming websites (Zhang & Jia, 2015). According to a report by the National Copyright Administration of China, 750 websites providing pirated streaming or download links were shut down only 2014 alone. Before these changes, only a tiny portion of revenue from movies came from licensed digital channels (Wang, 2017).

⁸Another reason of the popularity of unofficial subtitles is that the Chinese censorship system makes most of the latest international movies and TV programs unavailable through formal channels, which makes the pirated resources and the fan-made subtitles the only choices for Chinese audiences (Zhang, 2013).

prohibit unlicensed DVD sales. Most of the campaigns have been poorly coordinated and have aimed to produce readily quantifiable victories rather than address the root causes of endemic infringement (Montgomery & Priest, 2016). The piracy behavior of each individual hardly meets China's standard of being "relatively large" enough to be punished by law, and this is considered an important reason for the high level of piracy in China (Priest, 2006). Without serious penalties and consistent enforcement, these campaigns have little lasting impact on unlicensed movie distribution activities.

1.1.3. Institutional background of Chinese movie market

In China, all theatrical release schedules must be approved by the State Administration of Radio, Film, and Television (SARFT). According to SARFT's revenue allocation rules, theaters can keep approximately 57% of the box office revenue of domestic movies, and 48% of the box office revenue of quota movies. Since the market-oriented reform of the Chinese movie industry in 1992, the owners of Chinese movie theaters have been free to set ticket prices and screen allocations themselves (Leung & Lo, 2015). Chinese theaters usually adjust the prices and screens allocated to each film according to market demand, theater capacity, and purchase channels (Liu, 2009; Zhou, 2013).

The lack of theaters for major segments of the population is another reason for the high level of piracy in China. In 2009, most of the existing 4,723 screens were located in big cities. Pirated movies were the *only* option for people lacking nearby cinemas. The Chinese government then began to subsidize the building of theater chains in small cities, thereby increasing the availability of cinemas to a larger segment of the population. This policy led to enormous growth in the number of screens. In 2016, according to SARFT reports, the total number of movie screens in China was 41,056, which exceeded the number in the United States (40,928). The boom in cinema building also fueled rapid growth in the movie market. From 2006 to 2016, total box office revenues in China increased from approximately 320 USD million to 6.8 USD billion.

Distributors of foreign movies prefer to release their movies in China as early as possible to prevent losses from piracy in other markets. However, significant delays exist between worldwide release and release in Chinese theaters for most imported movies in China. These delays are mainly caused by policies of censorship and protectionism.

In China, foreign movies are subject to strict import quotas⁹ unless they are coproduced with local producers.¹⁰ Foreign movies can also be imported through buyout,¹¹ but this only allows producers to sell the copyright to the Chinese distributor; it does not allow them to participate in distribution. Most distributors of foreign movies want to choose either the public holidays with high demand or the earliest release day to prevent losses due to pirated movies being released early. However, the release date chosen by a movie's distributor may not get SARFT approval. Since

⁹In 2001, when it rejoined the World Trade Organization, China agreed to allow 20 imported films to have revenuesharing deals between Chinese and foreign distributors. Since 2012, China has allowed 34 film imports per year (Su, 2016).

¹⁰Strict requirements were issued on movie content and investment share. The key requirements are that one or more Chinese production entities that are accredited by the SARFT must be participants, that at least one third of cast members must be from the mainland, and that the story must have sufficient Chinese elements (Chu, 2010).

¹¹Chinese distributors pay a fixed price to foreign movie producers to buy the distribution rights of movies in China and keep all revenues from Chinese theaters.

Hollywood blockbuster movies usually seize too much market share away from domestic movies, the SARFT constantly blocks foreign movies during peak demand times, such as public holidays and summers, to increase the market share of domestic movies (McCutchan, 2013). Normally, domestic blockbusters occupy the peak seasons and only a small portion of foreign movies can be released on the distributors' preferred dates. These protectionist policies cause many of the release dates of foreign movies to be postponed.

Strict censorship systems exist in the Chinese movie industry. Prior to distribution in the Chinese market, all screenplays in China must be approved by the SARFT. In 2001, the SARFT issued mandatory guidelines for film content that highlight 31 categories of prohibited content, including violence, pornography, and other elements that may "incite ethnic discrimination or undermine social stability." If the content of the movies is "unsuitable" according to the SARFT's standards, the producers must cut this content to meet the standards before being able to show the movie in Chinese theaters. Otherwise, the movie will be prohibited from being shown in China. However, SARFT also uses the rules of censorship to achieve goals of economic protectionism and political purposes. In fact, several Hollywood blockbusters that contain violence, supernatural content, and other allegedly banned materials have been screened in Chinese cinemas, while those with less offensive content have been required to be edited or have been prohibited (McCutchan, 2013). Censorship and protectionism are complementary policies for achieving the political and economic aims of the SARFT, which cause long delays in the theatrical release of many movies and enable the piracy supply to appear relatively early in the distribution cycle.

1.2. Data

I use three kinds of data in this study: box office returns, extent of piracy, and film characteristics. The box office data set includes movies' overall and daily box office revenues at each theater. The movies' overall box office data are from the SARFT, which collects such data directly from the automatic ticketing system of each theater.¹² These data pertain to 1,039 movies in wide release from 2006 to 2013. Due to the limitations of the sample, I do not have access to box office revenue data for narrow-release movies. Most narrow-released movies were only shown in a limited number of theaters, though links to their pirated versions are available online to all. These movies thus tend to have relatively high piracy levels and relatively low box office revenues. The study may therefore underestimate the true cost of online piracy for this data limitation.

Figure 1 illustrates the summary statistics for the box office revenue of these widerelease movies by year, which shows that the market continued to grow during this period. The daily box office data are from the Wanda theater chain and date from December 2011 to June 2013.¹³ Table 1 shows how the movies are allocated, with

¹²The SARFT requires theaters to provide receipts with movie information to consumers to prevent the concealment of box office sales. The actual income received by a theater (rather than the ticket price), from discount, group, and theater VIP tickets, is counted in the box office total. Box office revenues are the money received by the theater chain, rather than the consumers' payments.

¹³Wanda posted each movie's daily box office data from its ticketing system on the website http://58921.com/boxoffice/ wanda. Wanda is the largest theater chain in China, with 14% of market share in 2017.

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Figure 1. Box Office Distribution over Years. Notes: The unit of "mainland box office" is 10,000 Yuan. The unit of "Hong Kong box office" is 10,000 Hong Kong dollars.

a daily average of 6.48 screens in each theater. The average daily audience is 225 people, and the average price is 60 yuan. The average daily box office is 14,984 yuan.

I collect the available piracy dates from nine movie-sharing websites.¹⁴ Movies with upload dates, download intensities, and resource-type information can be found on these websites. Information about the extent of piracy comprises the second part of the data. Figure 2 depicts an example of the piracy proxies, using them to estimate the extent of piracy for the movie "The Hunger Games" (2012).¹⁵ This figure demonstrates the opening lag, the date when the pirated version of the movie appeared, and the number of searches for it that were performed. A time lag was observed between the US and the Chinese opening days, which is the "opening lag." The TS and DVD versions of a movie become available between the two opening days. The gap between the date when the pirated version was uploaded online and the release date of the movie in China is Δt , which is the "DVD lag." The opening date information came from Mtime.¹⁶

I define the upload date of the first link to a pirated resource as the date of availability of a given version. Other websites may upload certain movies earlier than the websites used in this study. The Δt in the data may therefore be larger than the real value. Such potential measurement errors do not, however, pose significant problems, for two major reasons. First, other websites copy and share any movie once it has been uploaded to any website. The data show that the difference in upload time among various websites is less than a day for most movies. The websites' fast reaction time thus minimizes any measurement errors. Second, these websites are the major pirate websites used by consumers. If the websites cannot find a movie, most users will also fail to find it. The

¹⁴There are eight Chinese websites: UUNiao, Feiniao, Shengchengjiayuan, Third World, BTbbt, Dygod, Tiantian, and Zhuzhu. The government shut most of these websites down during its anti-piracy campaigns in 2014. The Pirate Bay is an international website that provides torrent files and magnet links to facilitate peer-to-peer file sharing using the Bit Torrent protocol.

¹⁵Its US release date was 23 March 2012. Its Chinese release date was 14 June 2012.

¹⁶Mtime, a China-based movie web portal, has dedicated itself to providing four categories of services: being the largest movie database, the top movie review and critics' service, and the largest movie marketing and promotion service in China.

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Variable	Mean	Std dev	Variable	Mean	Std dev
# of movies	1039		# of movies in Hong Kong	467	
Box office (10,000Yuan)	5954	(15,547.46)	Weekly box office	3713	(24,504.86)
Douban Rate	5.84	(1.51)	Opening day lag	79.07	(186.72)
Rating # on Douban	36,549	(57,295.28)	Hong Kong box office (10,000 HKD)	138	(31,408.17)
Mtime rate	6.12	(1.66)	Rating # on Mtime	5327.92	(60.96.09)
Impression rate	6.27	(1.69)	Picture rate	6.44	(1.72)
Performance rate	6.34	(1.71)	Music rate	6.18	(1.77)
Director rate	6.02	(1.75)			
Piracy information on piracy websites					
TS version day lag	-75.66	(291.88)	DVD version day lag	-56.93	(26.13)
Views # of the piracy post	42,016.68	(25,442.07)	Click # on a movie's piracy links	15,555.93	(37,490.43)
Click # on links of unreleased movies	11,679	(7084.68)	Click # on links of TV shows	73,048.77	(132,164.32)
Daily data information					
# of observations	320,86		# of theaters	116	
Daily Screen #	6.48	(5.98)	Daily Price	59.54	(26.13)
Daily Audience #	224.78	(412.77)	Daily box office(Yuan)	14,984.33	(31,408.17)
Daily occupancy rate	17%	(0.18)	Local GDP level (million Yuan)	20,272.21	(1572.29)
Screen # in each region	630	(696.59)	Local population (million)	44.91	(27.75)
Search number of "Movie's name" on Baidu	-				
1 day after Opening	717.84	(4274.87)	1 day before Opening	494.5462	(2422.80)
1 week before Opening	55,801.29	(319,296.41)	1 week after Opening	5453.264	(21,253.13)
Search number of " Movie's name downloa	d " on Baidu				
1 week before Opening	2403.48	(7557.645)	1 week after Opening	8480.595	(37,445.37)
1 month before Opening	3086.62	(9969.34)	1 month after Opening	9128.038	(39,312.51)
Type	Ratio	Type	Ratio	Type	Ratio
Film type information					
Family	8.34%	Horror	20.85%	Action	32.51%
Romance	22.94%	Cartoons	9.95%	3D	9.10%
Adventure	19.05%	Crime	8.15%	Musical	1.33%
Fantasy	11.85%	War	4.74%	lmax	4.17%
Comedy	27.68%	Drama	43.79%	Main stream	5.02%
Science Friction	7.77%	Thriller	3.98%	Biography	2.27%
					(Continued)

Table 1. Summary Statistics, Study Sample.

Variable	Mean	Std dev	Variable	Mean	Std dev
Producer information					
CFGC	10.24%	Bona	5.02%	US big8	11.56%
SFGC	4.36%	Huayi	3.41%	HK big10	14.03%
Import movies	13.08%	Co-production	21.99%)	
Distributor information					
CFGC	35.73%	Huayi	3.22%	Enlight	3.98%
Huaxia	25.31%	Bona	7.96%	1	
Release season					
Juanwu Day	4.23%	Children Day	6.48%	New Year	4.04%
-abor Day	4.61%	National Day	5.92%	Spring Festival	4.61%
Director level					
Hollywood Top	2%	China Top10	2%	China Top 30	3%
Leading roles' level China Top 20	13%	China Top 30	24%	USA Top 10	4%

(Continued		
Table 1.	Variable	

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Figure 2. Search # of "The Hunger Games (2012)" on Baidu. Notes: The data are from Baidu search data. The search number of Baidu is meant by daily search amount per 10 million users. "The Hunger Games Download" search amount means the everyday search amount of "The Hunger Games Download" in Chinese. "The hunger game" search amount means the daily search amount of "The Hunger Games Download" in Chinese. In this graph, the opening lag equals to the Chinese Opening day (the red line) minus the US opening day (the black line). TS/DVD lag equals the Chinese Opening day minus the TS (the green line)/DVD availability (the blue line) day.

 Δt in the data measures the piracy level of the majority of consumers. Piracy intensities are proxied by the number of clicks on the links to movies on two pirate websites, which is defined as the sum of the number of clicks on all of the links to pirated versions of a movie. I also obtain the popularity of movies from search engines. The variable "search intensity of pirated movies" records the number of times that searches of "[film name] download" between the date of TS availability and the first showing month of the movie were performed in search engines for a pirated movie. The number of the variable refers to this variable as a value that means the number of searches per ten million users per day. Table 1 summarizes the variables that were generated from the Baidu index. On average, the number of searches for "name download" is 35,533.¹⁷ Figure 3 shows the distribution of piracy levels. On average, the TS lag is approximately 1.

I obtain film characteristics data from Mtime and Douban.¹⁸ It contains budget, director, cast,¹⁹ film length, film type, producer information, and distributor information.²⁰ The Chinese public holiday system consists of solar and lunar calendar holidays. If a movie is distributed in the two weeks before the end of a holiday,

¹⁷The average download attempt is approximately 1.5 million because China has 0.6 billion internet users, and Baidu has approximately 80% of the search engine market share.

¹⁸Douban is a Chinese social networking website that allows registered members to create content related to film, books, and music.

¹⁹The Chinese director level is ranked by Forbes Celebrity ranking. The foreign director rank is from the Celebrity Networth website. The ranking of the starring foreign actors and actresses is from the Vulture website.

²⁰The top 10 US studios in my data are Twentieth Century Fox Studios, Warner Brothers Studios, Walt Disney Studios, Sony Pictures Studios, Universal Studios, Paramount Studios, New Line Cinema, Dreamworks Studios, MGM Studios, and Raleigh Studios. The top 10 Hong Kong firms are Media Asia Films, Emperor Motion Pictures, China Star Entertainment Group, World Wide Pictures, Mei Ah Films Production, Milkyway Image, Jet Tone Film production, Golden Harvest Films, Mandarin Films, and Shaw Brothers.



Figure 3. Distribution of Piracy Level. Notes: The x axis is valued in days. In the graph, "-100" means the value is smaller than 100 days; "100" means the value is larger than 100 days. The line of TS version is the gap between the upload time of the first TS version piracy movie and movie releasing time in theaters. The line of DVD version is the gap between the upload time of the first DVD version piracy movie and theater releasing time.

I assume that the movie is distributed during the holiday season, and assign it a dummy value of 1.

1.3. Empirical strategy and estimation results

In this section, I use both linear regression and structural estimation methods to evaluate piracy loss. With the linear model, I can check the substitution effects of pirated products on the demand and supply of theatrically released movies based on differences in movie quality.

The information from the linear model alone is insufficient to enable a welfare analysis and policy experiment. With the structural model, though, I can estimate the effects of the fixed factors on the demand for both licensed and pirated products, and do a welfare evaluation and policy experiment. The structural estimation, however, needs several assumptions to close the function forms. For instance, the structural model is static, which ignores the dynamic demand change over time and causes an estimation bias in the substitution rate. In the linear regression, on the other hand, I am able to use the information from the daily box office data and the difference-in-difference (DID) method to control for these effects. The linear and structural estimations have their own advantages and disadvantages. I therefore show the results of both methods. Based on the two specifications, I evaluate the effects of the fixed factors on the demand and supply of both licensed and pirated products, and do counterfactual experiments.

1.3.1. Linear specification

I first use a linear model to estimate the substitution effects of online piracy on the sales of theatrically released movies. The main specification is as follows:

$$\ln \pi_{ijt} = \beta_0 + \beta_1 P_{ijt} + \alpha X_i + \gamma Y_j + \delta Z_t + \varepsilon_{ijt}, \tag{1}$$

where π_{ijt} is movie i's box office revenue in region j at time t; P_{ijt} denotes the extent of piracy for movie i. I use the time gap between the date the pirated version was uploaded online and the release date of the movie, along with download intensity, as tproxies for piracy level; X_i denotes i's attributes, including film type, producer and distributor information, season, home country, movie length, film rating on Mtime and Douban, director level, number of superstars, and the number of searches on Baidu for the movie's name; Y_j is the region characteristics or theater dummies; and Z_t is the time characteristics. The variables of time characteristics include seasonal dummies, which are defined by whether the theatrical release week has public holidays, year dummies, and anti-piracy period dummies which are defined by whether there was an anti-piracy campaign during the week of a film's theatrical release.

1.4. Effects of delays in theatrical release

Table 2 presents the results using time differences as a proxy for piracy level. Column 1 presents the results of using TS lag as the piracy proxy. By controlling for the quality rating, film type, producer and distributor information, and season, the coefficient is roughly 0.0005. This result confirms that if the Δt_i increases by ten days, box office revenue will decrease by 0.5%. Given the huge range in the opening lag, with some movies having opening lags of over 1,000 days, the coefficient of Δt_i is small. I regress one dummy if the Δt_i is less than 0 on the box office. I deduce that if the Δt_i is less than 0, the box office loss could be 32.2% of the total revenue. In addition, Columns 3 and 4 of Table 2 present the results of using DVD lag and opening lag as proxies for Δt_i . The coefficients mean that if the DVD resource comes out 100 days earlier, box office revenue will be 4.7% lower. If the opening lag is 100 days longer, box office revenue will be 6% lower. As I control for more variables, the coefficient of Δt_i becomes smaller, which suggests that the omitted variables cause a downward bias.

Daily data can reduce the endogeneity problems by controlling the fixed effects of movies and theaters. Columns 6 and 7 of Table 2 display the daily box office results. The coefficient of the available TS dummy is – 0.729. This result means that the TS resources will decrease the daily box office intake by 72.9%. I add the interactions between the number of days and piracy availability dummies to check piracy loss over time. Column 7 shows that piracy losses decline as the number of days increases. I also add the interactions between the screen density and the piracy availability dummies to determine the effect of the increase in the number of screens. Column 8 shows that piracy losses decreased while the number of screens increased. Some theaters reduce the number of allocated screens and the price of movies being pirated earlier than others. In Column 9, the coefficient of TS availability decreases from – 0.729 to – 0.172 when price and screen allocation are added into the daily regression. The daily sample excludes movies for which there is no record that they were shown in theaters. The time trend and average effects are therefore underestimated.

1.4.1. Difference-in-difference estimation

The estimation of the ordinary least squares (OLS) regression of delay in theatrical release may be downward-biased because of omitted variable problems. For instance, Chinese

Table 2. OLS Regressions Using Time Differenc	ces as Piracy Proxies.				
	(1)	(2)	(3)	(4)	(5)
Dependent Variable Sample TS version lag	-0.000506** (0.000222)		Log (box office) Overall box office data		
TS version available before opening		-0.322*** (0.106)			
DVD version lag			-0.000474** (0.000205)		
DVD version available before opening				-0.311*** (0.109)	
Opening lag					-0.000606*** (0.000235)
Year and Season Dummies	Y	Y	~	Y	γ
Producer & Distributor Dummies	Y	Y	¥	٨	٨
Director & Cast level	٢	٢	7	۲	۲
Film Type Dummies	~	~	~	~	~
Movie Ratings	7	7	~	~	7
# of observations	1,039	1,039	1,039	1,039	1,039
k square	0.09 I (6)	(2) (7)	0.092 (8)	(9)	0.092
VARIABLES	<u></u>		Log (box office)		
Sample			Daily data		
TS available before the day	-0.729***	-0.966*** (0.01 EE)	-0.240***	-0.172*** (0.0057)	-0.819***
TS available xday #	(+610.0)	(cc10.0) 0.0580*** (0.0019)	(0010.0)	(/con.n)	(1110.0)
TS available $ imes$ screen/population			0.620***		
			(0.0679)		
Year and Season Dummies	×	Y	Y	٨	٢
Producer & Distributor Dummies	×	٢	¥	٨	
Director & Cast level	×	٢	Y	٨	
Film Type Dummies	×	Υ	Y	٨	
Movie Rating	×	٢	7	٨	
Day # and Weekday Dummies	Y	٢	*	≻ :	٢
Screen number and average price				Y	>
	No.	Ver	Ver	V	1
cluster by theater	res	res	Y es	res	res
# of observations	286,125	286,125	286,125	286,125	280,125
R square	0.336	0.338	0.393	0.88	0.539
Rohuct standard arrors in naranthases *** n < 0.01 **	n < 0.05 * n < 0.1 Frrors	are chistered by year The	author will use the same control	I variables in the following r	้าคนเครรเกท

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consumers and the SARFT prefer foreign movies that flatter China. Such movies may simply enter the Chinese market and pass censorship, thereby leading to a short release delay and high box office revenue. I use the anti-piracy campaigns undertaken by the Chinese government as a means of identifying revenue loss due to piracy. These campaigns, as natural experiments, cut off the piracy supply temporarily to address these omitted variable problems. Most anti-piracy actions are responses to pressure from the United States. The US government has used the World Trade Organization, for instance, to impose new obligations on China to crack down on pirated goods. The Chinese government started its anti-piracy actions as a response to this pressure. The Chinese government shut down or blocked the access to most of the pirate websites and cleared street DVD sales during the campaigns. It is difficult for normal internet users to find download links during these periods, as most pirate websites are shut down.

These effects prompt me to use a DID regression for estimation. I use three periods as treatment periods: 180 days after 14 July 2006 (when the Chinese government launched a 100-day campaign against piracy), August 2007 and December 2009 (when the Chinese government closed 500 file-sharing websites), and January 2011 (when the Chinese government closed most file-sharing websites). I choose Hong Kong as the control group for mainland China in the DID specification under the theory that the box office performance of movies would be most comparable in markets that have the most cultural similarities and economic ties. Since Hong Kong was transferred from British to Chinese sovereignty in 1997, the rapid growth of the movie market and favorable film policies made mainland China as the single largest export market for Hong Kong's movies (Chung & Yi, 2016). The Closer Economic Partnership Arrangement, a bilateral preferential agreement signed between China and Hong Kong in 2003, removed quota restrictions and tariffs from movies made in Hong Kong and also relaxed the rules governing film co-productions. Since then, the number of co-productions between Hong Kong and mainland companies have been growing rapidly every year (Yi, J., & Guannan, E. (43)). For example, of the total of 54 movies produced in Hong Kong in 2011, 39 were jointly produced with mainland Chinese producers. Hong Kong serves as a useful control for mainland China because Hong Kong is the region that is by far the most similar to mainland China in terms of movie production and culture.

Furthermore, the motion picture market in Hong Kong, which has an independent legal system and a government that is relatively independent of mainland China, was unaffected by these anti-piracy campaigns. According to research by an industry association, Hong Kong has the lowest level of piracy of any country in the world. In 2004, the level of video piracy in Hong Kong was only a bit less than 20%, while the level in mainland China was 93%. The government of Hong Kong has taken steps to fight piracy, and the amount of piracy there continued to drop over the next seven years (The Software Alliance, 2011). The anti-piracy campaigns removed the preexisting differences between the treatment and control groups that are caused by the different levels of piracy activities in the two groups. We thus might expect that the trends in the two markets would be similar during the periods of anti-piracy campaigns. In the DID specification, I only keep movies that have been shown in both markets in the sample. The following two dimensions are available in this model: mainland China or not, and anti-piracy period or not. Two dummies are required in order to be able to estimate using the DID regression. The specification is as follows:

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$$\ln \pi_{ijt} = \beta_0 + \beta_1 D_c \times D_{ml} + \beta_2 D_{ml} + \beta_3 D_c + \eta X_i + \gamma Y_i + \delta Z_t + \varepsilon_{ijt}.$$
(2)

In the equation, D_c is the control period dummy and D_{ml} is the treated dummy. X_i denotes movie i's attributes, and Y_j denotes region j's attributes. $D_c \times D_{ml}$ captures the effect of the movement. In the DID regression, differences in taste and piracy level between the two regions are captured by the region dummy. During the period of antipiracy campaigns, the piracy resource disappears and the licensed movies become the only choices. β_1 thus captures the influence of online piracy on box office revenue.

In the OLS specification, the estimation of Δt is downward-biased due to omitted variables. I also use the Difference-in-Difference-in-Difference (DDD) regression to deal with the correlation between unobserved qualities, which solves the endogeneity problem. The following three dimensions are available in this model: mainland or not, antipiracy period or not, and high level of piracy or not. Seven dummies are required in order to be able to estimate using the DDD regression. The specification is as follows:

$$\ln \pi_{ijt} = \alpha_0 + \alpha_1 D_c \times D_{ml} \times D_{\Delta t} + \alpha_2 D_{ml} + \alpha_3 D_{\Delta t} + \alpha_4 D_c + \alpha_5 D_c \times D_{ml} + \alpha_6 D_c \times D_{\Delta t} + \alpha_7 D_l \times D_{\Delta t} + \eta X_i + \gamma Y_i + \delta Z_t + \varepsilon_{ijt}.$$
(3)

In the specification, $D_{\Delta t}$ is the dummy for the extent or level of piracy and α_1 captures the effect of the movement. Here, I use the availability of the TS version before the theatrical release as the level of piracy. The validity of our identification strategy rests on the common trend assumption: two regions would have experienced similar box office performances in the absence of the pirated resources, and the changes I document in the box office performance in the mainland are due to the removal of pirated movies, and not due to differences in taste. Therefore, to probe the common trend assumption, I estimate the model using the periods of the six months before the campaigns as the treatment period. This is a placebo test because if the common trend assumption is valid, the box office performance in mainland China during this period should not be different from any other periods with pirated resources available.

To explore the dynamics of the effects of anti-piracy campaigns and to test the parallel trends assumption, I add the leads and lags of the implied contract exception, following the method of Autor (2003). Specifically, I add the variables of the month dummy and the mainland market dummies. The five indicators of that before the policy happened (month -1 to -5) capture the box office differences in the two markets before these actions, which can be used to test the common trends assumption. The eight indicators of that after the policy happened (month 0 to 7) capture the box office differences of the two markets after these actions, which can be used to estimate the policy effects over time.

1.5. Results of the difference-in-difference estimation

Columns 1, 3, and 5 of Table 3 present the DID specification results. I define the length of the treatment periods to determine whether these anti-piracy movements exert shortand/or long-term effects. The first period is from the beginning of the anti-piracy efforts until six months after the beginning. The government efforts had several effects that

Table 3. Effects of anti-piracy campaigns.								
	(1)	(2)	(3)	(4)	(5)	(9)	(2)	(8)
Dependent Variable					Log (box office	(
Sample	A	I	A	=	4		Beijing, Shanghai, V	Wuhan, and Hong
Control period	0–0 m	ionths	6–12 n	nonths	-0-0 r	nonths	0–6 m	onths
Mainland×Anti-piracy period	0.379**	0.577	-0.111	0.193	-0.0192	0.136	0.415	1.033
	(0.147)	(0.491)	(0.325)	(0.173)	(0.480)	(0.484)	(0.913)	(0.948)
Mainland	2.633***	2.690***	2.635***	3.001***	2.635***	3.111***	-0.767	-0.763
	(0.0181)	(0.303)	(0.0169)	(0.0729)	(0.0178)	(0.0712)	(0.0666)	(0.0630)
Anti-piracy period	0.338*	-0.143	-0.0507	1.128***	0.0372	0.270	-0.136	-0.270
	(0.156)	(0.478)	(0.264)	(0.248)	(0.211)	(0.196)	(0.607)	(0.394)
TS available before opening $ imes$		1.092**		0.0824		0.453		1.033
Anti-piracy period×Mainland		(0.398)		(0.311)		(0.533)		(0.948)
TS available before opening		0.806***		0.288*		0.376**		0.0834
		(0.138)		(0.150)		(0.116)		(0.0969)
TS available before opening ×Mainland		-0.846***		-0.955***		-0.983***		-1.906
		(0.213)		(0.183)		(0.138)		(1.090)
TS available before opening ×Anti-piracy period		-0.902***		0.0601		-1.001^{*}		0.239
		(0.254)		(0.186)		(0.459)		(0.593)
Control other variables	≻	≻	≻	≻	۲	≻	۲	۲
# of observations	934	934	934	934	934	934	390	390
R square	0.693	0.705	0.691	0.704	0.690	0.705	0.491	0.496
Robust standard errors in parentheses. *** $p < 0.01$,	** p < 0.05, * p	o < 0.1. Errors a	re clustered by	regions*year v	ariables.			

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent Variable	Log (box office)	Log(download intensity)	TS lag	Log (box office)	Log(download intensity)	TS lag
Control period definition		0–6 months			6–12 months	
Anti-piracy period	0.367** (0.177)	-0.456* (0.272)	30.50* (17.37)	-0.109 (0.0998)	0.0214 (0.156)	13.70 (11.94)
Control other variables	Y	Y	Y	Y	Y	Y
# of observations	1,039	1,039	1,039	1,039	1,039	1,039
R square	0.497	0.235	0.446	0.680	0.381	0.476

Table 4. Effects of anti-piracy campaigns on piracy.

Robust standard errors in parentheses. *** p < 0.01, ** p < 0.05, * p < 0.1. Errors are clustered by year. The author uses public holiday dummy to replace seasonal controls in the main specification. Errors are clustered by regions*year variables.

Table 5. Effects of anti-piracy campaigns over time.

	(1)	(2)
Sample	Movies shown on both market	All
VARIABLES	log(box office)	
Mainland market $ imes$ Month t-5	-0.312**	-0.0860
	(0.0201)	(0.0473)
Mainland market $ imes$ Month t-4	-0.0949	0.0823
	(0.426)	(0.398)
Mainland market $ imes$ Month t-3	-0.230	0.235
	(0.0820)	(0.270)
Mainland market $ imes$ Month t-2	-0.137	-0.217
	(0.171)	(0.0950)
Mainland market $ imes$ Month t-1	-0.346**	-0.371
	(0.0260)	(0.106)
Mainland market $ imes$ Month t	0.537	0.259
	(0.101)	(0.245)
Mainland market \times Month t + 1	0.394*	0.132
	(0.0363)	(0.204)
Mainland market \times Month t + 2	0.179	0.144
	(0.0876)	(0.182)
Mainland market \times Month t + 3	0.596*	0.620
	(0.0637)	(0.209)
Mainland market \times Month t + 4	0.271	0.00208
	(0.0674)	(0.00737)
Mainland market \times Month t + 5	0.0720*	0.515
	(0.00756)	(0.0997)
Mainland market $ imes$ Month t + 6	-0.237	0.0371
	(0.0434)	(0.157)
Mainland market $ imes$ Month t + 7	-0.118	-0.0930
	(0.221)	(0.243)
Control other variables	Y	Y
Observations	934	1,519
R-squared	0.682	0.614

Robust standard errors in parentheses. *** p < 0.01, ** p < 0.05, * p < 0.1. Errors are clustered by year. The author uses public holiday dummy to replace seasonal controls in the main specification. Errors are clustered by regions*year variables.

reduced box office revenue loss caused by piracy during that six-month period, and I find that the anti-piracy campaigns increased box office revenue by 38%. I then extend the control period to one year to check whether the anti-piracy policies have longer-term effects. I find that β_1 becomes insignificant in the one-year period regression. The insignificant results of the one-year regression indicate that, in the long run, as new





Notes: The x axis is valued in months. In the graph, "month 0" means the month starts the campaign. The y axis means the coefficient of "mainland market \times the number of months after the campaign". The coefficients are from Column 2 of Table 5.

websites replace the old ones, the piracy supply returns. Without legal actions prohibiting individual downloading, internet users can always find new websites or new technologies to replace those that have been banned.

Columns 2, 4, and 6 of Table 3 present the DDD specification results. The estimation of the coefficient α_1 suggests that the policies will decrease the piracy loss caused by TS availability before theatrical release by roughly 44 percent in the half-year range. The estimated piracy loss is bigger than the main specification and proves that the results of the OLS specification are downward-biased. I check the common trend assumption by defining the treatment period as six months before and after the anti-piracy periods. Columns 3 to 6 of Table 3 show that the common trend assumption is valid. I also seek to learn more about the mechanism linking the campaigns to the box office performance by looking at the piracy level during these periods.

In addition, I investigate the mechanism behind how the anti-piracy movements affected online piracy. Table 4 shows that the download intensities are reduced and that the TS lags increase during the campaign periods. All of these results support the idea that the anti-piracy campaigns decreased the piracy level by preventing internet users from accessing pirated movies during the campaign periods. They also increased the box office revenue of the movies released during those periods.

The results of the regression analysis of the dynamics of the effects are presented in Table 5. Figure 4 also provides graphical illustrations of these effects by showing the coefficients of the indicators. In the regression, month 0 means the month the campaign started. The negative coefficients of the indicators before the policies show that the box office sales in the mainland market were relatively lower than average before the policies started. The results suggest that it was the adoption of these policies that led to an increase in the box office revenue rather the different trends of the two markets.

The positive coefficients of the indicators in the first five months after the policies show no persistent effects of the anti-piracy campaigns. In the first five months, the campaigns increased the box office returns of the movies released in that period. However, the effects disappeared six months after these campaigns. The pattern of the coefficients provides evidence that these anti-piracy actions only had temporary effects on the sales of licensed media products.

1.5.1. Instrument variables estimation

The OLS estimation of download intensities may also be biased downward because of omitted variable problems. High-quality movies not only attract consumers to theaters to watch them but also cause more internet users to download them online. I propose two instrument variables (IV) for download intensities: (1) the number of clicks on links to movies that were not released in China and were uploaded during the week the pirated movie was uploaded; (2) the number of clicks on links to the television shows uploaded on pirate websites during the week the pirated movie was uploaded. The validity of the IVs relies on two assumptions: first, these variables are uncorrelated with the demand and supply of movies in theaters; second, the number of pirated resources available at the same time influence the supply and demand of pirated movies.

The first assumption holds because the release decisions of these movies and television shows in the home market will not take the Chinese movie market into consideration. All foreign television shows must also be submitted for approval to the SARFT before their release in China, and most of them cannot be shown on television and internet in China at the same time as the home market. The release schedule of these foreign media products, which are not released in China, will not take the conditions of the Chinese movie market into consideration. Thus, releasing decisions for foreign television and movies that are not released in China are independent of demand and supply in the Chinese movie market.

The second assumption holds because these variables can affect both the supply and demand of pirated movies. Chinese audiences can access their favorite foreign television shows and movies from pirated resources, even those that are not available on television, in theaters, and on legal streaming sites. Most television shows and movies will appear on pirate websites soon after they are released on television or streaming websites in the home market. These pirated resources can affect both supply and demand of the pirated movies that have licensed counterparts shown in theaters, through two channels.

First, demand for one pirated movie will be lower as more pirated movies and television shows are uploaded online at the same time. Most pirate websites have sections for both movies and television shows and a large portion of users of these websites enjoy watching both types of pirated products. Thus, when a popular show or movie is uploaded, pirate websites will recommend these resources on the front page and usually put the most popular one on the most important layout of the site. As more movies and television shows become available on pirate websites, consumers of pirated movies have more choices and are less likely to select specific movies.

Second, the supply of pirated movies is also affected by the number of foreign movies and television shows uploaded at the same time. Once pirated foreign movies are available online, subtitles are needed before it can spread on Chinese pirate networks. A fan subtitling group usually takes 4 to 8 times the length of a movie to produce its subtitles (Yuhan, 2019). Since fan subtitling groups are limited in size, these groups always prioritize subtitling the more popular movies and television shows first. Some of

Table 6. Effects of Download Inte	ensity on Box	Office Performance.					
	(1) OFS	(2) 2SLS	(3) 2SLS	(4) 2SLS	(5) 2SLS	(9) OLS	(7) 2SLS
					Panel A: First sta	age	
Dependent Variable			Log (download intensity)			Log (se	arch intensity)
Log(click # on TV shows links)		-0.0246***		-0.0273***	-0.0267***		-0.0267***
		(0.00798)		(0.00687)	(0.00686)		(0.00686)
Log(click # on other movie links)			-0.0588***	-0.0590***	-0.0590***		-0.0590***
			(0.00327)	(0.00325)	(0.00325)		(0.00325)
# of observations		1,039	1,039	1,039	1,039		1,039
R square		0.385	0.539	0.544	0.546		0.546
				Panel B: Second	l stage		
				Dependent Variable: Lo	og (box office)		
Log(download intensity)	1.070***	-0.258*	-0.312**	-0.315**	-0.303**		
	(0.0594)	(0.137)	(0.136)	(0.137)	(0.136)		
Log (search intensity)						0.0337***	-0.978*
						(0.00374)	(0.586)
TS version lag					0.000178 (0.000274)		
Conditional LR test for weak IV		[-0.815 0.322]	[-0.721, 0.271]	[-0.917 0.355]			[-1.521 0.943]
F-test for IV		F(1, 1039) = 209.12	F(1, 1039) = 13.05 F((2, 1039) = 413.87			F(2,1039) = 413.87
		Prob > F = 0.0000	Prob > F = 0.0000 P	rob > F = 0.0000			Prob > F = 0.0000
Year Dummies	۲	٢	۲	Y	٢	۲	۲
Season Dummies	۲	۲	۲	٢	۲	۲	۲
Producer & Distributor	۲	۲	۲	٢	٢	۲	۲
Director & Cast	۲	۲	7	٢	۲	۲	۲
Film Type	۲	۲	7	٢	۲	۲	۲
Movie Rating	۲	۲	۲	٢	٢	۲	۲
# of observations	1,039	1,039	1,039	1,039	1,039	1,039	1,038
R square	0.774	0.639	0.639	0.636	0.649	0.717	0.782
Robust standard errors in parentheses.	*** p < 0.01, **	p < 0.05, * p < 0.1. Errol	s are clustered by year.				

Table 6. Effects of Download Intensity on Box Office Performance.

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the subtitling work will be delayed as more movies and television shows become available on pirate websites at the same time. This is why the download intensity of any given movie will be affected by the number of new pirated resources available online.

The results of the first stage regression in Table 6 support the argument that the download intensity of a movie is lower when more competitors are available on pirate websites. Conditional on the validity of the IV, one may suspect a weak IV problem as the effects of competitors on pirated movies are limited. To be sure, the IV results reported below are accompanied by a conditional likelihood ratio test for weak instruments, and F-statistics for the first stage.

1.6. Substitution effects

Table 6 shows the substitution effects of pirated movies on movies in theaters. Columns 1 and 5 of Table 6 show the result of the OLS regression. The result suggests that movies with high download intensities and search intensities tend to bring in strong box office revenues. In addition to the OLS results in Columns 1 and 5, I present four columns of IV estimates: the first uses the number of clicks on the links to television shows as the only IV for download intensity; the second uses the number of clicks on the links to pirated movies as the only IV for download intensity; the third uses both IVs for download intensity; and the fourth uses both IVs for the search intensity of pirated movies. Column 1 presents the result of the OLS regression. The coefficient of the download intensity is 1.07. This result confirms that if the number of clicks on the unlicensed links increases by 10%, then box office revenue will increase by 10.7%. After correcting it with IVs, the magnitude of the effects becomes negative, implying that a 10% increase in download intensity can reduce the box office revenue of a movie by 3.1%. This confirms the concern that the OLS coefficient is biased downward. Taking Column 4 as the preferred specification, the two-stage least squares (2SLS) estimate suggests that an increase of one percentage point in the number of clicks on the links to a pirated movie will increase its box office returns by 0.31 percentage points.

Not all of the losses caused by delays in theatrical release are due to piracy alone. The delay by itself has a perverse impact, independent of piracy. To disentangle this effect, I add the TS lag variable into the regression. Column 6 reports the result that the coefficient of TS lag is about 0.000178 and insignificant after the piracy attempts are controlled in the regression. The coefficient is about one-third of the coefficient of TS lag in Table 2, which suggests that the high piracy level is not the only reason for the box office revenue losses caused by the delays. The result may underestimate the true totals of the substitution effects. Website tracking can cover only a minimal segment of the population and cannot track other piracy channels, such as unlicensed DVDs or filesharing, through the social network. The piracy intensity in such samples cannot represent the total intensity of piracy. In fact, members of these online pirate websites are heavy piracy product users (Gunter, 2009), which means the piracy intensity of these groups is much higher than the others. Therefore, by using the download intensity of a movie on these websites as the proxy for piracy level, the study may overvalue the piracy level of the population as a whole. To avoid this, I use the search intensity of pirated movies as another proxy to evaluate the substitution effect of such movies on movies in theaters. Column 7 shows that when the search intensity of pirated movies increases by

10%, the box office revenue will increase by 9.78%. This result indicates that the substitution elasticity is about 0.978. These results suggest that the biased sample may result in an underestimation of the true totals of piracy loss. Structural Estimation

In this part, I build a structural model to explore the mechanisms of the effects of online piracy on the sales of theatrically released movies, based on differences in movie quality and in the supply time of pirated resources. I then estimate the parameters of the model. I present a demand model of consumers' choices of the channel through which they watch movies. This model serves two purposes. First, it delivers qualitative predictions to guide my empirical evaluation of changes in piracy levels. Second, it provides an estimation framework that I use to quantitatively assess the counterfactual experiment to evaluate the effects of policy changes on piracy levels and box office revenues. Setup and Notation

In the model, the economy consists of continuous consumers, a single theater, and Imovies that are showing simultaneously both in theaters and online. The setting I consider is as follows. The theater first determines the price and screen allocation of each movie by taking into account all of the different movies available at the same time. Then, based on the price, quality, and availability of the different movie resources, the audience chooses whether to watch a movie and the channels through which to watch it.

To further simplify the exposition, I assume that consumers' utility function is linear. The setting of utility form implies that the demand for one movie doesn't directly affect the consumer's choice of other movies. However, the movies must compete for the limited number of screens in the theater. Thus, the demand for each movie affects the demand for the other movies through the channel of screen allocations and the price setting on the supply side. The setting of the utility form means that the model mainly focuses on the substitution effects that an online pirated movie has on the sales of the movie in the theater but ignores its effect on other movies. The estimation thus identifies the lower bound of the effects of online piracy on box office sales.

For the sake of further simplicity, I assume a static model instead of a dynamic one. As I discuss in more detail below, it is conceptually straightforward to extend the analysis to multiple periods, but this substantially complicates the graphical illustrations. In the model, the availability of pirated movies and theatrically released movies is proxied by the gap between the availability of a pirated version and the theatrical opening date for movie *i* by Δt_i , which is given as exogenous. Consumers gain value from watching the movie early. Theatrical release delays may increase the attractiveness of pirated movies and reduce box office sales in theaters. If the theater distributes the movie later than a pirated version becomes available online ($\Delta t_i > 0$), then watching the movie in the theater has an additional cost $\gamma \Delta t_i$. γ is the patience parameter, which indicates the utility gain from watching a movie early.

I define the total number of theater consumers as D_{τ} , which captures the size of the potential movie audience at time τ . p_i is the ticket price of movie *i*, which is determined by theaters²¹; and Q_i is the vector of movie characteristics of movie *i*, which is an

²¹Since the market-oriented reforms of the 1990s, Chinese theaters have been free to set prices and screen for movies according to length, plot, and local demand (Leung & Lo, 2015).

exogenous given. η_i is the share of the box office revenue given to theaters, which is also an exogenous given.

1.6.1. Consumer choice

I begin with a demand model that can be used to recover consumer preference. The utility of watching movie *i* in a theater is $u_i^t = V_i^t + \in_i^t$, with $V_i^t = \beta Q_i - p_i - \gamma \Delta t_i$. The utility of watching movie *i* online is $u_i^p = V_i^p + \in_i^p$, with $V_i^p = \alpha \beta Q_i$. α is the discount effect of watching the movie online, with $\alpha < 1$, which indicates that consumers obtain more utility from watching movies in theaters than from watching them online. $u_i^n = \in_i^n$ is the utility of not watching the movie. \in_i^j is type 1 i.i.d extreme value distributed, $j \in \{p, t, n\}$. Consumers maximize their utility by selecting their methods for watching a movie as follows:

$$u_{i} = \max_{\{p,t,n\}} \left\{ u_{i}^{t}, u_{i}^{p}, u_{i}^{n} \right\}$$
(4)

1.6.2. Screen allocation and pricing

The theater incurs zero cost in releasing the movies.²² The theater has S_{τ} seats in total, which captures the capacity of the licensed movie market. The theater allocates the number of seats s_i to movie i, such that $S_{\tau} = \sum_i s_i$. Then, the theater selects the optimal price p_i . N_i^p is defined as the part of the audience that watches movie i online, such that $N_i^p = \frac{D_r e^{V_i^p}}{1 + e^{V_i^p} + e^{V_i^i}}$. N_i^t is defined as the part of the audience that watches movie i in theaters, such that:

$$N_{i}^{t} = \min\left\{s_{i}, \frac{D_{\tau}e^{V_{i}^{t}}}{1 + e^{V_{i}^{p}} + e^{V_{i}^{t}}}\right\}.$$
(5)

When $s_i \leq \frac{D_r e^{V_i^t}}{V_r^p + e^{V_i^t}}$, the theater cannot charge lower prices to increase the total revenue when all of the seals are occupied.

In view of the restriction of the number of screens, a shortage of large screens leads to a high price, thereby encouraging people to watch free pirated movies online instead. In most developing countries, S_{τ} is small and only a small portion of the population can access theaters, thereby making pirated movies the only choice for the majority of the population. Theaters maximize their profits by choosing the optimal prices and screen allocations as follows:

$$\Pi_i = \max_{\{p_i, s_i\}} \sum_i \eta_i p_i N_i^t \tag{6}$$

when all of the screens are fully occupied, such that $s_i^t = N_i^t$.

²²The costs for Chinese theaters are facility overhead and property rent. These costs do not affect the pricing of certain movies in the short term. In China, distributors do not charge theaters money for copies of movies.

1.7. Box office revenue and piracy level

In the equilibrium, different movies have the same price. Otherwise, if one movie has a higher price margin, a theater can allocate more screens to the movie and obtain a higher profit. If the demand is more than s_i^t , then all of the seats allocated to movie *i* are fully occupied. There is a low bound of the price- p_i , such that p_i satisfies that $s_i = \frac{De^{\beta Q_i - p_i}}{1 + e^{\beta Q_i - p_i} + e^{\beta Q_i + p_i}}$. If $p_i < p_i$, then the demand will be higher than the number of seats allocated to movie *i*. In this case, increasing the price will increase the total revenue. p_i is therefore always larger than p_i in the equilibrium. Define $\hat{p_i} = \frac{1 + e^{V_i^p} + e^{V_i}}{e^{V_i^p} + e^{V_i}}$ such that $\hat{p_i} = \arg \max \frac{\eta_i p_i D e^{V_{ii}}}{1 + e^{V_{ip}} + e^{V_{ii}}}$. The price function is thus:

$$p_i^* = \begin{cases} \widehat{p_i}, \text{if } \sum_i N_i^t < S_\tau \\ \beta Q_i + \ln \frac{s_i + s_i e^{\alpha \beta Q_i + \gamma \Delta t_i}}{D_\tau - s_i}, \text{ otherwise} \end{cases}$$
(7)

When $s_i^t = N_i^t$, the seats allocated to movie *i* are fully occupied. Hence, the theater allocates fewer screens to movies with higher levels of piracy. In this case, online piracy reduces both the demand and supply of the movies in the theater. Theater reactions are likewise attributed to the damage caused by pirated movies. High levels of piracy cause theaters to reduce the number of screens that are allocated to a movie, thereby exacerbating losses caused by piracy. Decreasing Δt_i causes the theater to increase p_i and s_i , which will cause a high N_i^t .

If a delay occurs in uploading the pirated movie online, then the box office revenue of movie *i* can increase. People become tired of waiting for unlicensed movies and opt to watch the movie in a theater, given the delay in uploading a pirated movie online. A large availability gap for a pirated movie therefore results in a high box office return. A delay in the appearance of a pirated movie online leads the audience to lose patience and visit theaters instead.

I now examine the benchmark case in which only movies in theaters are available. \tilde{u}_i^t is the utility for watching movie *i* in a theater. Consumer maximizes the utility by $\tilde{u}_i = \max\{u_i^t, u_i^n\}$. In this case, the optimal price is \tilde{p}_i ; and the number of audience members for a movie without piracy is \tilde{N}_i^t , such that $\tilde{N}_i^t = \min\{\tilde{s}_i, \frac{De^{\tilde{v}_i}}{1+e^{\tilde{v}_i}}\}$. The total number of consumers of movie *i* is defined as N_i^{all} , which is the sum of the audiences that are watching the movie both online and in theaters. According to these equations, box office revenue when there is no piracy is $\tilde{\pi}_i = \tilde{N}_i^t \tilde{p}_i$ and box office revenue with piracy is $\pi_i = N_i^t p_i$. Usually, by assuming full substitution, in which every person who pirates a work would have otherwise purchased it at full price, the revenue loss claimed by media industries will be $p_i(N_i^{all} - N_i^t)$, which is considerably higher than the actual box office loss of $\tilde{\pi}_i - \pi_i$.

1.8. Identification and estimation

From the previous section, I obtain the equations with error terms:

$$\ln N_i^t - \ln(D_\tau - N_i^{all}) = \beta Q_i - p_i - \gamma \Delta t_i + \varepsilon_1$$
(8)

and

$$\ln N_i^t - \ln N_i^p = (1 - \alpha)\beta Q_i - p_i - \gamma \Delta t_i + \varepsilon_2$$
(9)

I define the value of S_{τ} proportional to the overall number of screens each year,²³ such that $S_{\tau} = \zeta N_{scr}$. I use the market size of the week with the largest size of the audience group each year as the market size of the year. The demand functions generate $N_i^p = \frac{D_r e^{V_i^p}}{1+e^{V_i^p}+e^{V_i^t}}$, which allows me to use the parameters estimated above to get the predicted value of $\frac{e^{V_i^p}}{1+e^{V_i^p}+e^{V_i^t}}$. I jointly evaluate the effect of time lags on box office losses by using Equations 8 and 9. The linear specification is as follows:

$$\ln N_i^t = \beta Q_i - \gamma \Delta t_i - \ln \left(N^d - N_i^{all} \right) - p_i + \partial Y_j + \delta Z_t + \varepsilon_{ijt}$$
(10)

and

$$\ln N_i^t = \theta \ln N_i^p + (1 - \alpha)\beta Q_i - p_i - \gamma \Delta t_i + \ln \phi_\tau + \varepsilon_{ijt}$$
(11)

where N_i^t is movie *i*'s number of viewers in region *j* at time *t*; p_i is represented by the average price in the opening week; Δt_i is represented by the TS lag; Q_i denotes *i*'s attributes, such as film types, producer and distributor information, season, home country, movie length, film rating on Mtime and Douban, director level, number of superstars, and the number of searches on Baidu for the movie's name. N^d is the total number of active members of Douban on the movie section; and N_i^t is represented by the size of the theater audience. In the linear estimation, D_{τ} is captured by year fixed effects, and the number of people who did not watch the movie is proxied by $N^d - N_i^{all}$. To use the daily box office data, I also add time characteristics Z_t and theater characteristics Y_j in these regressions. The download intensity N_i^p is represented by the number of clicks on the links to each movie on pirate websites and the search intensity of pirated movies on search engines. The substitution elasticity θ captures the portion of the download attempts made by marginal consumers, who will be affected by the movies supplied by theaters and pirate websites. With this estimation, I get the estimation results of the parameters θ , α , β , γ , ∂ , and δ .

I use linear regression to estimate two equations simultaneously while accounting for the correlated errors. However, the estimation has an endogeneity problem, because the distribution of Δt_i across movies is not random. The movies that would be hurt more by piracy are also subject to shorter Δt_i , which caused a downward-biased estimation result. In addition, since the model also ignores the spillover effects of pirated movies on other movies, the estimation and simulation results using the model provide the lower bound of the effects of piracy on box office sales.

²³The number of screens was approximately 18,000 in 2013; 13,000 in 2012; 9,200 in 2011; 6,200 in 2010; 4,700 in 2009; 4,000 in 2008; 3,500 in 2007; and 3,000 in 2006.

		Standard	•		Standard
Estimate	Mean	deviation	Estimate	Mean	deviation
	002	acviation		2024	acviation
# of the observation	803		# of screen in 2006	3034	
# of screen in 2007	3527		# of screen in 2008	4097	
# of screen in 2009	4/23		# of screen in 2010	6258	
# of screen in 2011	9286		# of screen in 2012	13,118	(2.22)
# of screen in 2013	18,195	(0.00)	D (market size, $\times 10,000$)	22,026	(2.22)
γ (unit waiting cost)	0.00035	(0.00)	a (quality discount)	0.28	(0.05)
ζ (screen capacity, ×10,000)	0.19	(3.19)	τ (revenue share of quota movies)	0.48	
β (rating on Douban)	0.39	(0.33)	τ (revenue share of domestic movies)	0.57	
β (rating on story)	-0.86	(0.97)	β (rating on music)	0.67	(0.89)
β (rating on performance)	-0.24	(0.84)	β (rating on impression)	-0.22	(1.24)
β (rating on picture)	1.031	(0.89)	β (rating on director)	0.078	(1.25)
β (coproduced movie)	0.171	(0.86)	ß (movie log(length))	6.30	(2.25)
β (3D movie)	6.71	(0.92)	ß (Imax movie)	3.20	(1.28)
ß (quota movie)	-0.14	(0.92)	ß (documentary)	-2.22	(2.60)
β (political propaganda	-0.12	(1.21)	ß (cartoon)	-0.42	(1.01)
movie)	2.42	(1.2.1)		5.4.6	(1.01)
β (family)	2.42	(1.07)	β (children)	-5.16	(2.76)
β (horror)	0.31	(0.73)	β (love story)	-0.24	(0.66)
β (drama)	0.18	(0.59)	β (Action)	0.60	(0.63)
β (fantasy)	0.28	(0.81)	β (crime)	0.027	(0.93)
β (comedy)	0.23	(0.62)	β (adventure)	1.09	(0.78)
β (released in labor day)	1.44	(1.27)	β (released in new year)	-0.57	(1.17)
β (released in spring festival)	1.32	(1.18)	β (released in national day)	-1.72	(1.04)
β (released in labor day)	1.44	(1.27)	β (released in mid-autumn)	-0.15	(2.10)
β (distributed by CFGC)	-0.20	(0.61)	β (distributed by Huaxia)	-0.81	(0.65)
β (distributed by Huayi)	0.37	(4.67)	β (distributed by Bona)	0.45	(1.14)
β (distributed by Guangxian)	0.37	(1.65)	β (USA movie)	1.70	(0.93)
ß (Hong Kong movie)	-0.085	(0.88)	ß (Taiwan movie)	0.40	(1 22)
β (Korea movie)	4 10	(2.18)	ß (Japan movie)	_2 14	(1.52)
β (produced by Guangyian)	0.67	(2.10)	ß (produced by Huavia)	_0.96	(7.30)
ß (produced by Guangxian)	2.40	(2.05)	B (produced by Yingmei)	_0.20	(2.51)
B (produced by fiday)	2.49	(4.07)	B (produced by Shangving)	-0.22	(1.30)
β (produced by CFGC)	0.90	(0.93)	p (produced by Shangying)	1.02	(1.23)
p (produced by US big 6)	-0.20	(0.92)	p (produced by Hong Kong big 10)	1.22	(0.83)
β (Chinese top director)	5.40	(1.77)	β (# of top Chinese actor/actress)	2.65	(0.98)
β (World top director)	-0.43	(1.81)	β (# of top world actor/actress)	0.93	(1.57)
β (year = 2008)	-3.17	(1.48)	β (year = 2011)	0.16	(1.43)
β (year = 2009)	-2.99	(1.48)	β (year = 2012)	0.95	(1.39)
β (year = 2010)	-2.43	(1.47)	β (year = 2013)	1.34	(1.38)

Table 7. Results of Structura	l Estimation, Stud	y Sample
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Parameters from estimation.

1.9. Estimation results

Table 7 reports the posterior means and standard deviations of the parameters of the structural model. The first and second columns are the mean and variance of the vector of parameters. Based on the structural model and the parameters estimated, I use simulation methods to show the counterfactual results. I initially check the sample fit of the model prediction via simulation. The coefficients are from the estimation part. In the simulation, the release time of each movie has no changes; the competitors are thus the same for each movie.

Table 8. Counterfactual results.

Full sample (N = 803)					
Real price	31.50	(7.03)	Real box office(10,000Yuan)	5954.49	(15,547.46)
Predicted price	33.20	(11.27)	Predicted box office	5861.54	(16,260.19)
Predicted price without piracy	44.17	(22.91)	Predicted box office without piracy	9765.48	(26,427.73)
Domestic movies (N = 467)					
Real price	30.73	(7.04)	Real box office(10,000Yuan)	5539.43	(16,706.19)
Predicted price	31.08	(10.08)	Predicted box office	4974.33	(16,489.51)
Predicted price without piracy	35.56	(17.31)	Predicted box office without piracy	7763.34	(25,512.04)
Quota movies (N = 138)					
Real price	33.16	(6.01)	Real box office(10,000Yuan)	12,353.68	(18,803.80)
Predicted price	36.36	(11.16)	Predicted box office	14,723.78	(23,660.16)
Predicted price without piracy	44.06	(22.94)	Predicted box office without piracy	21,545.07	(35,714.15)
Buyout movies (N = 198)					
Real price	32.29	(7.27)	Real box office(10,000Yuan)	3912.09	(9328.88)
Predicted price	36.03	(51.32)	Predicted box office	3713.62	(8467.76)
Predicted price without piracy	40.19	(20.93)	Predicted box office without piracy	8703.24	(21,642.21)

Data from simulation.



Figure 5. Predicted Box Office from Structural Estimation.

Notes: The first figure is one of the real box office and predicted box office. The second figure is one of the real price and predicted price. The box office unit is 10,000 Yuan and the price unit is Yuan.



Figure 6. Predicted Box Office without Opening Lag.

Notes: In the experiment, the gaps between China releasing date and global earliest releasing date to zero. The first figure shows the experimental effects on foreign movies. The second figure shows the experimental effects on domestic movies.



Figure 7. Policy Experiment without Theater Subsidy.

Notes: In the experiment, the screen increasing speed didn't change after 2009. The first figure is the total screen number in China. The blue line is the one that from real data. The red line is the one that from the simulation. The second figure is the box office from the actual box office data and the estimation result. The solid lines are from the simulation.

Table 8 shows the sample fit for box office revenue and price. I simulate the model and report the mean and standard deviation of the moments of the distribution. The distribution of both the box office returns and price matches the data well. The predicted prices of domestic, quota, and buyout movies are higher than the real value. Figure 5 shows that the distribution of the actual box office revenue is flatter than predicted. Overall, the model does relatively well in matching these moments. The estimated model can fit basic patterns.

Table 8 also shows the simulation results of the case without online piracy. By removing the piracy supply, consumers can only watch movies in the theater and the theater maximizes its profit according to the new demand curve. Under this setting, I check the box office revenue loss due to piracy by comparing the predicted box office π_i . The estimate of piracy loss is approximately 64% on average, which is similar to the loss in the DID regression. Table 8 also presents the effect of online piracy on the box office revenue of different types of movies. Online piracy has a stronger effect on buyout movies than on others. This is a result of the fact that the buyout movies tend to have long release delays, which cause large box office losses. Part of the box office increase is due to the change in the ticket price after removing online piracy. After removing it, the theater can charge higher prices than before. Having no other choice, more audiences will choose to watch movies in theaters, despite a higher ticket price.

2. Discussion

In this part, I conduct several counterfactual experiments to estimate supply-side reactions to online piracy and the effects of these reactions on box office sales, as well as the effects of removing release delays on box office sales. Thus, in the policy analysis section, I calculate the percentage changes in these measures as I impose the institutional changes. The settings of the parameters are the same as the benchmark settings in the previous section.

	(1)	(2)	(3)	(4)
Dependent Variables		Log(box off	ice)	
Sample	Foreign movie	Domestic movies	2006-2009	2009-2013
Method	OLS	OLS	OLS	OLS
TS available before opening	-0.471***	-0.224*	-0.312*	-0.266*
	(0.125)	(0.123)	(0.172)	(0.155)
Control other variables	Y	Y	Y	Y
# of observations	415	634	462	577
R square	0.726	0.530	0.704	0.674
	(5)	(6)	(7)	(8)
Dependent Variables		Log(box off	ice)	
Sample	Foreign movie	Domestic movies	2006-2009	2009-2013
Method	2SLS	2SLS	2SLS	2SLS
Log(download intensity)	-0.549**	-0.268*	-0.312*	-0.302**
	(0.260)	(0.119)	(0.129)	(0.152)
Control other variables	Y	Y	Y	Y
# of observations	415	634	462	577
R square	0.582	0.659	0.626	0.737

Table 9. Robustness Checks.

Robust standard errors in parentheses. *** p < 0.01, ** p < 0.05, * p < 0.1. Errors are clustered by year.

2.1. Delays in theatrical releases

Delays in theatrical releases are a result of the opening lag caused by China's policies of censorship and protectionism. Distributors prefer to release their movies in China as early as possible to prevent losses to pirated versions in other markets. The policies of censorship and protectionism cause significant delays between worldwide release and release in Chinese theaters.

As shown in the first two rows of Table 10, foreign movies suffer more revenue loss due to online piracy than domestic movies do. Protectionism plays an important role in the difference in the effects of online piracy on the box revenues of foreign versus domestic movies. The SARFT constantly blacks out quota movies – typically Hollywood blockbusters – during peak season to increase the market share of domestic movies, thereby causing a long opening lag for foreign movies. Column 9 of Table 10 shows that foreign movies are less likely to be released during peak seasons and public holidays. In addition, buyout movies cannot be shown in China simultaneously. These movies have been shown in foreign markets for months or even years, and usually have exhibited box office success before being purchased by Chinese distributors, and then have long opening lags. These release delays are the major reasons for the major differences between foreign and domestic movies.

I use a subsample with only foreign movies and regress the dummy "whether the movie was released in the home country during a Chinese holiday season" on the opening lags. Column 12 of Table 10 shows that foreign movies released in their home country during a Chinese holiday season will have a 12-day longer release delay in China on average. The results support the claim that the SARFT blacks out foreign movies during peak seasons to protect domestic blockbusters' revenue.

Censorship can increase the opening lag of both domestic and foreign movies. If the content of the movies is "unsuitable" according to the SARFT's standards, the producers must cut this content to meet the standards before being able to show the movie in Chinese theaters. These actions can take several weeks or months and cause extended opening lags. Column 6 of Table 10 demonstrates that eliminating "unsuitable" content through

Table 10. Mechanisms.				
	(1)	(2)	(3)	(4)
Dependent Variables Samule	Log(# of rate on Mtime)	Log (# of rate on Douban) All cample	Open week #	Log(download intensity)
TS lag	-6.39e-05	-0.000185	-0.000693**	0.000653*
1	(0.000227)	(0.000235)	(0.000310)	(0.000347)
Control other variables	Yes	Yes	Yes	Yes
# of observations	1,039	1,039	1,039	1,039
R square	0.690 (5)	0.736 (6)	0.506	0.373 (8)
Dependent Variables	TS lag	Opening lag	Log(screen #)	Log(price)
Sample	All sa	mple		Dialy data
Opening lag	-0.622*** (0.03)		-0.164*** (0.00537) 0.0174***	-0.0311*** (0.00351) 0.000160
Movie is cut or not		69.11***	(0.000468)	(0.000282)
		(19.32)		
Rating on Douban	10.399	22.469	0.1411**	0.414**
	(26.668)	(23.992)	(0.0493)	(0.00706)
Control other variables	Yes	Yes	Yes	Yes
# of observations	1,039	1,039	1,039	1,039
R square	0.468	0.384	0.506	0.506
	(6)	(10)	(11)	(12)
Dependent Variables	Released in holiday		Opening lag	
Sample	All the	sample		Foreign movies
Methods	Probit	OLS	OLS	OLS
Produced by US big 8 studios	-0.524*** (0 199)	-41.24** (17 71)		
Produced by foreian studios	-0.117	138.4**		
	(0.180)	(15.25)		
Coproduced with domestic firms	-0.240	-124.5***	-173.9***	
	(0.206)	(16.57)	(20.69)	
Import quota movie	-0.112	-0.382	-215.9***	
	(0.585)	(0.391)	(19.98)	
Release time in home market during Chinese public holidaies	0.0320			11.96**
	(0.702)			(5.731)
Control other variables	Yes	Yes	Yes	Yes
# of observations	1,039	1,039	578	578
K square		0.389	0.477	0.393
Robust standard errors in parentheses. *** p < 0	0.01, ** p < 0.05, * p < 0.1. Errors are c	lustered by year.		

Table 11. Results of	^c Policy Experiments.			
Predict box office wi	thout releasing delay (Sample: F	oreign movies)		
Stats	Predicted box office (10,000 Yuan)	TS lag	Predicted box office/real box office	Change of TS lag
Mean	7450.24	70.18	1.43	50.04
Std dev	(13,913.29)	(208.94)	(1.60)	(75.16)
# of observations	432	432	432	432
Predict box office wi	thout releasing delay (Sample: L	Jomestic movies)		
Stats	Predicted box office (10.000 Yuan)	TS lag	Predicted box office/real box office	Change of TS lag
Mean	4592.56	-14.19	1.09	6.28
Std dev	(11,913.49)	(141.19)	(1.13)	(29.95)
# of observations	608	608	608	608
Predict box office wi	thout theater subsidy (Sample: (Dverall box office data from 2009 to	2013)	
Stats	Predicted box office	Real box	Predicted box	Predicted piracy loss rate/real piracy loss rate
	(10,000 Yuan)	office (10,000 Yuan)	office/real box office	
Mean	4754.80	7904.94	0.65	1.29
Std dev	(9910.52)	(16,087.80)	(0.19)	(0.07)
# of observations	578	578	578	578
Predict box office if t	theaters don't adjust according p	piracy level (Sample: Movies being p	oirated)	
Stats	Predicted daily box office (Yuan)	Predicted box office/real box office	Predicted screen ratio/real screen ratio	Predicted price/real price
Mean	38,854.08	1.38	2.48	1.07
Std dev	(14,044.28)	(0.00)	(3.71)	(0.00)
# of observations	252,621	252,621	252,621	252,621
The first and second pa Chinese government level.	rt are the predict values without re began to subsidize building theate	leasing delay in China. The third one is rs in small cities. The fourth part is the	the predict values that the screen increasin, predict value that theaters cannot adjust th	g speed was the same as that before 2009, when e screen allocation and price according to piracy

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censorship increases the opening lag by 69 days on average, thereby increasing release delays by approximately 42 days according to the estimation in Column 5 of Table 10.

I check the effects of release delays on China's movie box office revenue by keeping other variables unchanged and assuming that the opening lag is 0. Table 11 indicates that removing the opening lag will increase the box office revenue of foreign movies by 43%. The effect is only 9% on domestic movies. Figure 6 shows that the experiment has a larger effect on foreign movies than it does on domestic movies. This is because protectionism only affects the opening lag of foreign movies. The counterfactual results suggest that censorship and protectionism exacerbate the effects of pirated movies on box office revenue.

2.2. Supply-side reactions

I also check the factors on the supply side, such as theaters' reactions to piracy availability and the effects of the growth in the theater coverage rate on box office sales. As shown in the third and fourth rows of Table 9, the revenue loss due to online piracy decreased after 2009. The rapid growth in the theater coverage rate plays an important role in this change. A low theater coverage rate limits the supply of movies in theaters and causes the market to be more vulnerable to online piracy. Theaters react quickly to the change in demand caused by online piracy because of the lack of theatrical screens, which may magnify piracy loss. Furthermore, China's rate of internet penetration is much higher than its rate of theater coverage. Watching online movies is the only choice for internet users who do not have access to theaters. Only a small number of piracy attempts are carried out by marginal consumers who select between pirated movies and movies in theaters. Pirated movies can fully substitute for movies in theaters for marginal consumers, but the proportion of marginal consumers is minimal in the data. An increase in the rate of theater coverage causes theaters to be more accessible to the population.

Column 3 of Table 10 shows that a high piracy level decreases the number of weeks that movies are shown in theaters. This result may better resolve the issue of the shorter opening periods of most movies in China than in markets that are less vulnerable to piracy. Short screening periods prevent consumers who are insensitive to the latest movie news from watching these movies in theaters. Theaters reduce the price and the number of screens that are allocated to the movies when pirated resources are available.²⁴ Columns 7 and 8 of Table 10 show that theaters decrease the number of allocated screens and ticket prices for movies that are being pirated. Responding quickly to piracy increases immediate theater revenues, but decreases the overall box office revenues of movies. When theaters react to piracy by limiting the numbers of screens and the market structure, it actually magnifies piracy loss.

I check the effects of theaters' reactions on the demand change caused by online piracy on China's movie box office revenue. On the basis of the structural model and parameters estimated, I use an experiment in which theaters are unable to adjust either their prices or the way they allocate screens in accordance with the level of piracy. In the experiment, the number of screens and the price of each film are unaffected by the piracy level. Theaters determine screen allocation and price according to the quality of the movie and that of its competitors. The results are shown in the fourth row of Table 11. In the experiment,

²⁴Screen allocations and ticket prices in most theaters in China are determined one or two days in advance.

theaters will allocate additional screens and assign a higher price to a movie that has been pirated than they do in the actual data. The overall theater box office revenue of movies that have been pirated will increase by 38%, which is approximately 52% of the loss caused by piracy. The experiment suggests that the supply reaction of licensed products to online piracy leads to a second-step revenue loss caused by piracy. The massive box office revenue loss caused by online piracy is not just a result of the replacement effects on consumers. Adjustments on the supply side also magnify these effects, especially when screens are scarce in the market. The results prove that the box office revenue loss estimated by reduced form regression is an equilibrium result that combines the impacts of online piracy on both the supply of and demand for movies in theaters.

I also check the effects of the rapid growth of the theater coverage rate on China's movie box office revenue. On the basis of the structural model and parameters estimated, I set the speed of screen construction as unchanging after 2009 and keep other variables unchanged. Figure 7 demonstrates the change in the growth rate of the number of screens over time. In 2009, the Chinese government began to subsidize theater buildings in small cities, which significantly increased the speed of screen construction in the country. In the experiment, the number of screens predicted to exist after 2009 is much lower than what the actual value was. I use the average growth rate in the number of screens from 2002 to 2009 as the growth rate in the number of screens after 2009, while leaving other variables unchanged. The effects of the experiment are summarized in Table 11. The results suggest that the predicted box office revenue without the subsidy after 2009 will only be 65% of the actual number. The subsidy also reduces the rate of piracy loss rate by approximately 23% because more people have access to theaters. The rapid growth in the rate of theater coverage increases each movie's box office revenue and reduces the revenue loss caused by piracy. These results affirm that the rapid increase in the number of screens as a result of the screen subsidy policy has contributed to the rapid growth of the Chinese movie market since 2009. In addition, as more people get easy access to theaters, online pirated movies will no longer be the only choices for internet users, which will increase total box office revenue and reduce piracy intensity. The lack of theaters for major segments of the population is another reason for the high level of piracy in developing countries.

3. Conclusion

This study estimates the substitution effects of pirated movies – the unlicensed online movies available on file-sharing websites – on box office revenue from movies shown in theaters in China. I use newly constructed data collected from pirate websites to evaluate the extent of piracy and construct a new proxy for the time lag between the pirated supply and the licensed supply. I deduce that piracy has a significant causal effect on box office revenue in China. The results of the structural estimation show that the average piracy loss is 64% in this market and the substitution elasticity of unlicensed movies on box office sales is 0.31. DID regression results imply that although the anti-piracy actions that shut down the major websites were able, in the short run, to increase the box office revenue of movies released during the period by roughly 60%, the effects disappear in the long run. Protectionism and censorship policies cause the piracy supply to appear earlier relative to theater supply and lead to a higher level of piracy. The low theater coverage rate also contributes to the high level of piracy in China.

Subsidies for screen building after 2009 have caused theaters to be more accessible to the population, which increases box office revenue and reduces the rate of piracy loss.

A limitation of this study is its focus on the long-run supply change caused by piracy. This limitation is imposed by data constraints. When long-term supply effects are not considered, pirated movies increase social welfare. In the static model, piracy losses of producers will be transferred to consumers, thereby affecting their welfare. When low theater coverage rates and policy restrictions are considered – solely in the short term – piracy diversifies consumers' choices, allows more people to watch movies, and improves overall welfare. What this model does not consider, however, is that piracy may ultimately reduce social welfare by reducing the incentive of producers to produce movies. Evaluating piracy's long-term welfare effects is thus a promising direction for future research.

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