The Impact of Early International Digital Release of Films on U.S. Box Office Revenues

Completed Research

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Abstract

For film studios, the development of new digital distribution channels has created new opportunities and challenges, which are in particularly stark contrast in the Chinese market. In recent years, Hollywood studios have responded to China's film import quota and widespread piracy by releasing some films on Chinese digital streaming platforms, in many cases while the film is still showing in the U.S. box office. Though the selection of such films was not random, we identified and controlled for several confounding factors that may lead to selection bias, and then used a difference-in-differences strategy to identify the causal effect of early Chinese digital release on the sales revenues in the U.S. box office. Our results show that the early release on Chinese digital streaming platforms does in fact lead to early appearance of piracy. However, this piracy does not seem to cannibalize U.S. box office revenues.

Keywords

Digitization, film industry, online streaming, international release, digital piracy, difference-in-differences

1. Introduction

The digitization of the media industries has brought new challenges to media firms as they try to understand how to protect their intellectual property in the face of Internet piracy. At the same time, digitization has also brought new, cheaper distribution platforms and enabled new strategies for content dissemination and monetization. One such strategy in the film industry involves releasing films very early on digital channels in countries where piracy has caused great harm to home entertainment sales. Making the film available early at an attractive price on a convenient channel may entice consumers in those countries to consume the film legally rather than through illegal channels. However, when such releases occur early enough, the high quality digital source will lead to earlier availability of high quality digital piracy, which may proliferate throughout the Internet and reduce sales in other markets.

This paper attempts to evaluate the effect of a particular early digital release strategy: releasing films internationally on digital channels while the film is still in U.S. theaters. This strategy has become increasingly common in recent years as film studios attempt to exploit the Chinese market which became the second largest box office market globally in 2012 (MPAA 2012). Historically, Hollywood studios have found it challenging to capture revenues from this market due to the annual film import quota of 34 foreign films (Brzeski 2015). The studios typically target their largest blockbusters for inclusion in the Chinese theatrical market, while monetizing smaller releases solely through a home video release which had worked poorly due to the prevalence of copyright infringement in China (Levin and Horn 2011).

Starting in 2010, the Chinese government launched a series of operations against copyright infringement (see, for example, Wang 2010, Xu 2010, and Zhao 2013). This forced online streaming websites that previously depended on user uploaded contents (many of which were copyright infringing) to explore new legal business models. Market leaders such as Tencent, Youku, Tudou, and iQiyi were among the first to

test the subscription video-on-demand (SVOD) business model which typically costs $5 per month to access a large collection of catalog films and an extra $1 per view to rent new releases (Garrahan 2014). Since 2013, two major Hollywood film studios, which we will refer to as Studios AB hereafter, have selected a portion of their new films to release on China's major online streaming platforms while they are still showing in U.S. cinemas (Garrahan 2014). We call this strategy "early Chinese digital release." In contrast, the other four major studios have strictly followed a sequential release strategy, waiting until the end of the U.S. theatrical window or even longer before releasing their films online to the Chinese audience. Their primary concern is the possibility that overlapping the foreign digital release window with the U.S. theatrical window may adversely impact U.S. box office revenues because a high quality leak may occur sooner than it otherwise would have (e.g. at DVD release).

The goal of our research is to analyze two main questions. First, does the early Chinese digital release lead to an early availability of high quality digital piracy? Second, does this high quality digital piracy induced by such strategy cannibalize sales in the U.S. box office? The answers to these questions are of practical importance as the domestic box office represents a significant share of the total film revenue and causally impacts film performance in downstream channels such as home video as well as licensing agreements with foreign exhibitors (Choi, Boatwright, and Smith 2015). In addition, our quasi-experiment-based empirical framework provides a tool for the studios to evaluate different variations of early release strategies in order to optimize release schedule in today's multi-channel, multi-market environment.

The paper proceeds as follows. Section 2 reviews the prior literature related to our research and highlights our contributions. Section 3 introduces our data collection and selection process. Section 4 describes our empirical analysis and results. Section 5 concludes by discussing the implications of our findings and outlining the future work.

2. Literature Review

Our research pertains to several streams of the academic literature. First, it relates to the literature on film release strategies. In this literature, Elberse (2002) and Elberse and Eliashberg (2003) analyze the optimal timing between domestic and international theatrical releases. Eliashberg et al. (2006) observe that the window between U.S. and international theatrical releases is shrinking. Hennig-Thurau et al. (2007) show that releasing films simultaneously in theaters and on rental DVD maximizes the studios' revenue but cannibalizes the theaters' revenue.

Our paper also relates to the extensive literature on piracy's effect on sales. These studies are reviewed by Smith and Telang (2016) who conclude that the vast majority of peer reviewed studies show that online piracy harms media sales. Notably, however, there is little empirical work on whether piracy harms the U.S. box office, as piracy may be less of a substitute for theatrical release than it is for home video, and the U.S. box office generally opens before other international markets, leaving fewer opportunities for the film to be available on pirate networks while still in the U.S. box office. An exception is Ma et al. (2014) who show that pre-release piracy (e.g. leaks in the production process) is particularly damaging to box office revenue, although such leaks only happened to less than 10% of the films.

Our paper is most closely aligned with an emerging literature that attempts to determine what strategies firms can take to mitigate the impact of piracy on sales. Danaher et al. (2010) and (2015) note that distributing goods digitally reduces piracy without cannibalizing physical sales, suggesting that some percentage of piracy is motivated by the desire for a digital copy that is available in a timely, convenient, high quality format. Sivan et al. (2015) use a field experiment to show that when a search engine promotes legal links over illegal ones in searches, consumers shift their consumption of media files toward paid legal options.

Our study contributes to the literatures by examining an increasingly popular yet particularly aggressive release strategy of releasing a film digitally during its initial U.S. box office run, in a country traditionally known for weak intellectual property enforcement and heavy piracy. It is the first paper we are aware of to analyze the impact of these strategies on studios' holistic film release plans, and it is the first study we are aware of to examine whether there are cross-country effects between a studio's strategy in one country and its revenues in another country due to the fact that online piracy transcends geographical boundaries.

3. Data

3.1 Data Collection

We compiled a panel dataset of films that had a U.S. theatrical release in 2013 and 2014. Our data include the weekend domestic box office revenue for each film, whether or not and when it was released on Chinese digital platforms, and a number of other film-invariant characteristics such as genre, studio, release pattern, etc. The weekend box office revenue for each film were sourced from the-numbers.com and boxofficemojo.com while film-specific metadata were obtained from imdb.com.

We use weekend (Fridays, Saturdays, and Sundays) box office revenue (rather than weekly revenue) consistent with prior literature (Danaher and Waldfogel, 2012) for two reasons. First, weekend revenue comprises approximately 70% of total box office revenue and is less noisy than daily fluctuations in the daily box office. Second, using weekend revenue allows us to align the revenue cycles of films released on different days of the week. For example, let us assume that Film X and Film Y are released on Wednesday, Jul 10, 2013 and Friday, Jul 12, 2013 respectively, both during the same week. By using weekend revenue, we align the opening week box office of both films at the weekend of Jul 12-14, 2013, the second week at the weekend of Jul 19-21, 2013, etc.

We only consider the first ten weekends of the box office for each film. Box office returns fall rapidly after the first few weekends. After the tenth weekend, returns are both small and noisy. Also, we only include wide release films in our dataset. Limited release films are lower selling titles that are typically rolled out slowly to an increasing number of theaters, leading to a very different pattern of revenues over time. Our identification rests on the average decay rate of films in the box office being fairly similar on average, and including limited release films would violate this assumption.

In addition to the revenue data, we also obtained proprietary data on the films' earliest availability of pirated version. This dataset lists each unique source of piracy leaks of a film, its source type (e.g. cam-cording, home video, DVD), audio and subtitle languages, video quality, and, most importantly, the date when it first appeared on the Internet.

3.2 Identifying Film Groups

The core identification strategy of our empirical analysis is a difference-in-differences model. We consider each film's decay rate in the box office – how much its weekend revenue decreases each week after the first – and ask whether the decay rate of treated films is more or less rapid after they are released early on Chinese digital platforms (and subsequently leaked to piracy sites) relative to the average decay rate of the control films. To prepare for the discussion on empirical analysis, we first discuss our dataset and categorize films based on some of their key characteristics as they relate to our identification strategy.

As we mentioned before, Studios AB are the two studios who chose to give some of their films an early Chinese digital release. We scraped the web archives of the Chinese streaming websites to obtain the list of the films in our data with early Chinese digital releases as well as the dates of those releases, and we verified this information with our studio contacts to ensure its accuracy. There are 33 such films, which we will refer to as ECDR ("Early Chinese Digital Release") films. Table 1 shows the number of weekends into U.S. theatrical release window ("weekends-into-release") when these films first became available on Chinese digital platforms. No films were released during their first or second weekends. This allows us to control for differences between films and their natural decay rate before any early Chinese digital releases occur. The majority of the ECDR films became available on Chinese digital platforms 4 weekends after the U.S. theatrical release. Note that, if a film was released during a weekend, we count the following weekend, not the current weekend, to be the first weekend of its digital release. Once a film is made available on Chinese digital platforms, it has to be downloaded, processed (compression, file type conversion, etc.), and distributed via channels such as BitTorrent and file hosting services. This will limit its impact on U.S. box office revenue during the same weekend as its Chinese release.

For the difference-in-differences approach to causally identify the effect of early Chinese digital release on U.S. box office, we must assume that the ECDR films would have decayed similarly to the non-ECDR films if not for the early digital release. After examining the data, we identified two types of films that violate this parallel trend assumption. First, we drop all Disney films because they decay more slowly than those

from the other studios particularly during the later weeks (Figure 1), which could cause downward bias of the treatment effect (none of the Disney films received early Chinese digital release). Second, we notice in Figure 2 (left) that a large chunk of the biggest-budget, highest-grossing blockbusters did not receive early Chinese digital release. This is because the studios that experimented with early Chinese digital release did so only with non-blockbuster films that did not make the quota for Chinese theatrical release. In our dataset, 51 films had theatrical runs in China, of which 19 films were from Studios AB, and none of these films were released early. Because of such substantial distinction which would lead to an obvious selection bias, we will leave films with Chinese theatrical release out of the treatment effect estimation, but use them as an auxiliary test for cross-studio differences. If we just zoom in on films without Chinese theatrical release, the ECDR and non-ECDR films have comparable distributions of their production budgets and total weekend revenues, as shown in Figure 2 (right).

U.S. Box Office Weekend #	1	2	3	4	5	6	7	8	9	10
# of ECDR Films Newly Released	0	0	4	24	0	1	1	1	1	1

Table 1: Number of Films Newly Released Digitally in China by Weekends-into-release

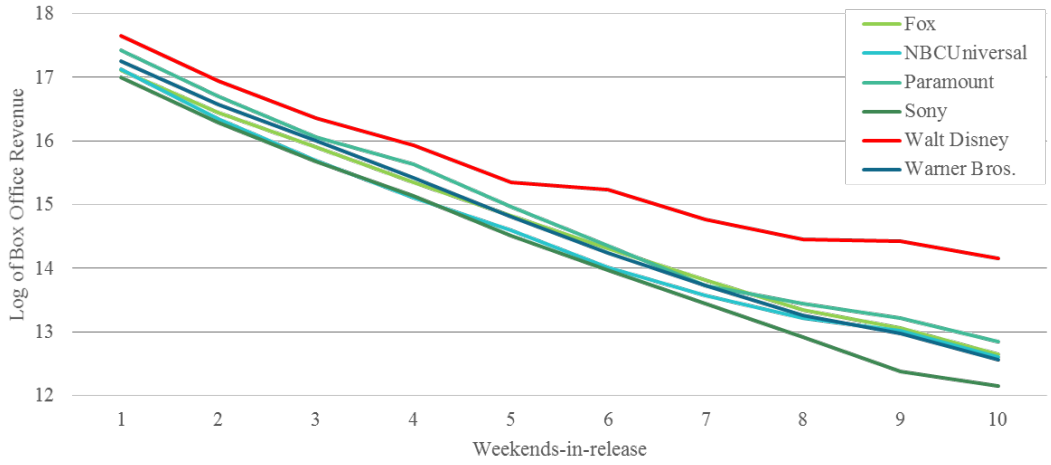

Figure 1. Average U.S. Box Office Decay by Studio

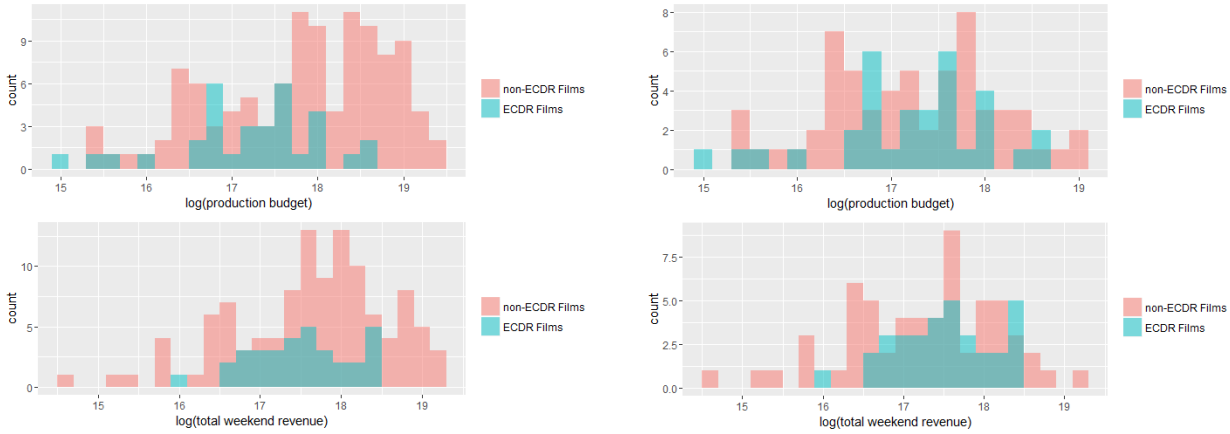

Figure 2: Distributions of Production Budget and Total Weekend Revenue of All Films (left) versus Films without Chinese Theatrical Release (right)

The final dataset consists of five groups of films summarized in Figure 3. As we will demonstrate in Section 4, we identify the treatment effect using the 93 films without Chinese theatrical release from five studios, among which 33 were ECDR films (labelled as Group 2, all from Studios AB) and 60 were non-ECDR. These 60 non-ECDR films are further broken down into Group 3 which contains 13 films from Studios AB, and Group 1 which contains 47 films from the other 3 studios (which we refer to as Studios CDE). In addition, we include another 51 films with Chinese theatrical releases (19 from Studios AB and 32 from Studios CDE, labeled as Group 5 and Group 4 respectively) for an auxiliary test. For each film, we observe up to the first ten weekends of U.S. box office returns, yielding a total of 1336 film-weekend observations (some films did not remain in the theaters for a full ten weekends).

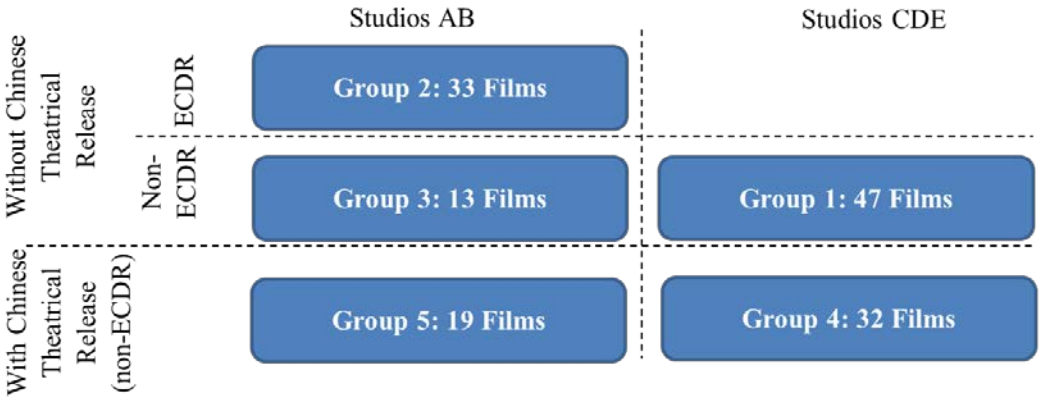

Figure 3: Illustration of Film Groups

4. Results

4.1 Evidence from Piracy Forensics Data

Before asking whether early Chinese digital release impacts the U.S. box office, we ask whether films that received an early Chinese digital release actually experienced earlier piracy leaks than those that did not.

Among the 33 ECDR films, 23 films have new non-cam-cording piracy sources appearing within a week after their early Chinese digital release dates (and 21 films have an early digital release appear within 1 day of the Chinese release date). These piracy leaks were all identified as "electronic home video" source type, had high video quality, and had Simplified Chinese subtitles – the exact traits that a leak ripped from the digital releases in Chinese streaming channels would have. More importantly, in each case these leaks are the first known high quality piracy source available for their respective films (prior to these leaks, the only piracy sources available were low quality cam recordings).

As point of reference, in Figure 4, we consider the number of days between the U.S. theatrical release for a film and its first known high quality piracy source for all films in our dataset.[1] This figure shows that the ECDR films have a much lower median and mean time to their first high quality leak than their non-ECDR counterparts. The median for the ECDR films is 14 days after U.S. box office premiere, which is when most ECDR films from Studios AB were scheduled for early Chinese digital release.[2] The median for non-ECDR films is about 78.5 days, roughly the same time when the DVD and Blu-Ray typically become available.[3] With this strongly suggestive evidence that early releases on Chinese digital platforms lead to

[1] Here we include films with Chinese theatrical release. The distribution of days elapsed for non-ECDR films remains similar even if we exclude these films.

[2] This agrees with what we showed in Table 1 that most treated films became available during the fourth weekend. Most of the films are released during the weekends (the first, or opening weekend). Adding two weeks (14 days) brings us to the third weekend when Chinese digital release takes place. And as we mentioned in the data section, if the early release occurs during a weekend, we assume its impact on box office is delayed and therefore count the next weekend (the fourth) as the first "treated" weekend.

[3] A Welch's t-test yields $t = 9.42$, indicating the difference is strongly statistically significant.

early international piracy sources, we now turn to the question of whether the existence of these early piracy sources impacts sales in U.S. theaters.

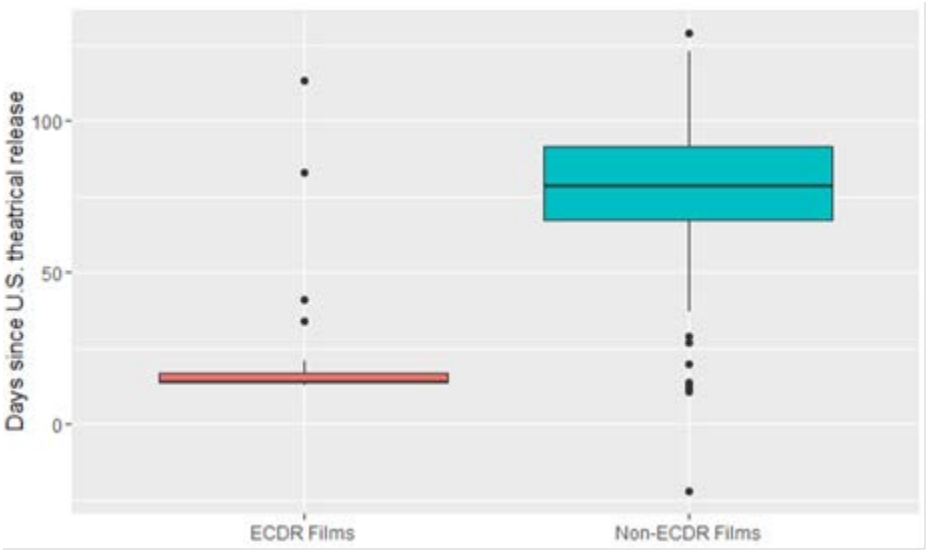

Figure 4: Days Elapsed between U.S. Theatrical Release and First High-quality Leak

4.2 Measuring Treatment Effect

As we outlined above, our empirical tests measure the treatment effect using a difference-in-differences approach on the 93 films without Chinese theatrical releases from five studios. However, the assignment of ECDR films was not randomized – only Studios AB experimented with early Chinese digital release while Studios CDE did not. To account for this potential source of selection bias, we design an approach that resembles a placebo-controlled experiment with three non-overlapping groups of films: Group 1 in Figure 3 serves as the control group, Group 2 serves as the real treatment group, and Group 3 serves as the placebo treatment group. We first run a difference-in-differences model between the control group (Group 1) and the real treatment group (Group 2) to obtain the treatment effect. We then run a second difference-in-differences model between the control group (Group 1) and the placebo treatment group (Group 3) to test for any placebo effect of, in this specific case, whether films from Studios AB naturally decay differently from those from Studios CDE. If the placebo effect turns out to be zero, we can more reliably attribute the treatment effect entirely to the real treatment, i.e. early Chinese digital release.[4]

We start by estimating the treatment effect. As mentioned in Section 3.2, our difference-in-differences strategy rests on the assumption that that treated films would have decayed similarly to control films if not for the treatment. Because no films were released digitally in China during the second weekend, and only a handful were released during the third weekend, we can partially test this assumption by plotting the decay trends of the (real) treated films and the control films and examining if they decay similarly before weekend four (i.e. during the pre-treatment period).[5]

[4] The executives at Studios AB informed us that, besides the "non-Chinese-theatrical release" rule, they are not aware of any extra criteria based on film attributes (e.g. genre, production budget, etc.) to select films for early Chinese digital release.

[5] The studios informed us that the Chinese digital release date was negotiated before the film hits U.S. theaters, making it highly unlikely that the release was chosen for the exact weekend when the decay rate is expected to deviate from the norm.

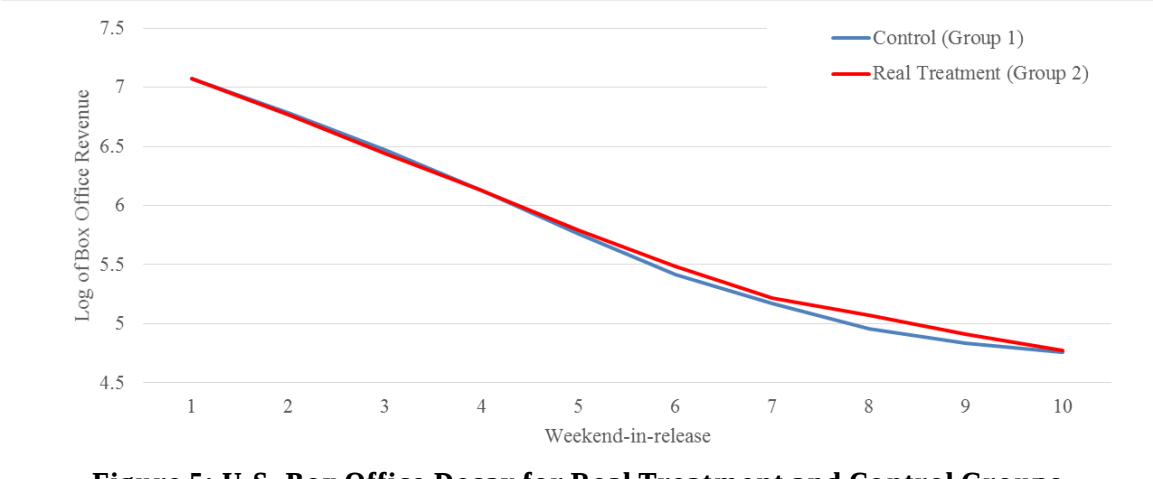

Figure 5: U.S. Box Office Decay for Real Treatment and Control Groups

In Figure 5, the box office revenue decay for the control group is indistinguishable from that of the treatment group until the fourth weekend, when the majority of the treatments arrived. Statistically, we cannot reject the null hypothesis that the trends are the same for the second weekend ($p = 0.750$).[6] If we drop the four films treated in the third weekend (allowing it to be part of the pure "pre-treatment" period), a Wald test of joint significance for the second and third weekends fails to reject the null hypothesis that the trends are the same ($p = 0.706$). These results partially validate the parallel-trend assumption during the pre-treatment period. During the later weekends, the difference in decay rate becomes conspicuous and persists for most of the subsequent weekends despite its relatively small magnitude. Surprisingly, it is the control films whose box office revenues decay faster. The treated films, on the other hand, perform marginally better in box office despite the early leaks induced by early Chinese digital release. We use the following model to quantify this average treatment effect:

$$\ln(Revenue_{ij}) = \beta_0 + \beta_1 WIR_j + \beta_2 OnlineInChina_{ij} + X_i + D_{ij} + \varepsilon_{ij}$$

where $Revenue_{ij}$ is the weekend box office revenue of film i in its j^{th} weekend of the U.S. theatrical window[7], WIR_j is a vector of dummy variables for weekends-in-release (omitting the first weekend), X_i is a vector of film fixed effects, and D_{ij} is calendar date fixed effects (the weekend date that film i had its j^{th} weekend). Our parameter of interest is β_2, the coefficient of $OnlineInChina_{ij}$, a dummy variable which equals to one if film i is available in Chinese streaming platforms during its j^{th} weekend of U.S. theatrical window, and zero otherwise. Replacing the interaction term in the standard difference-in-differences model with the $OnlineInChina_{ij}$ dummy allows us to account for the difference in treatment-starting-weekend of ECDR films. We estimate this model using OLS and cluster standard errors at the film level as suggested in Bertrand et al. (2004). As shown in Table 2, Column I, the model estimates the treatment effect to be about +4.6%, although it is not statistically significant ($p = 0.530$).

Next, we move to the placebo test, which compares the decay rate between Group 1 (control) and Group 3 (placebo treatment). Again, we start by plotting the average decay trends of these two groups of films.

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[6] The null hypothesis is that $\beta_2 = 0$ for the second weekend in the difference-in-differences model $\ln(Revenue_{ij}) = \beta_0 + \beta_1 WIR_j + \beta_2 WIR_j Treat_i + X_i + D_{ij} + \varepsilon_{ij}$.

[7] We take the natural log of box office revenue because decay rates across films are more likely to be similar on a percentage basis (the difference between the first and second weekend of a $100m blockbuster will be different than that of a $2m film in dollars, but may be similar in percentage terms).

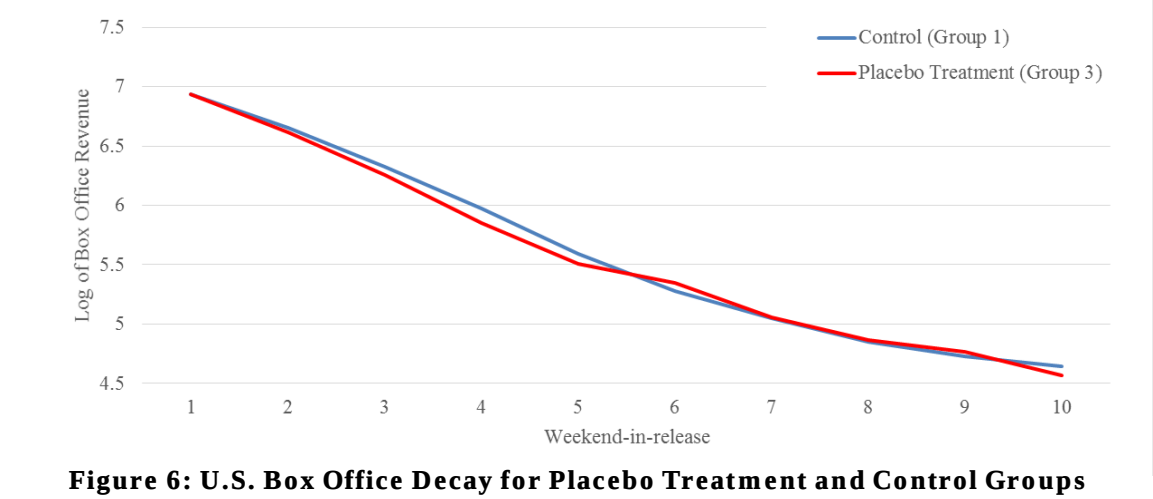

Figure 6: U.S. Box Office Decay for Placebo Treatment and Control Groups

A Wald test of joint significance for the second and third weekends yields $p = 0.746$, indicating that the parallel trend assumption holds for the pre-treatment period. More importantly, the two trends are intertwined through most of the post-treatment period (Figure 6). To obtain a quantitative measurement of the placebo treatment effect, we estimate the following model:

$$\ln(Revenue_{ij}) = \beta_0 + \beta_1 WIR_j + \beta_2 PlaceboTreat_{ij} + X_i + D_{ij} + \varepsilon_{ij}$$

where $PlaceboTreat_{ij}$, is a dummy variable that equals to 1 for film i from Group 3 during its $j \geq 4^{th}$ weekend of U.S. theatrical window (when most of the actual treatments occur). The result (Table 2, Column II) is indistinguishable from zero ($p = 0.948$). As an additional check for natural decay trends between films from the two studio groups, we apply a similar placebo test on films *with* Chinese theatrical releases by letting Group 4 be the control and Group 5 be the placebo treatment. The result (Table 2, Column III) again confirms that the placebo effect is not statistically significant ($p = 0.390$).

To summarize, both placebo tests indicate that the box office decay trends of films do not differ between Studios AB and Studios CDE in the absence of the actual treatment of early Chinese digital release, and thus the treatment effect we estimated does reflect the impact of early Chinese digital release on the films' U.S. box office revenues.

4.3 Robustness Tests

We run a series of robustness checks to demonstrate that the slight positive and statistically insignificant nature of the treatment effect estimate is consistent under variations in model specifications. We relax the constraint of 10 revenue weekends by shifting the number of revenue weekends between 8 and 15 (the longest in our dataset) and found similar results (Table 2, Columns IV and V). Column VI shows that the result holds if we remove date fixed effect D_{ij} from the model[8]. The treatment effect estimate remains consistent even if we vary the choice of control group. In Column VII, we exploit the finding from the placebo test and expand the control group to include both Group 1 and Group 3 in order to improve the statistical power of our estimates. In Column VIII, we eliminate the cross-studio-group difference by only using films from Studios AB for the model fitting. In both scenarios, the nature of the estimate holds, confirming that the ECDR films indeed have slightly higher box office returns than the non-ECDR films, although the difference is not statistically significant.

[8] It also implies that the timing of the early Chinese digital releases does not seem to systematically correlate with particular weekends of the year when the box office is particularly high or low.

	I	II	III	IV	V	VI	VII	VIII
β_2	0.046 (0.072)	-0.008 (0.122)	-0.057 (0.066)	0.061 (0.075)	0.017 (0.068)	0.042 (0.078)	0.050 (0.072)	0.025 (0.088)
Real Treatment / Placebo	Real	Placebo	Placebo	Real	Real	Real	Real	Real
Treatment Group (Studios)	2(AB)	3(AB)	5(AB)	2(AB)	2(AB)	2(AB)	2(AB)	2(AB)
Control Group (Studios)	1(CDE)	1(CDE)	4(CDE)	1(CDE)	1(CDE)	1(CDE)	1(CDE)+3(AB)	3(AB)
Films with Chinese Theatrical Release	No	No	Yes	No	No	No	No	No
# of Weekends Included	10	10	10	8	15	10	10	10
Weekend Fixed Effects Included	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
# of Observations	736	537	498	619	913	736	838	403
# of Films	80	60	51	80	80	80	93	46
Adjusted R^2	0.937	0.937	0.967	0.934	0.933	0.927	0.938	0.944

Cluster-robust standard errors in parentheses
**Significant at 5%
*Significant at 10%

Table 2: Empirical Results

5. Discussion

Our results indicate that although early digital releases on Chinese streaming platforms lead to digital piracy leaks that occur earlier than they otherwise would, these early digital copies do not have a statistically significant impact on U.S. box office revenues. This result is somewhat surprising given the findings in Ma et al. (2014) that pre-release piracy significantly cannibalizes theatrical revenue. However, it is important to note that the early Chinese digital releases occur 3-10 weekends *after* the U.S. box office release, and piracy at this stage may have a very different impact on box office sales than piracy that might occur earlier. The first two weekends since the film's opening (where no treatment took place in our data) contribute to about 70% of the total weekend revenue, whereas the fourth weekend and beyond (where most treatments took place) contributes to only about 15%. Even if the early leaks caused some damage, its magnitude may be so small that it is indistinguishable from random noise.

In practice, our results suggest that releasing films on Chinese digital channels as early as 3 weekends after U.S. theatrical release is an effective way of generating revenues in China without cannibalizing revenues in the important U.S. theatrical market. By licensing films not scheduled for theatrical runs in China to Chinese streaming platforms, the studios open up a new revenue stream in a market with great potential. Moreover, while such early digital releases do induce early high quality leaks, they do not adversely impact the box office revenue in the domestic market. Maintaining the U.S. box office is vital not only because it is a large source of revenue by itself, but also because it is often considered an "uplift market", meaning that performance in this key market drives later performance in other countries and distribution channels. For example, if certain contracts with downstream distributors (e.g. Redbox) or foreign exhibitors are financially tied to the U.S. box office, or if the box office has a promotional effect on downstream channels like home video, a reduction in U.S. box office revenues would lead to indirect revenue losses in other channels. Absent such worries, the studios can continue to release new films in China through online streaming as a workaround for the film import quota. This also benefits the Chinese market by giving consumers a convenient, high-quality and legal option to enjoy newly released Hollywood films in a timely fashion at low cost. Offering such an option may help nurture the respect for copyright and the habit of paying for intellectual property in China's emerging entertainment market.

Our research also provides an empirical framework for studios to analyze and optimize their existing channel release strategies. In this particular setting, most films were released digitally in China during the

third or fourth weekend after U.S. theatrical release. Earlier releases may generate higher Chinese licensing fees for U.S. studios, but could also lead to statistically significant cannibalization of U.S. box office. If studios choose to experiment with earlier Chinese digital releases, our methodology could help analyze the impact of those releases on U.S. box office revenues.

We hope to extend our results in several dimensions. First, we would like to include box office in countries other than the U.S. and test if the results change. Each country has its own cultural attitude towards piracy, so it will be interesting to compare the effect across different countries to see if greater damage is caused in countries where copyright infringement is more widespread. Second, we hope to look beyond the theatrical window and examine how early Chinese digital release affects revenue from other distribution channels, particularly the electronic sell-through (e.g. iTunes) in the U.S. which is arguably a closer substitute to digital piracy than theatrical experience. This would allow us to more accurately determine the net impact of the early Chinese release on all U.S. revenue sources.

REFERENCES

Bertrand, M., Duflo, E., and Mullainathan, S. 2004. "How Much Should We Trust Differences-in-Differences Estimates?" *Quarterly Journal of Economics*. 119(1).

Brzeski, P. 2015. "China Film Quota Full for 2015, Hollywood Releases Confirmed," *Retrieved from http://www.hollywoodreporter.com/news/china-film-quota-full-2015-832925*

Choi, P., Boatwright, P., and Smith, M. D. 2015. "The Perfect Storm: Using Snowstorms to Analyze the Effect of Theatrical Attendance on the Demand for Subsequently Released DVDs," *Working Paper, Carnegie Mellon University, Pittsburgh, PA. (https://ssrn.com/abstract=2639303)*

Danaher, B., Dhanasobhon, S., Smith, M. D., and Telang, R. 2010. "Converting pirates without cannibalizing purchasers: the impact of digital distribution on physical sales and internet piracy," *Marketing science*, *29*(6), 1138-1151.

Danaher, B., and Waldfogel, J. 2012. "Reel Piracy: The Effect of Online Film Piracy on International Box Office Sales," *Working Paper. Available at SSRN 1986299.*

Danaher, B., Dhanasobhon, S., Smith, M. D., and Telang, R. 2015. "Understanding Media Markets in the Digital Age," *Economic Analysis of the Digital Economy*, 385.

Elberse, A. 2002. "Demand and supply dynamics for sequentially released products in international markets: An empirical application to motion pictures," *Ph.D. dissertation*, London Business School.

Elberse, A., and Eliashberg, J. 2003. "Demand and supply dynamics for sequentially released products in international markets: The case of motion pictures," *Marketing Science*, *22*(3), 329-354.

Eliashberg, J., Elberse, A., and Leenders, M. A. 2006. "The motion picture industry: Critical issues in practice, current research, and new research directions," *Marketing Science*, *25*(6), 638-661.

Garrahan, M. 2014. "Hollywood studios eye China streaming deal to beat piracy," *Retrieved from http://www.ft.com/cms/s/0/17727d9c-cddb-11e3-9dfd-00144feabdc0.html#axzz3qJSsi44k*

Hennig-Thurau, T., Henning, V., Sattler, H., Eggers, F., and Houston, M. B. 2007. "The last picture show? Timing and order of movie distribution channels," *Journal of Marketing*, *71*(4), 63-83.

Levin, D., and Horn, J. 2011. "DVD pirates running rampant in China," *Retrieved from http://articles.latimes.com/2011/mar/22/entertainment/la-et-china-piracy-20110322*

Ma, L., Montgomery, A., Smith, M. D., and Singh, P. 2014. "The Effect of Pre-Release Film Piracy on Box Office Revenue," *Information Systems Research*. 25(3) 590-603.

MPAA. 2012. "Theatrical Market Statistics 2012," *Retrieved from https://www.mpaa.org/wp-content/uploads/2014/03/2012-Theatrical-Market-Statistics-Report.pdf*

Sivan, L., Smith, M. D., and Telang, R. 2015. "Do Search Engines Influence Media Piracy? Evidence from a Randomized Field Study," *Management Information Systems Quarterly*, Forthcoming.

Smith, M.D., and Telang, R. 2016. *Streaming, Sharing, Stealing: Big Data and the Future of Entertainment*. MIT Press.

Wang, J. 2010. "China launches 'Sword Net Operations' and creates a blacklist of copyright-infringing websites," *Retrieved from http://politics.people.com.cn/GB/1027/12215477.html#*

Xu, L. 2010. "Youku and Tudou say goodbye to 'free lunch' by announcing complete removal of pirated videos," *Retrieved from http://media.people.com.cn/GB/40606/10934496.html*

Zhao, G. 2013. "National Copyright Administration of China announces shutdown of 201 websites during 'Sword Net Operations' in 2013," *Retrieved from http://media.people.com.cn/n/2013/1230/c14677-23982068.html*