

**WINDOWS OF OPPORTUNITY:
The Impact of Piracy and Delayed International Availability on DVD Sales**

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WINDOWS OF OPPORTUNITY: The Impact of Piracy and Delayed International Availability on DVD Sales

ABSTRACT

For many years movies have been released using a series of staggered release windows, where releases are strategically timed across different product and geographical markets. These release windows have meant that movies were released first in theaters and several months later on DVD, and in most cases were released first in the United States and later in international markets. These established release windows have come under increasing pressure from digital piracy. In responses, studios have changed their strategies to reduce these delays. Nonetheless, delayed releases persist for a variety of operational, financial, and regulatory reasons, which means that pirated digital DVD rips can be available for several weeks, and in some cases months, before the DVD is legally available in international markets.

Our research seeks to measure the impact of this early piracy availability on DVD sales in legitimate channels. Our methodology uses observed box office revenue in the theatrical window to break the endogeneity between release window timing and DVD sales. Using data from 2009-2011, our results suggest that an additional 10-day delay between the availability of digital piracy and the legitimate DVD release date in a particular country is correlated with a 2-3% reduction in DVD sales in that country. This result is robust across a variety of different specifications and, as expected, is higher for high piracy countries than for lower piracy countries. Our results show how digital networks have increased the interconnection between geographically dispersed markets, and suggest a continued need for studios, their market partners, and government agencies to revisit established marketing and regulatory practices given the widespread availability of pirated content.

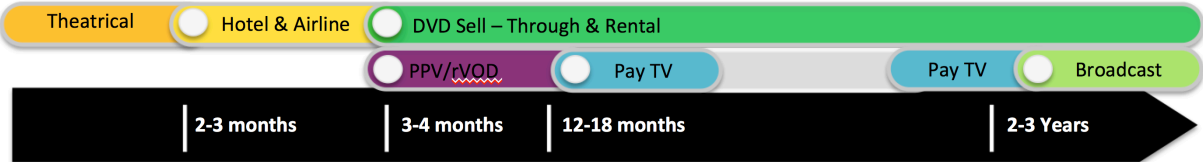
Keywords: *DVD sales, release windows, digital piracy, motion picture industry.*

1. Introduction

Movie studios typically stagger the release of their content across geographic and product markets. For product markets, these staggered release windows follow standard inter-temporal price discrimination strategies where content is first released in a high-price, high-value channel to attract customers with the highest willingness to pay, and later in lower-price, lower-value channels to secure revenue from lower willingness to pay consumers.

Figure 1 shows a typical product release schedule for movies. In this schedule, the movie is first released in theaters; around 3 months later is released on DVD, video-on-demand, and digital sales channels (e.g., iTunes); 9-15 months after that is released on pay-television channels (e.g., HBO, Showtime); and 12-18 months after that is licensed to ad-supported television channels (e.g., TNT, TBS, ABC).

FIGURE 1: TYPICAL MOVIE RELEASE SCHEDULE

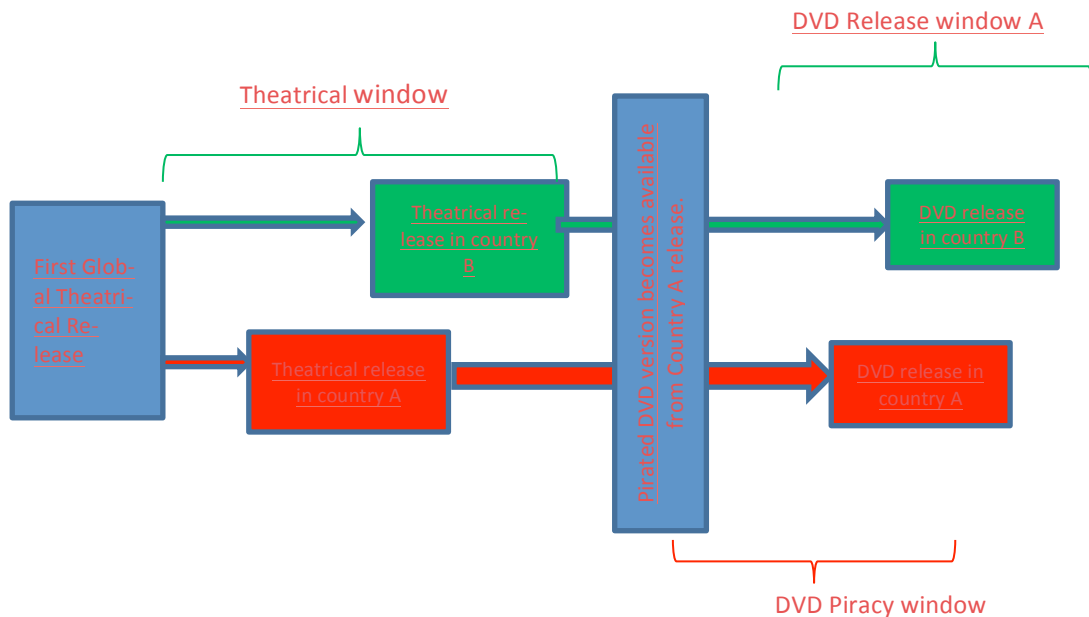


At the same time, owing to a variety of operational and regulatory constraints, studios have historically also staggered their release windows across geographic markets, typically releasing movies first in the United States and later in Europe, Asia, South America and other smaller markets (Lehmann and Weinberg 2000; Waterman and Lee 2003). There are a variety of reasons for these international delays. In the era of analog projection, films were distributed to theaters on 35mm reels, delayed international releases were driven primarily by an effort to economize on the cost of producing and distributing film prints (around \$1,500 per reel). Studios

would print a limited number of reels for their highest value market (typically the domestic U.S.), and then after the movie left theaters in the U.S., would clean and refurbish these reels at a cost of a few hundred dollars and send them to theaters in international markets.

With the widespread adoption of digital projection technologies, these cost-driven considerations are no longer an important factor in international delays,¹ causing significant reductions in the theatrical release dates across countries. Nonetheless, there are many reasons a studio may need to delay the release of content in particular countries. For example, international exhibitors also frequently ask for delayed releases so they can judge the quality of movies based on their performance in the other countries. Local holidays, marketing constraints, editing/censorship, and dubbing/subtitling also play a role in international delays.

FIGURE 2: TIMELINE OF GLOBAL THEATRICAL AND DVD RELEASE



¹ The cost to distribute a digital copy of a film to a theater with digital projection equipment is an order of magnitude lower (\$150 instead of \$1,500, Alexander and Blakeley 2014) than the cost to distribute an analog reel.

To maintain the inter-temporal price discrimination between the theatrical and DVD windows, if a movie's theatrical release is delayed in a particular country, the DVD release is also typically delayed. Thus, if the UK theatrical release occurs 1 month after the US theatrical release, the UK DVD release will also typically occur 1 month after the US DVD release (see Figure 2). Some countries (e.g., France, China) have a legal limit on the minimum number of days between a movie's release in theaters and its release on other home entertainment platforms, adding additional rigidity to the studios' release options.

These strategies worked well in the absence of global digital networks. However, these established release windows are coming under increasing pressure from interconnected global markets where promotion in one country can drive demand in other countries, and from shifting consumer tastes that are reducing the importance of the theatrical window for revenue generation (see Bakhshi 2007, Danaher and Waldfogel 2011, Bounie et al 2011).

However, the most notable pressure on these windows has come from the global availability of digital piracy. Strategies that delayed availability in international markets also relied on the assumption that international consumers were unable to obtain a copy of the movie until it was released in their country. The presence of digital content and digital piracy changes this assumption. Once the digital content enters the manufacturing process it is stolen either within the manufacturing process or during the shipping and distribution process as DVDs are shipped to retail stores prior to the release date. Because of that, ripped copies of DVDs are typically available for download on worldwide piracy networks 2-3 weeks *before* their initial release date.

Additional international delays after the DVD is released in its first country only compound this problem. If a movie is released in the U.S. 1 month before it is released in the U.K., U.S. customers will need to wait 2-3 weeks after the first pirate copy is available before they can

make a legal purchase, and consumers in the U.K. will have to wait approximately 6 weeks before being able to make a legal purchase in their country. Given that the biggest fans of a movie are likely to be the ones who want to consume it immediately, these delays could be particularly harmful for sales.

Conflicts between delayed international releases and global piracy aren't unique to the motion picture industry. The music industry is trying to address a similar challenge. Historically, music has been released on a different day of the week in different countries: Mondays in Britain, Tuesdays in the U.S., Wednesdays in Japan, and Fridays in Germany, Australia, and Sweden. As with movies, the presence of global piracy places pressure on these local practices. When an album is released on Friday in Germany, a pirated copy is available almost immediately to consumers in the U.S. who then have to choose between consuming the content illegally immediately or waiting 4 days for the Tuesday release in the U.S.

On February 26, 2015, the International Federation of Phonographic Industries acknowledged that the variation in release dates was “causing frustration for consumers when music fans in other parts of the world can access new releases before them,” and that going forward their members would standardize their new music releases on Fridays in all countries to harness worldwide excitement around a common release date and to “reduce the risk of piracy by narrowing the gap between release days in different countries.”²

However, it is also important to acknowledge that the music and movie industries face very different markets with different strategic and cost drivers for their staggered international release schedules. While the staggered release schedule for music was based primarily on local

² <http://www.ifpi.org/news/Global-release-day-announced>

practices and stocking concerns in physical stores, staggered movie release schedules for movies are driven primarily by exhibitor demands and the need to maintain temporal price discrimination strategies between the theatrical and DVD release windows.

A key question in determining the value that could be gained by reducing international release windows is how much money is lost to piracy when releases are delayed in a particular country. However, measuring the impact of piracy or the impact of delayed availability is complicated due to the obvious identification challenges arising from the endogeneity of the release decisions themselves.

We propose to analyze this question in the context of delayed international releases of DVDs. Specifically, our research addresses whether a longer lag between the availability of the first DVD rip on global pirated networks and the domestic DVD release date reduce domestic DVD sales, and if so, by how much? Analyzing the DVD window is important for both practical and methodological reasons. Practically, DVD and other home entertainment sales make up a majority of film revenue and piracy may play a larger role in the DVD release window than in the theatrical window because of the pristine quality of piracy available from DVD and Blu-ray rips versus the widely varying quality of piracy available in the theatrical window.

Methodologically, analyzing the DVD release window allows us to use revenue in the theatrical window to control for (otherwise unobserved) expectations about popularity in the DVD window, breaking the endogeneity between observed DVD sales and the timing of the DVD release. Our empirical strategy also relies on the fact that most pirated sources become available before the first global release of the DVD. However, the actual release of the DVD in a local market is uncorrelated with the first global piracy source. We use this shock to analyze the impact of reducing the delay between piracy availability and DVD availability on DVD sales. In

addition to allowing us to control for popularity through theatrical revenue, our empirical approach allows us to separately identify the effect of piracy and the effect of the window.

Our empirical results suggest that each additional 10 days consumers must wait between the first availability of pirated content and the first availability of legitimate sales channels translates into 2-3% lower sales in that country. These results suggest that (i) movie piracy has a substantial negative impact on DVD sales, (ii) studios, their supply chain partners, and local regulators need to consider the global nature of piracy availability when evaluating international release schedules.

2. Literature Review

Our paper draws on two main literatures: the economics and information systems literature on the impact of piracy on sales and the marketing literature on the optimal timing of product releases.

Within the piracy literature, the fact that piracy generally harms legal sales is well established across a wide variety of peer-reviewed publications (see reviews of the literature by Liebowitz (2008), Oberholzer-Gee and Strumpf (2010), and Danaher, Smith, and Telang (2014)). In the context of motion picture piracy, researchers have shown that piracy harms sales in the theatrical window (Bounie et al. (2006), Hennig-Thurau, Henning, Sattler (2007), Rob and Waldfogel (2007), DeVany and Walls (2007), Bai and Waldfogel (2012)), in the DVD window (Hennig-Thurau, Henning, Sattler (2007)), and in the digital home entertainment window (Danaher et al. (2010), Danaher and Smith (2014)). Within this literature, our research question is most closely related to Ma et al. (2014) and Ma, Montgomery and Smith (2015) who find that pre-release theatrical piracy causes much more harm than does post-release piracy in the theatrical window, suggesting that pre-release piracy attracts the highest value users: those who wish to consume the

movie as soon as possible after it is available. Our question is also closely related to Danaher and Waldfogel (2011) who show that delay in theatrical releases in international markets reduce sales in the delayed countries. Our present paper extends these results by focusing on the operational question of managing delayed international release windows in the presence of piracy and by doing so in an environment that allows for cleaner identification than the environment available to Danaher and Waldfogel (2011).

In the marketing literature on release windows, our work is most closely related to Lehmann and Weinberg (2000) who analyze the trade-offs inherent in staggered theatrical-home entertainment windows. Their analysis in the context of motion picture sales suggests that studios would benefit financially by reducing the delay between the theatrical and home video windows. In a related paper, Waterman and Lee (2002) find that home entertainment windows for the major studios are longer than what would be expected under a purely competitive model. Mukherjee and Kadiyali (2012) use a structural model to analyze cross-channel cannibalization for purchases and rentals in the home entertainment window. Bakhshi (2007) analyzes how release windows are affected by various movie and market characteristics. Our work extends this literature by analyzing the timing of release windows in the presence of digital piracy.

3. Data

Our data include 220 movies released from January 2009 through April 2011, covering all major studio releases during this timeframe. Our data also cover seven different geographical markets and include data for both theatrical and DVD revenue. We note, however, that not every movie is released in every country.

Our data also include the date the movie was released in theaters and on DVD in each country, the first theatrical and first DVD release date globally, and both box office revenue and

DVD sales data. We also have information on when the first high quality (Blu-ray or DVD quality) pirated source becomes available, allowing us to compare the legal release date to the piracy availability date in each of our countries.

Figure 2 explains the data more clearly. Typically, movies are released at different times in different countries (labeled as theatrical window). They are then released on DVDs in respective countries at different times. Before the first global release of the DVD, a high quality pirated version becomes available (typically 2-3 weeks before the initial release date). The gap between theatrical release and DVD release is labeled as DVD release window. The gap between pirated DVD release and DVD release is labeled as DVD piracy window. While DVD release window may be endogenous, we believe that the DVD piracy window after controlling for movie and country fixed effects is exogenous and allows for clear identification.

TABLE 1 – DESCRIPTIVE STATISTICS

Country	DVD sales (in '000)	Box office (million \$)	DVD piracy window	Theatrical Delay	DVD release window
USA	1,262 (1,650)	80.1 (89.5)	45 (40)	10 (38)	123 (36)
UK	274 (402)	15.1 (20.1)	83 (49)	34 (47)	138 (38)
Australia	68.7 (105)	10.2 (12.7)	91 (46)	38 (46)	141 (36)
Japan	63.1 (79.1)	19.5 (3.4)	179 (74)	77 (70)	190 (94)
Germany	108.6 (207)	9.3 (16.7)	111 (54)	52 (54)	147(26)
Italy	30.2 (63.7)	6.1 (1.1)	108 (53)	58 (55)	139(38)
Spain	11.4 (25.3)	6.9 (11.3)	115 (45)	52(53)	149 (26)

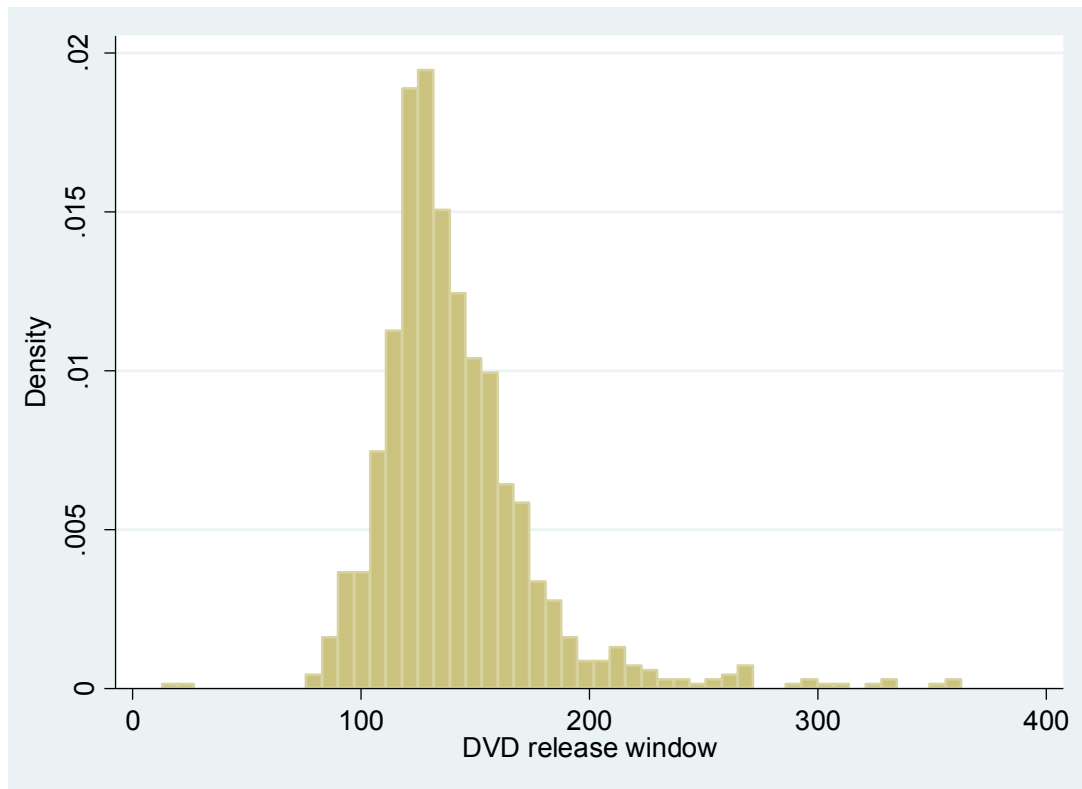
Average values with standard deviation displayed in parenthesis

Table 1 shows the summary statistics for our data. This table shows that in our data there is considerable heterogeneity in both theatrical and DVD release window. It takes on average slightly over 6 months (190 days) for a DVD to release in Japan after its theatrical run, which

itself is delayed substantially after the initial worldwide theatrical release (77 days on average). Because of this, consumers in Japan had to wait, on average, 179 days between the time a movie is available on pirate networks until they can purchase the DVD legally in the domestic market. This problem isn't unique to Japan, even in the U.S., a pirated version of the DVD is available on average 45 days before the legal version in our data.³

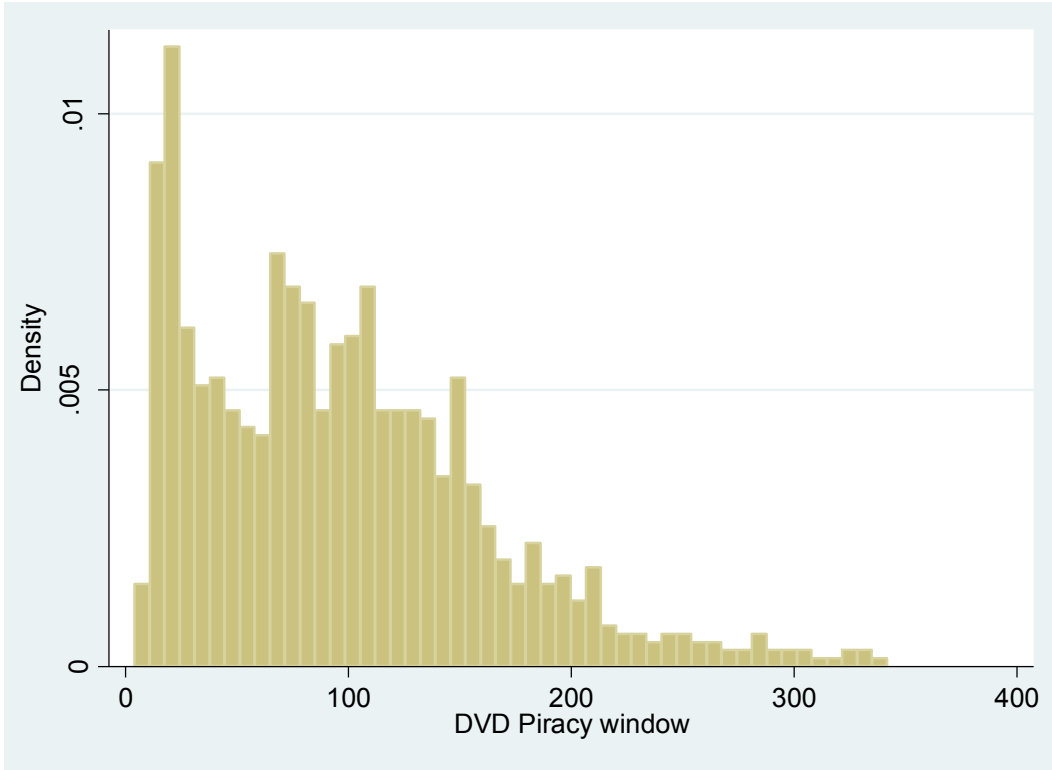
Figures 3 and 4 display these data graphically, showing the DVD release window values vary widely around a mean of 4 to 5 months (Figure 3), and that difference between the legal DVD release and the availability of the first DVD-based piracy rip varies widely with a modal value of around 2 weeks (Figure 4).

FIGURE 3 — DVD RELEASE WINDOW DISTRIBUTION



³ We note that although the release lags have reduced in recent years, there are still considerable differences between theatrical and DVD release dates across countries.

FIGURE 4 — DVD PIRACY WINDOW DISTRIBUTION



4. Empirical Model and Results

4.1. Empirical Model

To understand the modeling challenges inherent in this setting, consider the following model for DVD sales of movie i , in country j , with delay t :

$$\begin{aligned}
 S_{ijt} &= S_{ij}^0(x_{ij})e^{-\alpha t} \\
 \ln(S_{ijt}) &= \ln(S_{ij}^0(x_{ij})) - \alpha t
 \end{aligned}
 \tag{1}$$

where S^0 is the counterfactual DVD sales that would have resulted for movie i in country j if there had been no delay in its release ($t=0$). The problem with this model is that delay (t) is likely correlated with S^0 (which is unobserved), biasing the estimate on α . It might be possible to ad-

dress this correlation using movie- and country-level fixed effects, but this invalidate identification at these levels.

Our approach to addressing this estimation problem relies on using box office performance (B_{ij}^0) as a proxy for the unobserved S_{ij}^0 in our model. Box office performance is useful here because it is strongly correlated with eventual DVD sales and, unlike S_{ij}^0 , is observable to the researcher. Thus, if a studio chooses to accelerate or delay the release of a movie in a particular country based on its sales potential in that country, our approach relies on observed box office sales for that movie in that country as a proxy for the unobserved DVD sales potential driving the manager's choice of release dates. We also note that this strategy is not available to Danaher and Waldfogel's (2011) study because they are examining the impact of delayed releases in the initial (theatrical) window where there is no strong proxy on expected sales.

Our identification strategy also uses the fact that the piracy window is probably a lot more random in the DVD window than it would be in the theatrical window. Pirated DVD versions typically appear 2-3 weeks before the first global DVD release. However, by then the actual DVD window for a country is fixed and cannot be changed. Said another way, the date the first global pirated version of a movie is available is likely uncorrelated with a country's DVD window.

Using box office performance (B_{ij}^0) as an instrument for the unobserved DVD sales expectations (S_{ij}^0), and including fixed effects for movie, country, and time, we identify the effect of the DVD piracy window on DVD sales using the following variation on (1):

$$\begin{aligned} \text{Log}(\text{DVD sales}_{ij}) = & \alpha_i + \delta_j + \theta_t + \beta_1 \text{Log}(\text{Box office}_{ij}) + \beta_2 (\text{number of DVDs}_{jt}) \\ & + \beta_3 (\text{theatrical window})_{ij} + \beta_4 (\text{DVD piracy window})_{ijt} + \varepsilon_{ijt} \end{aligned} \quad (2)$$

where DVD sales, box office, theatrical window, and DVD piracy window are defined as above; and where the number of DVDs is the number of DVD being released in a given month in the country (accounting for the effect of competition on release timing), θ_t is a vector of calendar month dummies to account for seasonal variation, and α_i and δ_j are country and movie fixed effects.

The resulting estimates for (1) are shown in the Table 2 below. The statistically significant results ($p < 0.05$) are bolded. The estimate on Log(Box Office) shows, as expected, that box office revenue is strongly correlated with DVD sales. The coefficient on DVD piracy window, our variable of interest is negative and significant. Its magnitude suggests that an additional 10-day increase between the first global piracy source and the DVD release date in a particular country leads to about a 2% decline in DVD sales in that country, which translates into about 36,000 fewer DVDs sold for the average movie in our sample. We note that if we did not control for box office revenues then our estimate would be much larger (a 6% decline).

Our results are robust to a variety of different specification and sensitivity analyses. Specifically, our results hold under a log-log specification, when we drop large movies (e.g., Avatar), when we drop U.S. and Japan, and when we drop movies with particularly long release windows. In short, our model provides a consistent effect of the piracy window on DVD sales.

TABLE 2 – IMPACT OF THE DVD PIRACY WINDOW ON SALES

Log(DVD_sale)	Coef.	T-stat
Log(Box Office)	0.429	8.9
DVD piracy window	-0.002	-2.25
Theatrical Delay	0.000	-0.19
Month	0.004	0.56
US	NA	
Australia	-2.218	-13.87
Spain	-3.855	-24.84
Japan	-3.026	-12.08
UK	-0.954	-5.71
Germany	-1.600	-9.23
Italy	-3.017	-15.71
constant	6.065	7
Movie fixed effect	Yes	
Time Fixed effects	Yes	

N=907 for 198 movies. U.S. is the excluded variable in the panel of countries. Coefficients presented in bold are statistically significant at $p=0.05$.

One might wonder whether an early English-language pirated release has the same impact on English speaking countries as it does on non-English speaking countries, and vice-versa. To analyze this question, we run our results separately for English-speaking and non-English speaking countries. The results are displayed below in Tables 3 and 4.

**TABLE 3 – IMPACT OF THE DVD PIRACY WINDOW ON SALES
(ENGLISH SPEAKING COUNTRIES)**

Log(DVD_sale)	Coef.	T-stat
Log(Box Office)	0.042	5.6
DVD piracy window	-0.003	-2.05
Theatrical Delay	-0.001	-0.28
Month	0.007	0.56
US	NA	
Australia	0.160	-13.87
UK	0.167	-5.71
constant	0.867	7
Movie fixed effect	Yes	
Time Fixed effects	Yes	

Coefficients presented in bold are statistically significant at p=0.05.

**TABLE 4 – IMPACT OF THE DVD PIRACY WINDOW ON SALES
(NON-ENGLISH SPEAKING COUNTRIES)**

Log(DVD_sale)	Coef.	T-stat
Log(Box Office)	0.040	6.4
DVD piracy window	-0.004	-2.7
Theatrical Delay	0.002	1.4
Month	0.021	1.7
Spain	-0.878	-4.7
Germany	1.460	7.7
Japan	NA	
Italy	0.030	0.2
constant	3.180	2.4
Movie fixed effect	Yes	
Time Fixed effects	Yes	

Coefficients presented in bold are statistically significant at p=0.05.

The estimates in Table 3 and 4 are similar to each other and similar to the main regressions in Table 2. This suggests, among other things, that the language of the initially released pirated version does not strongly impact our results, likely because the piracy market for foreign

language sub-titles are remarkably efficient: most movies have domestic language subtitles within a matter of days after the pirated video source is available.

Another potential concern is whether the decrease in sales when the DVD release is delayed is primarily due to the presence of piracy or to the simple fact that people are more likely to lose interest in the movie the longer the delay after the movie leaves the theater. To analyze this question, we modify our specification in (2) to include a separate variable for the DVD release window. This specification is valid if the DVD release window is not endogeneously determined after the theatrical window but is rather driven by the pre-determined theatrical delay across countries.

**TABLE 5 – IMPACT OF THE DVD PIRACY WINDOW ON SALES
(INCLUDING DVD RELEASE WINDOW)**

Log(DVD_sale)	Coef.	T-stat
Log(Box Office)	0.429	8.900
DVD release window	0.000	0.190
DVD piracy window	-0.002	-3.030
Month	0.004	0.560
US	NA	
Australia	-2.218	-13.870
Spain	-3.855	-24.840
Japan	-3.026	-12.080
UK	-0.954	-5.710
Germany	-1.600	-9.230
Italy	-3.017	-15.710
constant	6.044	7.220
Movie fixed effect	Yes	
Time Fixed effects	Yes	

Coefficients presented in bold are statistically significant at p=0.05.

In this specifically, our estimates on the DVD piracy window are essentially the same as those in the main regression, while the estimates on the DVD release window variable are essentially zero. This suggests that the vast majority of the losses observed in specification (2) are driven by the availability of piracy as opposed to reductions in awareness of interest over time.

Another piece of evidence suggesting that piracy is the main driver of the observed drop in sales comes from variance in piracy levels across countries. Table 6 below uses data provided by several studios tracking the average levels of BitTorrent based piracy for our movies, broken out across the seven countries in our sample.

**TABLE 6 – IMPACT OF THE DVD PIRACY WINDOW ON SALES
(TOTAL DOWNLOADS, INCLUDING DVD RELEASE WINDOW)**

Country	Average	Standard Deviation
AUS	49,419	34,493
GER	27,040	60,105
ITALY	398,509	389,359
JAPAN	5,775	3,882
SPAIN	356,032	352,605
UK	104,981	74,585
US	113,804	88,792

Although limited to BitTorrent piracy, and thus not representative of total piracy levels, these statistics reveal significant differences in piracy consumption across countries. Piracy usage in Italy and Spain is about six times larger than the observed piracy usage in our other countries. Because of this, following similar logic to that used in Danaher and Smith (2014), one would expect that the availability of DVD piracy in those high piracy countries will have a proportionally larger impact on sales than it does in countries with low piracy usage. This expectation is consistent with what we find in our data. When we run our regressions on Spain and Italy

alone, we observe a 10% drop in sales for every 10-day delay in legal availability, as compared to a 2% drop in sales for every 10-day delay in the entire sample. This difference is roughly in line with the difference in overall piracy levels, which again suggests that our observed effect is due to the impact of piracy as opposed to some other factor.

5. Conclusions

Globally interconnected data networks are placing pressure on international windowing strategies in the entertainment industries. As noted above, a variety of factors have caused delayed international movie releases, and many of these factors are outside of the studios' control. Historically, these delays were driven by the cost associated with the distribution of analog movie reels. However, as theaters have increasingly adopted digital projection technologies, the remaining delays are driven primarily by exhibitor demands for delays to allow them to gauge movie popularity, local laws protecting the theatrical exhibition market, local holiday schedules, and other operational and promotional constraints. To maintain the temporal price-discrimination strategies inherent to the theatrical-DVD release windows, when a movie is delayed in the theaters in a particular country, it must also be delayed on DVD.

Although these strategies may have been financially and operationally viable in an environment where it was difficult for consumers in the delayed countries to obtain the movie before its local release, the global availability of Internet piracy makes it much more difficult to delay digital availability of content across countries. Once a DVD enters the manufacturing and distribution process, it is almost impossible to prevent the digital content from leaking into piracy networks. As a result, pirated copies of DVDs are typically available 2 weeks *before* the legal release of the DVD in the initial country. Prior research suggests that the availability of piracy

prior to theatrical release (when there are no legal channels where consumers can purchase the movie) has a particularly strong negative impact on theatrical revenue.

We analyze the impact of piracy on staggered international release schedules in the context of delayed DVD releases. Analyzing the DVD release window has a variety of practical and methodological advantages for our analysis. From a practical standpoint, the DVD release is an important revenue driver for movies. DVDs and other home entertainment release windows have replaced the theatrical window as the dominant source of revenue for movies. From a methodological standpoint, the DVD window provides us with a useful proxy for unobserved expected DVD sales. Specifically, we use observed box office revenues as an instrument for unobserved expected DVD sales to break the endogeneity between realized DVD sales and the timing of DVD releases. This provides us with a methodological advantage over prior studies of the impact of delays on theatrical sales where no such proxy for expected sales levels was available.

Instrumenting in this way, our models show that each additional 10-day delay in the legal availability of DVDs in a particular country after the global availability of a pirated DVD rip of a movie results in a 2-3% decline in DVD sales in that country.

There are three clear implications of this result. The first implication is, consistent with the vast majority of the academic literature, our data show that the availability of piracy has a strong negative impact on legal sales.

Second, our results point to the global interconnection between international markets in the age of the Internet. Unlike physical copies of pirated DVDs sold on streets in Bangkok or Mumbai, the scale and scope of digital piracy is global: an early release in one country can have significant externalities on sales in other international markets.

Third, our results suggest that studios, their distribution partners, and local regulators should evaluate delayed international movie releases in the presence of global piracy. As with most factors related to piracy, addressing this challenge will require coordination between studios and a variety of other industry and governmental actors. Nonetheless, the data show that such coordination is vital given the negative impact of piracy on sales.

Our results are limited in a variety of ways. One notable limitation is that, owing to limited data availability, our data come from 2009-2011, and there have been many changes in the distribution of movies in the last 5 years.

Finally, we note that delayed international releases are not unique to movies. International licensing agreements frequently cause television programs to be delayed internationally after their domestic release date, which again opens the possibility that pirated copies of television shows will be available in countries well before their legal availability. It would be interesting for future research to analyze the impact of these delays on local viewership and sales.

References

- Alexander, H., R. Blakely. 2014. That's all folks: what the end of 35mm film means for cinema. *NewStatesman*, September 8. (Available from <http://www.newstatesman.com/2014/08/s-all-folks>, last accessed February 25, 2015).
- Bakshi, Hasan. 2007. The theatrical window: uncharted waters? Available from <http://www.bfi.org.uk/sites/bfi.org.uk/files/downloads/theatrical-window-unchartered-waters.pdf>, last accessed February 25, 2015.
- Bai, J., J. Waldfogel. 2012. Movie Piracy and Sales Displacement in Two Samples of Chinese Consumers. *Information Economics and Policy*, **24**(3) 187-196.
- Bounie, D., M. Bourreau, P. Waelbroeck. 2006. Piracy and the Demand for Films: Analysis of Piracy Behavior in French Universities. *Review of Economic Research on Copyright Issues*, 3(2) 15-27.
- Danaher, Brett, Michael D. Smith. 2014. Gone in 60 Seconds: The Impact of the Megaupload Shutdown on Movie Sales. *International Journal of Industrial Organization*. 33 1-8.
- Danaher, B., S. Dhanasobhon, M.D. Smith, R. Telang. 2010. Converting Pirates without Cannibalizing Purchasers: The Impact of Digital Distribution on Physical Sales and Internet Piracy. *Marketing Science*, 29(6) 1138-1151.
- Danaher, Brett, Michael D. Smith, Rahul Telang. 2014. Piracy and Copyright Enforcement Mechanisms, Lerner and Stern, eds. *Innovation Policy and the Economy*, Volume 14, Chapter 2 (pp. 31-67), National Bureau of Economic Research, University of Chicago Press, Chicago, Illinois.
- Danaher, B., J. Waldfogel. 2012. Reel Piracy: The Effect of Online Movie Piracy on Film Box Office Sales. Working Paper. Wellesley College. Boston, Massachusetts.
- De Vany, A.S., W.D. Walls. 2010. Estimating the Effects of Movie Piracy on Box-office Revenue. *Review of Industrial Organization* 30:291-301.
- Lehmann, D.R., C.B. Weinberg. 2000. Sales Through Sequential Distribution Channels: An Application to Movies and Videos. *Journal of Marketing*, 64, 18-33.
- Liebowitz, Stan J. 2008. File-Sharing: Creative Destruction or just Plain Destruction? *Journal of Law and Economics*, 49 1-28.
- Ma, Liye, Alan Montgomery, Michael D. Smith, Param Singh. 2014. The Effect of Pre-Release Movie Piracy on Box Office Revenue. *Information Systems Research*. 25(3) 590-603.
- Ma, Liye, Alan Montgomery, Michael D. Smith. 2015. The Dual Impact of Movie Piracy on Box-Office Revenue: Cannibalization and Promotion. Working Paper, Carnegie Mellon University, Pittsburgh, Pennsylvania.

Mukherjee, A., V. Kadiyali. 2011. Modeling Multichannel Home Video Demand in the U.S. Motion Picture Industry, *Journal of Marketing Research*, **48**, pp. 985-995.

Oberholzer-Gee, F., K. Strumpf. 2010. File Sharing and Copyright, Lerner and Stern, eds. Innovation Policy and the Economy, Volume 10, University of Chicago Press, Chicago, Illinois.

Rob, R., J. Waldfogel. 2007. Piracy on the Silver Screen. *Journal of Industrial Economics*, **55**(3) 379-393.

Waterman, D. and S.C. Lee. 2003. Time Consistency in the Distribution of Theatrical Films: An Empirical Study of the Video Window. Econometric Society Annual Winter Meeting (American Economic Association), Washington, D.C., January 3-5, 2003.