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Abstract

Hollywood blockbusters are usually released in the U.S. before other foreign markets. The release gaps have declined significantly over time and varied greatly across countries. While movie piracy has been suggested as an important determinant for the release gap decision of distributors, theory and evidence suggest there are other important determinants. In this paper, we use a discrete choice release gap decision game model to disentangle the impacts of the i) release gap effect, which includes factors that provide incentives for a distributor to shorten the release gap; ii) word-of-mouth effect, which provides incentives for a distributor to lengthen the release gap; and iii) strategic effect, which accounts for the incentives blockbusters have to avoid each other. We obtain box office and release gap data from the private industry source Boxofficemojo.com. Our results suggest all three factors have an economically significant impact on distributors' release gap decision.

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Keywords: Hollywood, movie exports, release gap, intellectual property rights

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1 Introduction

Movie executives fear the collapse of Hollywood exports in the face of rising worldwide piracy rates. Yet box office sales growth remains stable. According to the Motion Picture Association of America (MPAA), U.S./Canadian and international box office sales grew 12% and 32% between 2008 and 2012.[1] The movie industry must be doing something right.

One characteristic of the movie industry often mentioned in connection with piracy is the release gap between when a movie appears in the U.S. and a foreign market. Hollywood studios try to preempt piracy by releasing movies as quickly as possible. Industry observers often note the decline in movie release gaps worldwide, a point made by Eliashberg, Elberse, and Leenders (2006). Looking at the years 1980, 1990, 2000, and 2010, for example, we observe this trend when comparing the average release gap for those top ten box office hits from the U.S. which were also released in Hong Kong. The average release gap declines from 168 days in 1980, a year which saw the hits Star Wars: Episode V - The Empire Strikes Back (1980) and The Blues Brothers (1980), to 149 days in 1990 to 43 days in 2000 to 20 days in 2010. Out of the top ten movies in 2010, two were released first in Hong Kong, one was released on the same day in both the U.S. and Hong Kong, and one was released less than a week later in Hong Kong.[2] McCalman (2005) provides evidence that the release gap has a non-linear relation to the level of intellectual property rights in a country: either very weak or very strong protection of intellectual property rights is associated with a longer release gap.

Although piracy affects release gaps, it is only one of many possible factors contributing to the release gap decisions made by Hollywood studios. We categorize the factors contributing to release gap variation observed in the data into three main effects: the release gap effect, word-of-mouth effect, and strategic effect.

The release gap effect refers to factors that provide incentives for a distributor to shorten the release gap. These include i) the prevalence of digital cinema, which can significantly reduce the duplication and delivery cost of a movie, estimated to be approximately 3.5% of the total cost to create and distribute a movie (Husak (2004)), and ii) movie piracy, which has become

[1] We use the MPAA's *Theatrical Market Statistics 2012* for various statistics throughout the paper. This report currently resides at `http://www.mpaa.org/policy/industry`

[2] The numbers for this example were constructed from information accessed from Boxofficemojo.com and IMDb.com.

more important after the spread of Peer-to-Peer (P2P) file sharing technology.

The word-of-mouth effect refers to the positive effect of longer release gaps on box office performance. In particular, a longer release gap allows a movie more time to accumulate box office revenue in the U.S. market and, thus, more positive word-of-mouth in the foreign market. Moul (2007) shows word-of-mouth has a positive impact on domestic box office performance. Elberse and Eliashberg (2003) argues that U.S releases act as a filter which selects the more successful movies to be released abroad.

The strategic effect refers to the interactions among Hollywood distributors. Distributors want to release movies on popular movie-going weekends, like the Fourth of July in the U.S., but also want to avoid competition from other blockbusters. Krider and Weinberg (1998) cites, for example, a Vice President of Warner Brothers:

> ...all studios, including Warner Brothers, are constantly moving their opening dates, and we shift the pictures around the calendar in an effort to find the ideal release date for each picture on our schedule. Because the opening weekend is so critical, it is even more critical that we find exactly the right date for each movie.

This same Vice President cites the primary concern about the release date as being competition from other movies with a similar target audience. Krider and Weinberg (1998) relates an example of a studio adjusting its release date in the face of competition during the Christmas season of 1992. Columbia Pictures moved its release date of A Few Good Men (1992) from December 18 to December 11, which coincided with the release date of Twentieth Century Fox's Hoffa (1992). Both movies star the actor Jack Nicholson. Twentieth Century Fox feared losing ticket sales and moved the release of Hoffa (1992) to December 25. Strategy regarding release dates may also apply to foreign markets.

In this paper, we develop and estimate a model of discrete games, which allows us to disentangle the three effects when analyzing the release gap decision. Our theoretical modeling takes two steps. First, we model demand for movies as a function of movie quality, movie demand decay pattern, and seasonality underlying demand for a movie, as in Einav (2010). Second, we construct a private information sequential-move game on the release gap decision similar to Einav (2010). In the model, we take the movie decay pattern and seasonality as given and

re-parameterize the movie's quality as a function of the length of release gap and the expected accumulated U.S. box office to account for the release gap effect and word-of-mouth effect. We then take the season in which a movie is released as given and focus on the strategic decision of the release gap within the season.

We estimate the model using data on box office performance and release dates from the U.S. and 17 other countries between 2008 and 2012. For computational concerns, we choose four annual release seasons (President's Day, Memorial Day, Fourth of July, and Thanksgiving), all at around a dominant U.S. release date, to test our empirical model. We also only consider the strategic interaction between the top two Hollywood movies in each season. Our results suggest three things. First, word-of-mouth has a positive impact on the length of the release gap. In particular, we conduct a counterfactual in which a movie would receive all its box office revenue from its entire run in the first week in the U.S., which would reduce the incentive for the distributor to have a longer release gap. Our counterfactual results suggest the release gap would indeed decrease by almost 0.27 weeks (5.39%) on average across the 17 countries. Second, the release gap effect has a negative impact on the length of the release gap. When the release gap effect disappears, the average release gap across 17 countries would increase by 0.54 weeks (10.79%). Third, the dominant movie in the season is less responsive to changes in the release gap effect and word-of-mouth effect.

The remaining sections of our paper are organized as follows: Section 2 reviews the extensive and growing literature on box office revenues, piracy, and international trade in movies. Section 3 briefly discusses the movie industry in general and in the context of movie piracy and release gap trends. Section 4 describes our model of the release gap decision. Section 5 describes our data set we use in our analysis, while sections 6 and 7 present our estimates and counterfactuals. Section 8 concludes.

2 Literature Review

There is a large literature on the determinants of box office revenues. Einav (2007), Einav (2010) and Krider and Weinberg (1998) use the U.S. box office data to empirically analyze the effects of seasonality and competition on the box office revenues and release timing decisions. Dellarocas,

Zhang, and Awad (2007), Duan, Gu, and Whinston (2008) , and Moul (2007) evaluate the effects of user reviews and word-of-mouth on box office revenues. A few papers have analyzed other factors, such as a movie's script (Eliashberg, Hui, and Zhang (2007)), advertising (Rennhoff and Wilbur (2011)), and the presence of big stars (Elberse (2007)).

On top of these factors, there is a growing literature that attempts to evaluate the impact of piracy on box office revenues. Rob and Waldfogel (2007) collect survey data from 500 students from the University of Pennsylvania and find the displacement effect to be approximately 0.2. Zentner (2010) uses a panel of country-level data on movie consumption and broadband penetration to evaluate the effect of P2P file sharing on retail purchases as well as on box office revenue. He finds P2P file sharing has a large and negative impact on retail purchases but no statistically significant impact on box office revenue. DeVany and Walls (2007) finds a single widely-released movie lost $40 million in revenue due to pre-release and contemporaneous Internet downloads of the movie. Ma, Montgomery, Singh, and Smith (2013) use U.S. box office data together with unique Internet file-sharing data and find pre-release piracy can lead to a 20% decrease in box office revenue compared to piracy that occurs post-release. Danaher and Waldfogel (2012) make use of the variation in international release gaps and box office performances in 17 countries, together with time breaks for the adoption of BitTorrent, to identify the effect of release gaps on box office performances. Their results indicate international box office returns were at least 7% lower than they would have been in the absence of pre-release piracy. Danaher, Smith, and Telang (2014) provide a review of the recent literature.

Our study also fits into the international trade literature motivated by the availability of rich micro-level data sets. Most existing work, however, studies trade flows in manufacturing goods, as services data is often difficult to obtain. A recent exception has been the literature on international trade in movies. Marvasti and Canterbery (2005) determines cultural distance by applying a gravity-iceberg model to U.S. movie exports. Using a gravity framework as well, Hanson and Xiang (2008) finds market size, language, and trade costs are all important determinants of U.S. movie exports. Hanson and Xiang (2011) applies versions of the model in Melitz (2003) to trade in movies, finding the data reject the bilateral fixed export cost model in favor of the model with a global fixed export cost. Hanson and Xiang (2011) shows countries import the same number of U.S. movies but differ in their box office sales of these

movies. This variation across the intensive margin, not the extensive margin, differs from trade in manufacturing, since most studies find the extensive margin plays an important role in trade in manufacturing.[3] Bridgman (2012) finds results consistent with Hanson and Xiang (2011) but for the case of a particular company, United Artists, during the period 1935 to 1949, thus, providing a look at the historical data on trade in services. Ferreira, Petrin, and Waldfogel (2012) employs a structural econometric model of the global movie industry to quantify the gains from trade from importing U.S. movies. Half of these gains from trade result from access to higher quality movies.

3 Industry Background

This section provides a brief overview of the relevant aspects of the movie industry for our study. We first describe some of the key features of box office performance in general. We then discuss movie piracy as motivation for our discussion on release gap trends.

3.1 Box Office Performance

DeVany (2004) argues one of the defining features of the movie industry is the "wild" uncertainty producers face regarding the performance of their products. This uncertainty remains after a movie's initial release. DeVany (2004) reports the median box office revenue of a movie is better predicted by week five or week eight revenues than by week one revenues. Even the presence of super star celebrities, like Julia Roberts or Brad Pitt, do not guarantee success. Super stars only impact the minimum box office revenue, not the maximum, a movie earns.

There appears to be large amounts of heterogeneity across production costs and box office performance in the industry as well. DeVany (2004) finds the distributions of costs and box office revenue have large right tails. The world of movies is Pareto, not Normal. The top 20% of movies earn 80% of the revenue. A movie dropping from the number one weekly box office rank to the number two rank experiences a decline in weekly revenue of $2.4 million, whereas a movie dropping from four to five loses $235,000.

[3]See, for example, Hummels and Klenow (2005) and Kehoe and Ruhl (2013)

Movies' box office lives also vary. DeVany (2004) reports the average movie life as being close to six weeks. If a movie debuts in the top 50 box office list, it has less than a 25% chance of remaining there for more than seven weeks.

3.2 Movie Piracy

Piracy has long been an issue in the movie industry. In the past, movie piracy mostly occurred in developing countries. This piracy usually takes the form of people purchasing counterfeit VHS/VCD/DVD through street vendors at lower monetary cost than the legal options.

With the advent of the Internet, piracy becomes a more severe concern in developed countries. Anyone with a computer and internet connection can now download pirated movie files from anywhere in the world. As internet download speeds increase, sharing a movie file becomes quicker. Today, sharing a movie file of, say, 2 GB in size takes only a matter of minutes. The ability to trade larger file sizes also means higher quality movie files can be traded more easily. This drastically reduces the cost of pirating a movie. As a result of these technological changes, movie piracy no longer occurs exclusively in developing countries but is rather a worldwide phenomenon, including in countries such as the U.S. and U.K. According to a 2011 report put out by Envisional, an Internet intelligence company, approximately 25% of all internet traffic in the world is related to P2P usage.[4] Almost all of this traffic is used in sharing copyrighted files. Envisional estimated that 11.5 million peers were sharing movie content through PublicBT tracker, the largest P2P tracker worldwide, in December 2010.

According to the Motion Picture Association, the major U.S. motion picture studios lost $6.1 billion in 2005 to piracy worldwide, with 62% of the losses coming from pirated goods like DVDs and 38% of the losses coming from Internet piracy. In the U.K. alone, the Motion Picture Association estimates that $406 million worth of revenue was lost due to movie piracy in 2005. This is the second highest number among international markets, only second to Mexico ($483 million). The potential for internet piracy continues to grow with technological advances in the computer industry and with rising internet penetration rates throughout the world.

[4]The report of Envisional can be found at `http://documents.envisional.com/docs/Envisional-Internet_Usage-Jan2011.pdf`.

3.3 Release Gap

Hollywood studios do not sit by idly in the face of piracy. Instead, many different strategies have been used to combat piracy, from public awareness campaigns and lobbying for government action to adaptation in the types of movies produced and how movies are distributed worldwide. The MPAA, for example, maintains a library of resources regarding its activities at its website, currently `http://www.mpaa.org/contentprotection`. A perusal of the MPAA's efforts to combat piracy finds a public awareness campaign in New York City (`http://stoppiracyinnyc.com`) in which advertisements are placed in buses, taxis, theaters, and other locations alerting consumers to the costs of piracy. Aimed at college students, a group typically associated with piracy, the Higher Education Opportunity Act of 2008 requires U.S. educational institutions receiving federal student financial aid to develop plans for combating piracy on their campuses. Movies showing in theaters in the U.S. now appear with federal warnings threatening fines and imprisonment for customers engaged in piracy. The information efforts by the MPAA not only stress the illegality of piracy and the losses suffered by producers. The public awareness campaign in New York City, for example, urges consumers to "Get the Real Picture," a slogan designed to emphasize the inferior quality of pirated goods. Indeed, emphasizing audiovisual quality may be a way in which Hollywood studios have adapted to the pressures from piracy. Action and adventure movies with lots of special effects, including 3D, provide a better experience when viewed in a theater. According to the MPAA, 3D movie screens have increased by 16 times worldwide since 2008.

To combat piracy in foreign countries, Hollywood studios can also shorten the gap between when a movie is released in the U.S. and a foreign market to preempt global piracy. Long gone are the days when global blockbusters like Star Wars: Episode IV - A New Hope (1977) appeared in markets like Hong Kong 8 months after its U.S. release: Iron Man 3 (2013) was released in Hong Kong 1 week before its U.S. release.[5]

To show shrinking release gaps are a general trend, we obtain release gap data from Boxofficemojo.com and IMDb.com for the top ten U.S. box office hits appearing in seven countries,

[5]Specifically, information accessed from IMDb.com states Star Wars opened in the U.S. on May 25, 1977 and in Hong Kong on January 26, 1978, whereas Iron Man 3 opened in Hong Kong on April 25, 2013 and in the U.S. on May 3, 2013.

Table 1: Cross-Country Release Gap (Days) since the 1980s

Country	1980	1990	2000	2010
Argentina	131	77	48	11
Australia	169	69	31	13
Brazil	177	101	47	18
France	144	132	54	19
Germany	193	110	44	20
Hong Kong	168	149	43	20
Japan	178	183	71	80

Source: Boxofficemojo.com and IMDb.com

including Argentina, Australia, Brazil, France, Germany, Hong Kong, and Japan. These countries are some of the major exporting countries of Hollywood blockbusters. Table 1 shows that the trend of declining movie release gaps has been clear. In 1980, the average release gap for Hollywood blockbusters was more than 4 months, ranging from 131 days (Argentina) to 193 days (Germany). But, the average release gaps have dropped approximately 90% in 2010. One thing to note is that the drop in release gaps started before the emergence of widespread Internet piracy. From 1990 to 2000, before BitTorrent technology, the release gaps had already dropped more than 50% across the seven countries.

4 Model of Strategic Choice of Release Gap

4.1 Discrete Choice Demand Model for Movies

We follow Einav (2007) to build a discrete choice model of demand for movies in country k. For notational simplicity, we suppress the country subscript in the exposition of the demand model. We assume the utility of consumer i from going to movie j in week t is

$$u_{ijt} = \theta_j - \lambda(t - r_j) + \tau_t + \xi_{jt} + \zeta_{it} + (1 - \sigma)\varepsilon_{ijt}, \tag{1}$$

where θ_j is a movie j fixed effect, r_j is the release time of movie j, λ is the movie decay parameter, τ_t is a week fixed effect that captures seasonality, ξ_{jt} is an unobserved preference shock (assumed the same for every consumer) for movie j in week t, and $\zeta_{it} + (1 - \sigma)\varepsilon_{ijt}$ is an individual error term.

Consumer i can also choose not to go to a movie in week t and, instead, derive utility from

an outside good (good 0). Utility from the outside good is

$$u_{i0t} = \zeta'_{it} + (1-\sigma)\varepsilon_{i0t}.$$

We follow Berry (1994) in the nested logit demand setting by assuming ε_{ijt} (and ε_{i0t}) is distributed i.i.d. extreme value and ζ_{it} (and ζ'_{it}) has a distribution that depends on $\sigma \in [0,1]$. The sum $\zeta_{it} + (1-\sigma)\varepsilon_{ijt}$ (and $\zeta'_{it} + (1-\sigma)\varepsilon_{i0t}$) is also distributed extreme value.

The parameter σ captures the market-expansion effect. It captures whether a new movie draws consumers from other movies or from people who would otherwise not go to movies at all. When σ approaches one, there is no substitution between the outside good and inside goods, and hence no market-expansion effect. When σ approaches zero, the model boils down to a simple logit model in which more observed seasonality can be attributed to variation in the number and quality of movies across the year.

The market share for movie j is

$$s_{jt} = \frac{\exp\left(\frac{\theta_j - \lambda(t-r_j) + \tau_t + \xi_{jt}}{1-\sigma}\right)}{D_t^{\sigma} + D_t}, \tag{2}$$

where

$$D_t = \sum_{j' \in J_t} \exp\left(\frac{\theta'_j - \lambda(t-r_j) + \tau_t + \xi_{j't}}{1-\sigma}\right) \tag{3}$$

and J_t is the set of all movies shown in theaters in week t. Rearranging equation (2) gives us

$$\log(s_{jt}) - \log(s_{0t}) = \theta_j - \lambda(t-r_j) + \tau_t + \sigma \log\left(\frac{s_{jt}}{1-s_{0t}}\right) + \xi_{jt}. \tag{4}$$

The within-industry market share, $\frac{s_{jt}}{1-s_{0t}}$, is endogenous and requires an instrumental variable. One candidate for the instrument is the number of movies shown in a given week. As Einav (2007) argues, the number of movies is negatively related to the within-industry share. The key assumption is that the instrument is not correlated with the error term, ξ_{jt}.

We separately estimate the relevant parameters, $\theta_j, \lambda, \tau_t, \sigma$, for each countries. We then take λ and τ_t as exogenous and re-estimate θ_j in the release gap decision game, which we describe in more detail in the next section.

4.2 Release Gap Decision Game

We follow Einav (2010) to model the release gap decision game as a private information sequential game. Let the set of players in an international market k be $i = 1, 2, \ldots, N_k$. Then, the payoffs for player i are given by

$$\begin{aligned}
\pi_i(r_j, r_{-j}; \alpha, \sigma) &= \hat{\pi}_j(r_j, r_{-j}; \alpha, \sigma) + \epsilon^j_{r_j} \\
&= \sum_{t=r_j}^{r_j+H} \hat{s}_{jt}(r_j, r_{-j}; \alpha, \sigma) + \epsilon^j_{r_j} \\
&= \sum_{t=r_j}^{r_j+H} \frac{\exp((\hat{\theta}_j(r_j) - \lambda(t - r_j) + \tau_t)/(1-\sigma))}{\hat{D}_t^\sigma + \hat{D}_t} + \epsilon^j_{r_j}, \qquad (5)
\end{aligned}$$

where

$$\hat{D}_t = \sum_{l \in J_t(r_j, r_{-j})} \exp\left(\frac{\hat{\theta}_l(r_l) - \lambda(t - r_l) + \tau_t}{1-\sigma}\right) \qquad (6)$$

and $\hat{\theta}_l(r_l)$ is a movie fixed effect which is a function of the time that the movie is released (defined below in equation (7)). H is the total number of periods that distributors would take into account in making their release decision, which is guided by computational limitations.[6] $J_t(r_j, r_{-j})$ is the set of movies showing in theaters during week t. The profit shock, $\epsilon^j_{r_j}$, is assumed to be an i.i.d. draw from a type I extreme value distribution and is assumed to be private information of distributor j.

In the profit function, we make use of the market share function in equation (2) with some modifications. First, we assume $\xi_{jt} = 0$ for any j and t. Second, we modify the movie fixed effect, θ_j, with $\hat{\theta}_j(r_j)$ to capture two effects: i) the negative effect of the release gap between U.S. release and local release and ii) the positive effect of the word-of-mouth effect of the box office revenue of movie j in the U.S. market.

To capture the negative effect of the release gap, we would have to model that the movie fixed effect, $\hat{\theta}_j(r_j)$, decreases with the release gap. We first define $\delta(r_j)$ as the release gap if the distributor decides to release movie j in country k at r_j. We let $\delta(\bar{r}_j)$ be the actual release date observed in the data. We then assume the movie fixed effect, $\hat{\theta}_j(r_j)$, decreases with $(\delta(r_j) - \delta(\bar{r}_j))$.

[6] In our estimation, we assume $H = 2$. In the countries in our sample, the box office revenue of the first two weeks accounts for almost 60% of the total box office revenue of a movie on average.

To capture the word-of-mouth effect, we would have to model that the movie fixed effect, $\hat{\theta}_j(r_j)$, increases with the box office revenue in the U.S. But, since we cannot assume a distributor to perfectly foresee the U.S. box office revenue before its release in either the U.S. or foreign market, we replace the actual U.S. box office of movie j with expected U.S. market share of movie j using the movie demand estimates in the U.S. market. In particular, the expected U.S. market share of movie j released on r_j^{US} at week t is

$$\kappa_t = \frac{\exp((\theta_j^{US} - \lambda^{US}(t - r_j^{US}) + \tau_t^{US})/(1-\sigma^{US}))}{(D_t^{US})^{\sigma^{US}} + D_t^{US}}.$$

The cumulative U.S. market share of movie j at week t is $\sum_{s=r_j^{US}}^{t} \kappa_s$. We then assume the movie fixed effect to increase with $\sum_{s=r_j^{US}}^{r_j} \kappa_s$

The movie fixed effect is thus

$$\hat{\theta}_j(r_j) = \theta_j - \alpha(\delta(r_j) - \delta(\bar{r}_j)) + \beta \log\left(\frac{\sum_{s=r_j^{US}}^{r_j} \kappa_s}{\sum_{s=r_j^{US}}^{\bar{r}_j} \kappa_s}\right), \tag{7}$$

where θ_j is the estimate of movie j's fixed effect from the estimation of the discrete choice demand model.

The second part of equation (7) captures the effect of the release gap on the movie's fixed effect. We expect a longer release gap would reduce consumers' interest in the movie, and, thus, we expect $\alpha > 0$. The last part of equation (7) captures the word-of-mouth effect of U.S. box office performance of the movie. If a movie performs well in the U.S. market, consumers' interest in the movie in country k will also increase. We, thus, expect $\beta > 0$.

Let us define R_j as the set of weeks in which distributor j can choose to release the movie. Conditional on other distributors' release choices, r_{-j}, distributor j chooses to release the movie on r_j with the following probability:

$$\Pr(r_j | r_{-j}) = \frac{\exp(\hat{\pi}_j(r_j, r_{-j}; \alpha, \sigma))}{\sum_{r'_j \in R_j} \exp(\hat{\pi}_j(r'_j, r_{-j}; \alpha, \sigma))}. \tag{8}$$

As in Einav (2010), this game is played sequentially with each player moving according to a pre-specified order. Because the payoffs of distributor j only depend on the actions of other

players, but not on their profit shocks, $\epsilon^{-j}_{r_{-j}}$, each distributor's strategy would only depend on the actions chosen by distributors who moved previously.

We use pseudo-backward induction to solve the equilibrium. Let N be the total number of players, and the order of play specified as a permutation $o \in \mathcal{P}_N$, such that $o(m) = j$ implies that the mth player to move in the game is distributor j. Let $\text{prev}(j) = \{k : o^{-1}(k) < o^{-1}(j)\}$ be the set of distributors who decide their release dates before j. We solve the game backwards by solving the release date problem of the last distributor, $o(N)$, conditional on the other distributors' decisions. Using equation (8), distributor $o(N)$ chooses to release on $r_{o(N)}$ with probability

$$\Pr(r_{o(N)}|r_{-o(N)}) = \frac{\exp(\hat{\pi}_j(r_{o(N)}, r_{-o(N)}; \alpha, \sigma))}{\sum_{r'_{o(N)} \in R_{o(N)}} \exp(\hat{\pi}_j(r'_{o(N)}, r_{-o(N)}; \alpha, \sigma))}. \tag{9}$$

We then make use of equation (9) to update the continuation values for other players. In particular,

$$\hat{\pi}_j^{N-1}(r_{-o(N)}; \alpha, \sigma) = \sum_{r_{o(N)} \in R_{o(N)}} \Pr(r_{o(N)}|r_{-o(N)}) \hat{\pi}_j(r_{o(N)}, r_{-o(N)}; \alpha, \sigma) \ \forall j \in \text{prev}(o(N)) \tag{10}$$

and

$$\pi_j^{N-1}(r_{-o(N)}; \alpha, \sigma) = \hat{\pi}_j^{N-1}(r_{-o(N)}; \alpha, \sigma) + \epsilon^j_{r_j} \ \forall j \in \text{prev}(o(N)). \tag{11}$$

The conditional release choice probability can then be updated using the continuation values specified in equation (10):

$$\Pr(r_j|r_{\text{prev}(j)}) = \frac{\exp(\hat{\pi}_j^{o^{-1}(j)}(r_j|r_{\text{prev}(j)}))}{\sum_{r'_j \in R_j} \exp(\hat{\pi}_j^{o^{-1}(j)}(r'_j|r_{\text{prev}(j)}))} \tag{12}$$

This procedure enables us to obtain an equilibrium with a positive probability over each possible outcome of the game. Given a pre-specified order o, the likelihood of a particular outcome r is

$$\Pr(r|o) = \prod_{j=1}^{N} \Pr(r_j|r_{\text{prev}(j),o}). \tag{13}$$

To take the empirical model to the data, we need to reduce the computation burden by restricting the number of players (N) and the number of weeks in which a distributor j can

choose to release its movie (R_j) in each season.

We restrict the number of players in each season window to be 2 by choosing the top two U.S. movies in terms of their movie fixed effects (θ_j) in the U.S. market. In some cases, only one of the two movies was released in a foreign country. The game would then be boiled down to a release gap decision of only the one player in the season, who only has to weigh between the release gap effect and word-of-mouth effect without considering the strategic interaction with another distributor.

As in Einav (2010), we choose four annual release seasons, all at around a dominant U.S. release date, to test our empirical model. The four seasons are President's Day, Memorial Day, Fourth of July, and Thanksgiving. Each season includes the holiday week, 2 weeks before, and 8 weeks after, adding up to 11 weeks in total (that is, the number of weeks in R_j is always 11). We, thus, have a total of 20 seasons of observation for each of the 17 countries on which the estimates are based.

5 Data

Our data sample consists of all movie titles showing in theaters in a given country in each weekend over the period 2008 to 2012. Naturally, for any given country and week, the total list of movies contains U.S. and non-U.S. titles. For each movie title in a given country and weekend, the data include the movie's weekend box office revenue, box office revenue to date, release date in the U.S., box office revenue in the U.S., and other summary details. The sample contains movie data for 17 different countries, a list of which appears below in Table 2. The countries were chosen to create the largest possible set of countries with data available on a weekly basis for all years 2008 to 2012. Data on movies from publicly funded sources are limited and of low quality. Instead, we build our movie sample by collecting data from the private industry source Boxofficemojo.com.

We then supplement the movie data with data from other sources. Data on average movie ticket prices across countries come from two sources. The first, for the years 2008 and 2009, is UNESCO. The second is Numbeo.com, a cost of living database, which we use to collect the movie ticket price in the year 2012. Interpolation between the UNESCO movie ticket prices and

the price from Numbeo.com constructs the remaining prices in 2010 and 2011. Each country's population is taken from the World Bank's World Development Indicators.

We follow Einav (2007) to restrict our attention to movies which reached a wide release at some point during the whole period that they are on screen. In particular, we only include movies which reached 5% of the total number of screens in the country during some week.[7] We also drop observations of limited release and define the actual release date to be the first week in which the number of screens is high enough.[8]

Because the box office data set only has weekend box office revenue and box office revenue to date, we use the following procedures to back out the weekly box office. First, for weeks that a movie appears in consecutive weeks in the data set, we use the difference between the cumulative box office revenue to the current week and the cumulative box office revenue to the previous week as the weekly box office revenue in the current week. Second, because there are some missing weeks in the data set, there are some weeks that we cannot use the difference of box office revenue to date to back out the weekly box office. Instead, we calculate the average ratio of weekend box office revenue and weekly box office revenue for each movie and then use the ratio to extrapolate the weekly box office for the weeks whose previous week's data is missing.

We use the average ticket price, the weekly box office revenue, and the population in a country (which we take as the total market size in the country) to calculate the market share of movies in the country. We interpolate weekly ticket prices and weekly population from the annual ticket price schedule and annual population by assuming prices and population change linearly throughout the year. We then calculate weekly market shares for each movie by dividing weekly box office revenues by weekly ticket price and weekly population size.

5.1 Summary Statistics

We present two summary statistics from our data in Table 2. The first column of Table 2 shows that release gaps across all countries in our sample are around 5 weeks. The release gaps display

[7] Einav (2007) used a threshold of 600 screens, which is roughly 3-4% of the total number of screens in his data sample period.

[8] Operationally, we define actual release week to be the first week in which the number of screens exceeds the maximum of 5% of total number of screens in the country and 30% of the maximal number of screens showing the movie in its entire run.

huge variation across countries. Developed countries such as Japan can have an average release gap of 10 weeks, while developing countries such as Thailand can have a very short release gap of just above 2 weeks. We regressed the release gaps on Park (2008)'s patent protection index. An increase in the index by 1 (out of a maximum of 5, with a higher index indicating better protection) is associated with a 0.6 week increase in the release gap in the country. But, the R-square is only 0.03.

Table 2: Summary Statistics

Country	Release Gap (weeks)	Revenue from First Two Weeks (share of total revenue)
Argentina	6.5310	0.5177
Australia	3.5820	0.5656
Austria	5.9546	0.5239
Belgium	4.6239	0.5022
Bolivia	6.8538	0.5235
Brazil	5.4286	0.5427
Bulgaria	3.9116	0.5356
Germany	4.6334	0.5096
Hong Kong	4.3905	0.6857
Iceland	3.7388	0.5701
Japan	10.0336	0.4174
Mexico	5.6000	0.5776
Singapore	2.4560	0.6615
Spain	5.6192	0.5918
Thailand	2.3578	0.7431
Turkey	5.3184	0.5645
Uruguay	8.6938	0.4749
Mean	5.2781	0.5593

Source: Boxofficemojo.com

Column 2 of Table 2 reports that almost 60% of box office revenue of a movie comes from the first two weeks of its release on average across the 17 countries in the data. In most countries, the proportion ranges from 50% to 60%. Movies decay significantly faster in developing countries such as Thailand, with approximately 74% of a movie's total box office revenue coming from the first two weeks.

6 Estimates

6.1 Movie Demand Estimates

We first report the estimates from the discrete choice demand model for movies. Because the demand estimates, which are λ, τ, and σ, are not directly comparable across countries, we do not report them here. We instead calculate the mean decay elasticities (weighted by box office revenue) implied by the demand estimates for each country. We define decay elasticity as the percentage change of market share when the movie stays in the market for one more week. We then use the estimated decay elasticities to estimate the box office of first two weeks as a portion of total box office revenue, which can be compared with actual data.

Table 3: Estimated Decay of Box Office Revenue

Country	Estimated Decay Elasticity	Estimated Revenue from First Two Weeks (share of total revenue)	Actual Revenue from First Two Weeks (share of total revenue)
Argentina	-0.4481	0.6950	0.5177
Australia	-0.3762	0.6178	0.5656
Austria	-0.3809	0.6167	0.5239
Belgium	-0.3527	0.5810	0.5022
Bolivia	-0.3716	0.6050	0.5235
Brazil	-0.4943	0.7113	0.5427
Bulgaria	-0.3992	0.6383	0.5356
Germany	-0.3959	0.6350	0.5096
Hong Kong	-0.6812	0.8958	0.6857
Iceland	-0.4344	0.6801	0.5701
Japan	-0.3336	0.5559	0.4174
Mexico	-0.3474	0.5740	0.5776
Singapore	-0.7553	0.9401	0.6615
Spain	-0.5275	0.7766	0.5918
Thailand	-0.8550	0.9789	0.7431
Turkey	-0.5022	0.7518	0.5645
Uruguay	-0.3043	0.5159	0.4749
Mean	-0.4682	0.6923	0.5593

Table 3 reports the results. The first column of Table 3 shows the average decay elasticity across the 17 countries in our sample is -0.47, which means the market shares of a movie would drop almost by half with every additional week in the theater. The decay elasticities vary significantly across countries. The decay elasticities can be below -0.8 in a developing country like Thailand (-0.86), while most European countries and Australia have decay elasticities above

-0.4.

Because movies decay fairly fast on average, most of the box office revenue of a movie comes from the first two weeks of its release. The second column of Table 3 reports our demand estimates imply almost 70% of box office revenue comes from the first two weeks of a movie's release on average across the 17 countries in our data. While the estimated movie decays are consistently higher than the actual movie decays across countries (column 3), most of them are fairly close.

6.2 Release Gap Decision Game Estimates

Table 4 reports the estimates from the release gap decision game. All estimates have the expected sign. The estimates for the release gap effect, α, are positive in all countries, meaning that a longer release gap would lead to a decrease in the movie fixed effect. Also, the estimates for word-of-mouth effect, β, are also positive in all countries, meaning that a higher expected cumulative market share in the U.S. would lead to a higher movie fixed effect.

Table 4: Estimates by Country

Country	α	β
Argentina	0.0678	0.2206
Australia	0.2615	0.6928
Austria	0.1818	2.9744
Belgium	0.1848	0.2657
Bolivia	0.2719	0.9491
Brazil	0.1717	0.8855
Bulgaria	0.1513	0.7797
Germany	0.1526	1.1997
Hong Kong	0.1235	0.5759
Iceland	0.2340	1.3236
Japan	0.1815	0.9939
Mexico	0.1639	0.6154
Singapore	0.1703	0.2480
Spain	0.1796	0.9995
Thailand	0.3388	1.0089
Turkey	0.1824	0.9009
Uruguay	0.0534	0.3664

7 Counterfactuals

We conduct counterfactuals to evaluate i) the word-of-mouth effect and ii) the release gap effect on the release gap decision of movie distributors. From equation (7), the movie fixed effect of movie j released on week r_j is

$$\hat{\theta}_j(r_j) = \theta_j - \alpha(\delta(r_j) - \delta(\bar{r}_j)) + \beta \log\left(\frac{\sum_{s=r_j^{US}}^{r_j} \kappa_s}{\sum_{s=r_j^{US}}^{\bar{r}_j} \kappa_s}\right),$$

where $\bar{r}_j$ is the actual release week of movie j in the data, $\delta(r_j)$ is the release gap if movie is released on week r_j, and $\sum_{s=r_j^{US}}^{r_j} \kappa_s$ is the expected cumulative U.S. market share of movie j on week r_j.

7.1 Word-of-mouth Effect

We first conduct counterfactuals to evaluate the effect of word-of-mouth on the choices of release gap. In particular, we ask the question: how would a distributor's decision about the release gap be different if the movie is always released in a foreign country after its release ends in the U.S. market? To answer that, we assume a distributor would expect to accumulate the maximum market shares in the U.S., and, thus, maximum word-of-mouth in the foreign country, at the beginning of the season it is released and rewrite the movie fixed effect of movie j released on week r_j as

$$\hat{\theta}_j(r_j) = \theta_j - \alpha(\delta(r_j) - \delta(\bar{r}_j)) + \beta \log\left(\frac{\sum_{s=r_j^{US}}^{r_j^{end}} \kappa_s}{\sum_{s=r_j^{US}}^{\bar{r}_j} \kappa_s}\right),$$

where r_j^{end} is the end week of the season window in which movie j is released. Table 5 shows release gaps would be shorter when the need to accumulate word-of-mouth disappears.

Because the number of blockbusters vary across different season windows (some windows have only one blockbuster while others have two), we report the results by different groups. The first two columns of Table 5 report the overall decrease in weeks and percentage of the release gaps across countries. When we include both the one-blockbuster and two-blockbusters season windows, the average release gap will decrease by almost 0.27 weeks (5.39%) across the

Table 5: Release Gap Shortened when Incentives for Word-of-Mouth Disappear

	Overall		One Blockbuster		Two Blockbusters First Mover		Two Blockbusters Second Mover	
Country	Weeks	Percentage	Weeks	Percentage	Weeks	Percentage	Weeks	Percentage
Argentina	-0.1124	-2.1416	-0.1571	-3.0145	-0.0844	-1.5842	-0.0599	-1.1276
Australia	-0.2072	-4.2510	-0.2307	-4.4994	-0.1292	-2.8239	-0.2694	-5.5125
Austria	-0.4572	-8.4023	-0.6273	-11.5240	-0.3321	-6.1522	-0.3878	-7.0849
Belgium	-0.1759	-3.6679	-0.2312	-4.8045	-0.0659	-1.3193	-0.1475	-3.1748
Bolivia	-0.3624	-7.2815	-0.3786	-7.6333	-0.3690	-7.2790	-0.2907	-5.8770
Brazil	-0.4305	-8.5876	-0.5673	-11.1540	-0.2265	-4.5410	-0.2585	-5.5766
Bulgaria	-0.3449	-6.6175	-0.4138	-7.9552	-0.1725	-3.3438	-0.3968	-7.5503
Germany	-0.2643	-4.9046	-0.4539	-8.4272	-0.2023	-3.7501	-0.1603	-2.9769
Hong Kong	-0.2569	-4.8831	-0.2746	-5.2657	-0.3367	-6.2336	-0.0974	-1.8111
Iceland	-0.3028	-5.8987	-0.3538	-6.8999	-0.2928	-5.5956	-0.2313	-4.5999
Japan	-0.2305	-4.5565	-0.2305	-4.5565	N.A.	N.A.	N.A.	N.A.
Mexico	-0.3816	-7.5342	-0.4471	-8.8283	-0.2404	-4.7426	-0.4248	-8.3845
Singapore	-0.0861	-1.6992	-0.0958	-1.8948	-0.0680	-1.3490	-0.0510	-0.9737
Spain	-0.3282	-6.3449	-0.3980	-7.8973	-0.3176	-5.9717	-0.2790	-5.3874
Thailand	-0.3637	-7.9272	-0.4328	-9.4924	-0.2844	-6.1593	-0.1320	-2.6513
Turkey	-0.1968	-3.7559	-0.2628	-5.0656	-0.0689	-1.2815	-0.1764	-3.2833
Uruguay	-0.1703	-3.2108	-0.1774	-3.3852	-0.1223	-2.3049	-0.2024	-3.7242
Mean	-0.2748	-5.3920	-0.3372	-6.6058	-0.2071	-4.0270	-0.2223	-4.3560

17 countries when the incentive to accumulate word-of-mouth disappears.

Columns 3 and 4 report the drop in average release gap (in weeks and in percentage) for season windows with only one blockbuster. Columns 5 to 8 report the results for season windows with two blockbusters, with columns 5 and 6 reporting the release gap decreases for first movers and columns 7 and 8 reporting the release gap decreases for the second movers.

One thing to note is that the drop in release gap is higher in season windows with only one blockbuster. When the need to accumulate word-of-mouth disappears in these windows, the release gaps are, on average, 0.34 weeks (or 6.61%) shorter, while the release gaps would only drop by approximately 0.21 weeks (4.19%) in season windows with two blockbusters.

7.2 Release Gap Effect

To evaluate the release gap effect, we set $\delta(r_j) = 0$ for all r_j and leave $\delta(\bar{r}_j)$ as it is. Essentially, we assume a longer release gap has no effect on the movie fixed effect, $\hat{\theta}_j(r_j)$. We then re-calculate the equilibrium outcomes on release gaps using the new movie fixed effects. Table 6 shows the release gaps would be longer when a longer release gap has no effect on the movie's

fixed effect.

Table 6: Delays of Movie Release When Release Gap Has No Effect

	Overall		One Blockbuster		Two Blockbusters First Mover		Two Blockbusters Second Mover	
Country	Weeks	Percentage	Weeks	Percentage	Weeks	Percentage	Weeks	Percentage
Argentina	0.2627	4.9805	0.3391	6.4656	0.2007	3.7664	0.1872	3.5216
Australia	0.4664	9.5977	0.4071	7.9802	0.3316	6.8587	0.6409	13.4150
Austria	0.4132	7.6090	0.5046	9.2627	0.3401	6.3197	0.3817	7.0083
Belgium	0.6697	13.9787	0.7666	15.8732	0.3844	7.9033	0.7130	15.3179
Bolivia	0.6288	12.6061	0.6312	12.6873	0.6147	12.1267	0.6333	12.7610
Brazil	0.7111	14.5409	0.7506	14.9487	0.5871	12.3118	0.7264	15.6485
Bulgaria	0.5299	10.3005	0.5406	10.4820	0.4933	9.7887	0.5479	10.4947
Germany	0.3430	6.4106	0.4681	8.7325	0.2939	5.4868	0.2827	5.3028
Hong Kong	0.5581	10.7366	0.5838	11.3290	0.5093	9.3604	0.4908	9.4468
Iceland	0.5712	11.4420	0.5360	10.5861	0.5055	9.8461	0.6932	14.4072
Japan	0.6209	12.4254	0.6209	12.4254	N.A.	N.A.	N.A.	N.A.
Mexico	0.5880	12.0705	0.6020	12.3698	0.5735	12.1463	0.5816	11.5457
Singapore	0.5243	10.4497	0.5229	10.3438	0.5749	11.7410	0.4810	9.7407
Spain	0.5424	10.5251	0.5694	11.0460	0.4596	8.7145	0.6020	11.8892
Thailand	1.0940	24.5053	1.1240	25.0186	1.0292	23.6206	1.0235	23.0801
Turkey	0.3405	6.4823	0.3946	7.6153	0.2256	4.2180	0.3334	6.1973
Uruguay	0.2542	4.8065	0.2633	5.0220	0.2376	4.4757	0.2505	4.6523
Mean	0.5364	10.7922	0.5662	11.3052	0.4601	9.2928	0.5356	10.9018

The first two columns of Table 6 report the overall increase in weeks and percentage of the release gaps across countries. When we include both the one-blockbuster and two-blockbusters season windows, the average release gap will increase by 0.54 weeks (10.79%) on average across the 17 countries when the release gap effect disappears. The magnitude of the increase in release gap does not appear to have a strong correlation with the countries' piracy rates. While some countries with high piracy rates, such as Thailand and Brazil, have a bigger increase in average release gaps (24.51% and 14.54%, respectively), and countries with low piracy rates, such as Austria and Germany, have a smaller increase in average release gaps (7.61% and 6.41%, respectively), we also see countries with high piracy rates, such as Uruguay, that have a small increase in average release gaps (4.81%).

Columns 3 and 4 report the average increase in release gaps (in weeks and in percentage) for season windows with only one blockbuster. Columns 5 to 8 report the results for season windows with two blockbusters, with columns 5 and 6 reporting the release gap increases for the first movers and columns 7 and 8 reporting the release gap increases for the second movers.

There are several things to note. First, the impact of the release gap effect is larger in season

windows with only one blockbuster. The increase in release gap in one-blockbuster windows is approximately 0.57 weeks (11.31%), while the increase in release gap in two-blockbusters windows is approximately 0.50 weeks (10.10%) on average. Second, the impacts of the release gap effect are different between first movers and second movers in season windows with two blockbusters. In particular, first movers are less affected by the disappearance of release gap effects. In the absence of release gap effects, first movers (which are also the movies with higher movie fixed effects) would delay their releases in foreign countries by 0.46 weeks (or an increase in delay by 9.29%), while the second movers would delay their releases by 0.54 weeks (or an increase in delay by 10.90%).

8 Conclusion

Our paper sheds further light on the decision of Hollywood studios to enter foreign markets, which is a major source of U.S. exports in services. Our structural approach allows us to disentangle the role played by the release gap, word-of-mouth, and strategic effects on the release gap decision. Using international box office data from Boxofficemojo.com, we show all three factors are important.

Technological changes in production, distribution, and consumption methods continue to affect the movie industry, a major source of U.S. exports in services. The availability of rich micro-level data sets on international box office performance, such as we use in this paper, provides a means to analyze the continuing changes in this dynamic industry.

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