



**STRATEGIC PROMOTION AND RELEASE DECISIONS  
FOR CULTURAL GOODS**

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# Strategic Promotion and Release Decisions for Cultural Goods\*

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## Abstract

We study how producers of cultural goods can strategically increase their promotion budgets to secure the most profitable release dates for their goods. In a game-theoretic setting, where two producers choose their budget before simultaneously setting the release date of their good, we prove that two equilibria are possible: releases are either simultaneous (at the demand peak) or staggered (one producer delays). In the latter equilibrium, the first-mover secures its position by investing more in promotion. We test this prediction on a dataset of more than 1500 American movies released in ten countries over 13 years. Our empirical analysis confirms that higher budgets allow movie studios to move release dates closer to demand peaks.

*Keywords:* Non-price competition, Strategic promotion, Strategic timing, Motion pictures.

*JEL-Classification:* L13, L82

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# 1 Introduction

Since the extraordinary successes of *Jaws* in the summer of 1975 and *Star Wars* two summers later, the big Hollywood studios have increasingly chosen to release their would-be blockbusters in the United States during the summer period (starting Memorial Day weekend, at the end of May), when a bigger audience is available (because kids are out of school, adults are on vacation, and heat waves drive them all inside air-conditioned theaters). This trend culminated in the summer of 2013 with the release of 31 movies aiming at a large audience.<sup>1</sup> Although summer 2013 outperformed the previous summer in terms of overall box-office revenues, it is not really surprising that an important number of these 31 movies flopped.

To avoid a repeat of such a congested release schedule and its resulting head-to-head competition, some studios decided to make summer 2014 start earlier: Walt Disney, 21st Century Fox and Time Warner made their potential blockbuster debut in April.<sup>2</sup> They may have been inspired by some previous successful releases that took place outside the summer months.<sup>3</sup> Yet, even though the scheduling of movie releases looked smarter in 2014, summer 2015 was congested again and the same is likely to go for 2016 with speculations about a possible clash of superheroes in May.<sup>4</sup>

These recent events demonstrate that choosing release dates is a major strategic issue for movie studios, which places them in a configuration that resembles a game of chicken: all studios want to have their movies released in periods of large audience and although none of them is willing to yield, they all admit that spacing out releases is preferable. Release decisions are all the more important that movie studios do not seem to compete in prices. It is

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<sup>1</sup>Rampell (2013) reports that each of these 31 movies played on at least 3,000 screens in the US; over the previous decade, only an average of 23.3 movies reached the same distribution scale during the corresponding period.

<sup>2</sup>Respectively *Captain America: The Winter Soldier*, *Rio 2*, and *Transcendence*.

<sup>3</sup>For example, *The Hunger Games* in March 2012, *Gravity* in October 2013 or *The Lego Movie* in February 2014.

<sup>4</sup>“Following the recent announcement that *Captain America 3* was not moving from the May 2016 release window despite the opening of WB’s *Man of Steel* sequel (dubbed *Batman vs. Superman*), Warner Bros. president of domestic distribution, Dan Feldman, basically told Bloomberg that Marvel can move their release because they have no plans to do so: ‘It doesn’t make a lot of sense for two huge superhero films to open on the same date but there is a lot of time between now and 5/6/16. However at this time, we are not considering a change of date for *Batman vs. Superman*.’” (quoted in Kendrick, 2014)

indeed observed that ticket prices are generally uniform and relatively stable over time and across locations (see Orbach and Einav, 2007, and Chisholm and Norman, 2012). As Einav (2007, pp. 127) summarizes, “[w]ith virtually no price competition, the movie’s release date is one of the main short-run vehicles by which studios compete with each other.”

Other cultural industries share the same features: no (or limited) price competition, demand seasonality and strategic release decisions. Take for instance the market for literary works in France. First, price competition was neutralized in 1981 when a Fixed Book Price law was passed; second, the end-of-year holidays are traditionally the period when book sales culminate; third, the lion’s share of novels are released during the ‘*Rentrée littéraire*’, a period that spans from late August to early September.<sup>5</sup> Inevitably, clashes among closed competitors become more likely during this congested period, which may drive editors to reschedule the release date of their book.<sup>6</sup> Similar patterns can be observed for the release of video games or music albums.

The question that naturally arises is how producers of cultural goods can turn the odds in their favor in this game of chicken. Product pre-announcement may be a strategy. For instance, Keyes (2014) reports that “Marvel studios has mapped out films all the way to 2028” adding, however, that “[t]he roadmap of projects doesn’t necessarily mean that specific films are locked in with potential dates or a strict release order.” Yet, one can doubt that producers have sufficient commitment power to make such pre-announcements credible. Moreover, if an announcement turns out to be (intentionally or unintentionally) false, the producer’s reputation may be damaged.<sup>7</sup>

Producers of cultural goods must thus find other means to scare off the

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<sup>5</sup>Two reasons drive editors to favor this period; first, they want to initiate positive word-of-mouth for their books before the end-of-year holidays; second, they want to place their books in good order for the various book prizes (e.g., ‘*Prix Goncourt*’) that are awarded from September to November (as winning one of these prizes may substantially boost sales).

<sup>6</sup>As anecdotal evidence, in Belgium in October 2012, two books about the royal family were ready to be released at the same period but one of them made the choice to delay the release (the publisher gave several reasons but observers suggested that the main reason was to avoid head-to-head competition with the other book on the same topic that was released a few days before).

<sup>7</sup>The derisive term ‘vaporware’ is used to designate such announced products that are released far behind schedule (or never released); Dietz (2011) lists vaporware video games.

competition and keep the most profitable release dates for themselves. In this paper, we argue that promotion budgets can play this role. We first develop our argument in a simple game-theoretic model, where two producers of cultural goods choose their promotion budget before simultaneously setting the release date of their good. Assuming that the size of the potential demand decreases with time and that the life cycle of goods has a given length, we show that two equilibrium configurations are possible: either both producers release their good immediately (i.e., when demand peaks), or one producer releases its good at the peak while the other producer only releases its good once the life cycle of the first good is over. Interestingly, in the equilibrium with staggered release, the first-mover invests more in promotion than the second-mover (whereas in the equilibrium with simultaneous release, both producers invest the same amount). As a larger budget allows a producer to ‘steal’ part of the demand at the rival’s expense, we see that investing heavily in promotion may allow a producer to credibly secure the most profitable release date for itself. Our model also allows us to identify a number of factors that make staggered release more likely (and, conversely, simultaneous release less likely). In particular, we expect producers of cultural goods to space out more their releases if their goods are closer substitutes (e.g., because they belong to the same genre), if demand does not decay too fast after the peak, and if investment in promotion is less costly.

In the second part of the paper, we apply our theoretical model to the movie market and we bring its predictions to the data. Using information from *Box Office Mojo*, we compiled a dataset of more than 1500 American movies released over a thirteen-year period (from January 1, 2001 to December 31, 2013) in ten countries. For each movie, the data includes the following information: the official release dates, total box-office revenues, production costs, the genre of the movie, whether it is a sequel (or not), and the studio producing and distributing the movie. To verify whether movies with bigger budgets tend to be released closer to the demand peaks, we first identify the demand peaks in each season in the various countries. Then, we define our dependent variable as the number of weeks that separates the release date of movie  $m$  from the nearest demand peak. As independent variables, we include the budget of movie  $m$ , as well as the sums of the budgets of the other movies released during the same week, distinguishing

between movies of the same genre as  $m$  and movies of other genres; the last two variables are meant to measure the influence of competition. Finally, we regress this model using an OLS approach, controlling for country fixed-effects.

Our empirical analysis largely confirms the predictions of the theoretical model. In particular, we show that movies with larger budgets tend to be released closer to the seasonal peaks. We also find that an increase in the total budgets of competing movies moves the release date closer to the seasonal peak, and that this effect is larger for movies of the same genre than for movies of other genres. A number of robustness checks allow us to establish the validity of these results.

The remainder of the paper is organized as follows. In Section 2, we review the literature and stress the novelty of our contribution. In Section 3, we develop our theoretical model, from which we draw a number of hypotheses that we test and discuss in Section 4. We conclude in Section 5.

## 2 Related literature

Movies are, by far, the cultural goods that have attracted the largest body of academic research, both in economics and in marketing. This is not surprising given the economic importance of the movie industry, the set of interesting issues that it raises (because of its complex production process and its uncertain demand) and the large availability of data sources. The purpose of this section is by no means to review this literature.<sup>8</sup> Our goal here is to show that, despite the extensive research on the movie industry, very few papers have considered the strategic aspect of release decisions and no paper so far (to the best of our knowledge) has dealt with the issue that we study in this paper, namely the interplay between budgeting and release decisions in a competitive setting.

A busy strand of the empirical literature on movies aims at estimating the demand for movies and the determinants of box-office revenues. Among these determinants, the simultaneous release of similar movies (same genre or same targeted audience) is shown to have a negative effect (see Ainslie *et al.*, 2005, Basuroy *et al.*, 2006, and Calantone *et al.*, 2010). Recently,

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<sup>8</sup>We refer the interested reader to the complementary surveys of Eliashberg *et al.* (2006), Hadida (2009) and McKenzie (2012).

Gutierrez-Navratil *et al.* (2014) study to what extent box-office revenues are affected by the temporal distribution of rival films. Using data on movies released in five countries (USA, UK, France, Germany and Spain), they show that the effect of contemporary rivals is always larger than that of previously released movies or future rivals.

In the minority of papers that adopt an industrial organization perspective and explicitly incorporate strategic issues, a number of papers consider release decisions as the main strategic variables. However, the focus is often on the so-called ‘release window’, i.e., the sequence of release dates of a given movie through different distribution channels (movie theater, on-demand, DVD, cable TV, terrestrial TV). These papers argue that decisions about the release window are mainly driven by three effects: piracy (Danaher and Waldfogel, 2012), word-of-mouth (Moul, 2007) and substitution across versions (Calzada and Valetti, 2012). The analyses of the optimal release window are either purely empirical or, if theoretical, they adopt a monopoly framework. A notable exception is Dalton and Leung (2013), who consider another strategic determinant of the choice of release window, namely the incentive for studios to avoid releasing blockbusters at the same dates.<sup>9</sup>

Only a few papers study, as we do, studios’ choice of the premiere release date in a competitive setting. The closest in spirit to our paper is Krider and Weinberg (1998). They consider the competition between two movies in a share attraction framework and conduct an equilibrium analysis of the product introduction timing game; they test their model examining the 24 major movies released during the 1990 summer season. Our analysis goes much further by endogenizing the budget decision in the theoretical model and by testing the results on a much wider dataset. Close to our empirical part is Einav (2010), who develops an empirical model to study the movie release date timing game; he finds that released dates are too clustered around big holiday weekends and that box office revenues would increase if distributors shifted some holiday released by one or two weeks. Finally, Cabral and Natividad (2015) show, both theoretically and empirically, the importance for a movie’s future success of leading the box office during the opening weekend (because being number one induces a greater awareness

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<sup>9</sup>They use a discrete choice release gap decision game model to disentangle the impacts of this strategic effect from the effects of piracy and word-of-mouth. Their results suggest that all three factors have an economically significant impact on distributors’ release window decision.



among potential viewers); although this paper does not directly consider release decisions, it stresses another reason for which studios are likely to fight to release their movies close to demand peaks.

As for other cultural goods, we only found one paper that relates to our analysis. Engelstätter and Ward (2013) study the strategic release decisions of video game publishers. The results of their empirical analysis suggest that publishers adjust the release dates of their games so as to avoid weeks where competition within their niche is strong. No link is made, however, between release decisions and promotion or marketing expenditures.

### 3 A theoretical model of competition in cultural industries

In this section, we present our theoretical model, which depicts a two-stage competition between two producers of cultural goods. We first describe the setting and discuss the relevance of our assumptions. Then, proceeding by backward induction, we analyze the (short-term) choice of release dates before turning to the (long-term) choice of promotional efforts.

#### 3.1 The setting

Our objective is to build a reasonably simple model that captures what we believe are the main features of several cultural industries: (i) the absence of price competition; (ii) a seasonal and fast-decaying demand; and (iii) intertwined promotion and release decisions.

Regarding the first point, we observe that in contrast with most other industries, *price is not the main strategic variable* for cultural goods. As argued in the introduction, this may be due to specific legislations or industry-wide agreements that fix prices (as is common for books in Europe; see, e.g., Ringstad, 2004), or because prices are chosen by third parties in accordance with their own strategic motives (as is the case for movie tickets).<sup>10</sup>

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<sup>10</sup>Einav (2007, p. 129) explains that the motion picture industry “is dominated by the major studios that have integrated production and distribution”, whereas “with few exceptions, exhibitors are not vertically integrated with producers or distributors” (vertical disintegration is even the rule in the U.S. after a series of court orders that were taken in the late 1940s). McKensie (2008, p. 80) explains that exhibitors “have an incentive to hold down (relatively speaking) all ticket prices in order to increase the demand for popcorn (and other concessions).” Hartmann and Gil (2009) establish empirically that exhibitors do

As far as the shape of demand is concerned, *seasonality* plays an important part for many cultural goods. There are periods of the year that are more conducive to consuming cultural goods, because of availability (vacations, holidays), climate (for instance, air-conditioned theaters are more attractive during the hot summer days), or a specific context (such as upcoming awards or prizes).<sup>11</sup> Another characteristic of the demand for cultural goods is that it is usually *short-lived* as consumers have a strong taste for novelties.<sup>12</sup>

The seasonal and transient nature of demand for cultural goods make release decisions highly strategic. As Cartier and Liarte (2012, p. 17) write: “[t]o ensure the success of new cultural offerings, companies are encouraged to choose a release date that corresponds to a particularly favourable time slot in terms of demand.” Yet, as all producers make the same reasoning and as cultural goods are inherently experience goods, release decisions cannot be decoupled from promotion decisions.<sup>13</sup>

The interplay between promotion and release decisions lies at the heart of our model. We consider indeed the competition between two cultural goods supplied by two different producers.<sup>14</sup> Producers (indexed by  $i, j \in \{1, 2\}$ ) compete in two stages. At period 0, they choose their promotion budget  $b_i, b_j \in [0, 1]$ . At the end of period 0, after observing the budgets, they choose the release date of their good,  $t_i, t_j \geq 1$ , where  $t_i = 1$  (resp.  $t_i > 1$ )

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indeed resort to price discrimination through metering (theaters can ‘meter’ the surplus that can be extracted from a customer by how much of popcorn and other concessions they demand).

<sup>11</sup>As for movies, the usual demand peaks are the festive season, early May and the summer, with the addition of public holidays (we return in detail on this in Section 4). Demand for books also peaks at the end of the year (see, e.g., Gaffeo *et al.* (2008) for an empirical confirmation); the same applies for video games, whose demand also peaks when the school period is over (as reported by Engelstätter and Ward, 2013).

<sup>12</sup>Regarding movies, Einav (2007, p. 129) reports that “the first week accounts for almost 40% of total domestic box-office revenues on average.” As for video games, Engelstätter and Ward (2013, p. 3) write that “[s]ales for an individual product are strongest immediately after launch but fall quickly.”

<sup>13</sup>In our analysis, promotion will be widely understood as any activity aimed at capturing the attention of consumers and at signaling the quality of the cultural good and/or its potential fit to the tastes of the consumers; that is, promotion encompasses not only media advertising and other marketing tools (point of sale display, public relations, event planning, etc) but also the hiring of famous cast or director or costly special effects for movies, or higher quality graphics for video games.

<sup>14</sup>We discuss in Section 4.3 the case where the same producer supplies the two goods.

means that the good is released at the start of (resp. later in) the sales period.<sup>15</sup>

The number of consumers (readers, viewers, or gamers) that a particular good attracts at a particular date depends on a number of factors: (i) the budget decisions of the producers; (ii) the number of goods on sales at the same date; (iii) the degree of similarity between the two goods; and (iv) the date itself. Letting  $n_i(t, b_i, b_j)$  denote the expected number of consumers for good  $i$  at date  $t$  given the budgets  $(b_i, b_j)$ , we assume:

$$n_i(t, b_i, b_j) = \begin{cases} h(1 + b_i) Nt^{-\alpha} & \text{if } i \text{ is the only good on sale,} \\ h(1 + b_i - \beta b_j) Nt^{-\alpha} & \text{if both goods are on sale,} \end{cases} \quad (1)$$

with  $N > 0$ ,  $h \leq \frac{1}{2}$ ,  $b_i, b_j \in [0, 1]$ ,  $\alpha > 0$  and  $0 \leq \beta \leq 1$ .

The demand function (1) should be understood as follows. First, the potential audience for any good at date  $t$  is equal to  $Nt^{-\alpha}$ , where  $N$  is the number of consumers (each consumer may buy up to one unit of each good). That is, the audience is the largest at date  $t = 1$  (i.e., just after the budgets have been spent) and then it decreases at rate  $\alpha > 0$  per unit of time, as the interest for cultural goods fades away as time goes by.

Second, each good has an ex ante probability  $h \leq \frac{1}{2}$  of being chosen by any consumer. Producer  $i$  can increase this ex ante probability by spending more on promotion, i.e., by raising  $b_i$ . The ex post probability is indeed given by  $h(1 + b_i)$  when good  $i$  is the only one on sale. However, if producer  $j$  releases its good in the same period, the ex post probability that consumers will decide to consume good  $i$  is given by  $h(1 + b_i - \beta b_j)$ .<sup>16</sup> That is, by raising its budget ( $b_j$ ), producer  $j$  makes it *less* likely that good  $i$  will be chosen.<sup>17</sup> The influence of the other producer's budget depends on the

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<sup>15</sup>This sequence of decision corresponds to what is observed in the movie industry: as noted by Vanderhart and Wiggins (2001), the advertising campaign starts before the movie release date and culminates at the time the movie is released. Einav (2002) also notes that distributors tend to pre-announce the release date of their movies so as to scare off the competition, and that this practice is more common for movies with larger budgets. This suggests again that budget decisions are made before release decisions and with a view to influence them. In the model, we assume that once release dates are chosen, they cannot be modified at a later stage. In reality, as reported, e.g., by Einav (2010) and Dürr *et al.* (2014), it is not uncommon that studios reschedule the release dates of their movies. We discuss this further in Section 4.3.

<sup>16</sup>The assumptions that  $h \leq 1/2$  and  $b_i, b_j \in [0, 1]$  make sure that this ex post probability is positive and lower than one.

<sup>17</sup>We assume thus that promotion has, as defined by Marshall (1919), a “combative role”

degree of similarity (or substitutability) between the two goods, which is parametrized by  $\beta \in [0, 1]$ . At one extreme,  $\beta = 0$  means that the goods are totally differentiated, so that the audience for good  $i$  is not affected by the budget of good  $j$ . At the other extreme,  $\beta = 1$  means that the goods are perfect substitute, so that if both producers choose the same budget, they exactly neutralize each other. In the case of movies, an example for the former case could be one teen comedy and one documentary on astrology, while an example of the latter case could be two superhero movies telling similar stories, and having equally popular casts.<sup>18</sup>

We assume that the two cultural goods have the same life cycle (i.e., the period during which they are on sale), which is exogenously set to be equal to  $s > 0$ .<sup>19</sup> As prices are fixed, we assume that the margin that a producer gets from each purchase of its good is fixed and equal to  $m > 0$ . Hence, the profit of producer  $i$  at date  $t$  is given by

$$\pi_i(t, b_i, b_j) = \begin{cases} mhN(1 + b_i)t^{-\alpha} & \text{if } i \text{ is the only good on sale,} \\ mhN(1 + b_i - \beta b_j)t^{-\alpha} & \text{if both goods are on sale.} \end{cases}$$

We see that profits are scaled by the constant  $mhN$ . Without any loss of generality, we can set  $mhN = 1$  for the rest of the analysis. For the sake of simplicity, we assume that there is no discounting.<sup>20</sup> We can now express the flow of profits for producer  $i$  as a function of the promotional efforts and

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as it helps producers steal each other's audience. Cartier and Liarte (2012, p. 25) provide an illustration of how movie studios resort to such combative promotion: "studios will try to pre-empt the resources necessary for marketing and distributing a film (advertising space, large number of prints made available to theatres, based on the film's potential) and will allocate a bigger budget than usual."

<sup>18</sup>Under this formulation, if the two goods are on sale, the total number of consumers for the two goods at a given date  $t$  is given by  $T_t \equiv Nt^{-\alpha}h(2 + (1 - \beta)(b_i + b_j))$ . When goods are perfect substitutes ( $\beta = 1$ ),  $T_t = 2hNt^{-\alpha}$ ; with  $h = 1/2$ , we have that  $T_t = Nt^{-\alpha}$ , meaning that each consumer purchases exactly one good (the relative market share of each good being determined by  $b_i$  and  $b_j$ ). When goods are totally differentiated ( $\beta = 0$ ),  $T_t = hNt^{-\alpha}(2 + b_i + b_j)$ ; with  $h = 1/2$  and  $b_i = b_j = 1$  (maximum promotion), we have that  $T_t = 2Nt^{-\alpha}$ , meaning that all consumers purchase both goods. Our formulation of demand is thus based on the idea that consumers love variety.

<sup>19</sup>For instance, in the case of movies, Einav (2007, p. 130) notes that "[t]ypically, a theater screens a movie for six to eight weeks."

<sup>20</sup>Somehow, discounting is already included in the decaying interest for goods over time.

release dates chosen by the two producers:

$$\pi_i(t_i, t_j) = \begin{cases} \pi_a \equiv \int_{t_i}^{t_i+s} (1 + b_i) \tau^{-\alpha} d\tau & \text{if } 1 \leq t_i \leq \max\{t_j - s, 1\}, \\ \pi_b \equiv \int_{t_i}^{t_j} (1 + b_i) \tau^{-\alpha} d\tau + \int_{t_j}^{t_i+s} (1 + b_i - \beta b_j) \tau^{-\alpha} d\tau & \text{if } \max\{t_j - s, 1\} \leq t_i \leq t_j, \\ \pi_c \equiv \int_{t_i}^{t_j+s} (1 + b_i - \beta b_j) \tau^{-\alpha} d\tau + \int_{t_j+s}^{t_i+s} (1 + b_i) \tau^{-\alpha} d\tau & \text{if } t_j \leq t_i \leq t_j + s, \\ \pi_d \equiv \int_{t_i}^{t_i+s} (1 + b_i) \tau^{-\alpha} d\tau & \text{if } t_j + s \leq t_i. \end{cases}$$

In segments  $\pi_a$  and  $\pi_d$ , producer  $i$  enjoys exclusivity, either because it releases its good sufficiently before ( $\pi_a$ ) or sufficiently after ( $\pi_d$ ) producer  $j$ ; note that segment  $\pi_a$  only appears if  $t_j > 1 + s$ . In segments  $\pi_b$  and  $\pi_c$ , the life cycles of the two goods overlap, with good  $i$  being released either before ( $\pi_b$ ) or after ( $\pi_c$ ) good  $j$ .

We solve the game backwards for its subgame-perfect equilibria. Accordingly, we first consider the Nash equilibrium in terms of release dates for given budgets.

### 3.2 Release decision

We show here that only two equilibrium configurations are possible: either both producers release their good at the very first date ( $t_1^* = t_2^* = 1$ ) or one producer releases its good immediately while the other producer waits for the end of the life cycle of the first to release its own, i.e.,  $t_i^* = 1$  and  $t_j^* = 1 + s$ . We call the former configuration “simultaneous release” and the latter “staggered release”. We establish this result with the help of the following two lemmas. (All proofs are mostly technical and are therefore relegated to the appendix.)

**Lemma 1** *Producer  $i$ 's best response to  $t_j \geq 1$  is either  $t_i^*(t_j) = 1$  or  $t_i^*(t_j) = t_j + s$ .*

According to Lemma 1, the best conduct for a producer is to release its good either immediately or just after the other producer's good ceases to be sold. This result follows from the fact that segments  $\pi_a$ ,  $\pi_b$ , and  $\pi_d$  decrease with  $t_i$ , while segment  $\pi_c$  reaches its largest value at one of the extremities of the zone where it is defined (i.e., at either  $t_i = t_j$  or  $t_i = t_j + s$ ).

We now show that if the other producer sufficiently delays the release of its good, then it is best to release immediately.

**Lemma 2** *If  $t_j \geq 1 + s$ , then producer  $i$ 's best response is  $t_i^*(t_j) = 1$ .*

This result is very intuitive: if the other producer releases its good after date  $t = 1 + s$ , it is possible to avoid upfront competition for the full life cycle by releasing one's good sufficiently earlier than the other producer does; moreover, as interest decays with time, it is optimal to release the good as soon as possible, i.e., at date  $t = 1$ .

While Lemma 1 suggested that four equilibrium configurations were possible (as each producer's reaction function is made of two dates), Lemma 2 discards one possibility: both firms releasing their good at date  $t = 1 + s$  cannot be an equilibrium. There does remain three possibilities: simultaneous release ( $t_1^* = t_2^* = 1$ ) and staggered release ( $t_1^* = 1$  and  $t_2^* = 1 + s$ , or  $t_1^* = 1 + s$  and  $t_2^* = 1$ ). To establish the conditions under which one or the other configuration emerges at equilibrium, we introduce the following pieces of notation:

$$v_1 \equiv \int_1^{1+s} \tau^{-\alpha} d\tau = \begin{cases} \frac{(1+s)^{1-\alpha} - 1}{1-\alpha} & \text{for } \alpha \neq 1, \\ \ln(1+s) & \text{for } \alpha = 1, \end{cases}$$

$$v_s \equiv \int_{1+s}^{1+2s} \tau^{-\alpha} d\tau = \begin{cases} \frac{(1+2s)^{1-\alpha} - (1+s)^{1-\alpha}}{1-\alpha} & \text{for } \alpha \neq 1, \\ \ln(1+2s) - \ln(1+s) & \text{for } \alpha = 1. \end{cases}$$

These values should be interpreted as follows: recalling that  $mNh$  is set equal to 1,  $v_1$  (resp.  $v_s$ ) is the expected profit for a good released at date  $t = 1$  (resp.  $t = s$ ) when is the only one on sale during the whole life cycle and when budgets are zero. Naturally, as interest for goods decays over time, we have that  $v_1 > v_s$ . It is also clear that both  $v_1$  and  $v_s$  decrease with  $\alpha$ : as demands decays faster, the cumulated audience decreases. Also, the ratio  $v_s/v_1$  decreases with  $\alpha$ .

Suppose that  $t_j = 1$ . Then producer  $i$ 's best response is to choose  $t_i = 1$  if and only if  $\pi_b(1, 1) \geq \pi_c(1 + s, 1)$ , or

$$\begin{aligned} \int_1^{1+s} (1 + b_i - \beta b_j) \tau^{-\alpha} d\tau &\geq \int_{1+s}^{1+2s} (1 + b_i) \tau^{-\alpha} d\tau \Leftrightarrow \\ (1 + b_i - \beta b_j) v_1 &\geq (1 + b_i) v_s \Leftrightarrow \\ (1 + b_i) \beta_0 &\geq \beta b_j, \end{aligned}$$

where  $\beta_0 \equiv 1 - v_s/v_1$ . The threshold  $\beta_0$  can be interpreted as follows: in the worst-case scenario where  $t_j = b_j = 1$  and  $b_i = 0$ , producer  $i$  prefers simultaneous release (yielding  $(1 - \beta)v_1$ ) to staggered release (yielding  $v_s$ ) if  $\beta \leq \beta_0$ . With this interpretation in mind, one understands easily that the latter inequality is always satisfied if  $\beta \leq \beta_0$ . We can therefore already conclude that when the two goods are not too similar (i.e., when  $\beta \leq \beta_0$ ), simultaneous release is the only equilibrium configuration for any pair of promotional efforts.

When goods are closer substitutes (i.e., when  $\beta > \beta_0$ ), then four equilibrium configurations are possible, as illustrated in the three panels of Figure 1 and characterized in the next proposition.<sup>21</sup>

**Proposition 1** (1) For  $\beta \leq \beta_0 = 1 - (v_s/v_1)$ ,  $(t_1^*, t_2^*) = (1, 1)$  for all  $b_1, b_2 \in [0, 1]^2$ . (2) For  $\beta_0 < \beta < 2\beta_0$ , we have  $(t_1^*(b_1, b_2), t_2^*(b_1, b_2)) \in$

$$\begin{cases} \{(1, 1)\} & \text{if } \frac{\beta}{\beta_0}b_2 - 1 \leq b_1 \leq \frac{\beta_0}{\beta}(1 + b_2), \\ \{(1, 1 + s)\} & \text{if } b_1 \geq \frac{\beta_0}{\beta}(1 + b_2), \\ \{(1 + s, 1)\} & \text{if } b_1 \leq \frac{\beta}{\beta_0}b_2 - 1. \end{cases}$$

(3) For  $\beta > 2\beta_0$ , we have  $(t_1^*(b_1, b_2), t_2^*(b_1, b_2)) \in$

$$\begin{cases} \{(1, 1)\} & \text{if } \frac{\beta}{\beta_0}b_2 - 1 \leq b_1 \leq \frac{\beta_0}{\beta}(1 + b_2), \\ \{(1, 1 + s)\} & \text{if } b_1 \geq \max\left\{\frac{\beta}{\beta_0}b_2 - 1, \frac{\beta_0}{\beta}(1 + b_2)\right\}, \\ \{(1 + s, 1)\} & \text{if } b_1 \leq \min\left\{\frac{\beta}{\beta_0}b_2 - 1, \frac{\beta_0}{\beta}(1 + b_2)\right\}, \\ \{(1, 1 + s), (1 + s, 1)\} & \text{if } \frac{\beta_0}{\beta}(1 + b_2) \leq b_1 \leq \frac{\beta}{\beta_0}b_2 - 1. \end{cases}$$

We see from Proposition 1 and the top-right panel of Figure 1 that staggered release ( $t_i^* = 1, t_j^* = 1 + s$ ) requires two conditions: on the one hand, the two goods must be sufficiently similar ( $\beta > \beta_0$ ) and, on the other hand, the producers must have chosen relatively dissimilar budgets. To be more precise, a producer may force the rival to postpone the release of its good by

<sup>21</sup>Krider and Weinberg (1998) reach a similar result using a slightly different timing game. These results are also consistent with what Einav (2007, p. 129) concludes from his observation of the US motion picture industry: “The two important considerations for the release date are the strong seasonal effects in demand and the competition that will be encountered throughout the good’s run. Typically, goods with higher expected revenues are released on higher (perceived) demand weekends, and there is a tradeoff between the seasonal and the competition effects.”

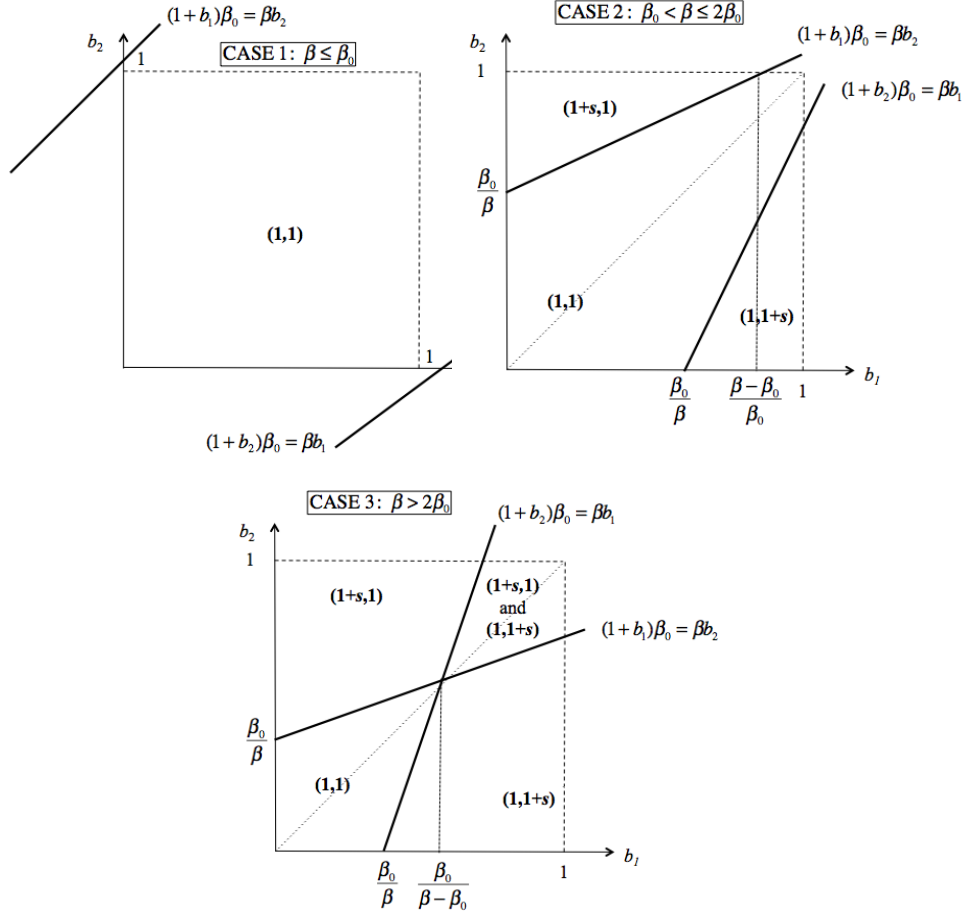


Figure 1: Equilibrium release dates

choosing a budget that is sufficiently larger than the rival's. The required difference in budgets becomes smaller as goods become closer substitutes. At some point ( $\beta > 2\beta_0$ ), staggered release may occur at equilibrium even if both producers choose the same budget; in that case, the similarity between the goods is so large that avoiding simultaneous release is the main motivation for both producers, resulting in the coexistence of the two staggered equilibria.

### 3.3 Budgeting decision

Our goal is to analyze how producers choose the budget for their good, anticipating the equilibrium release dates that will ensue. We assume that



costs are convex:  $C(b_i) = (\gamma/2)b_i^2$ , where  $\gamma > 0$  is an inverse measure of the efficiency of the promotion technology. If  $\beta \leq \beta_0$ , the first stage is extremely simple as a unique equilibrium obtains in the second stage. Firm  $i$  chooses its budget  $b_i$  to maximize  $(1 + b_i - \beta b_j)v_1 - (\gamma/2)b_i^2$ . The optimum is  $b_i = v_1/\gamma$ . To guarantee  $b_i \leq 1$ , we assume that  $\gamma > v_1$ . At the other extreme, when  $\beta > 2\beta_0$ , a full characterization of the first-stage equilibrium is not possible as there exist couples  $(b_1, b_2)$  leading to subgames where multiple equilibria obtain, meaning that producers cannot predict the ensuing equilibrium release dates. In what follows, we rule out this case by assuming that  $2\beta_0 \geq 1$ .<sup>22</sup> We therefore focus here on the case where  $\beta_0 < \beta \leq 1$ .

### 3.3.1 Equilibrium with simultaneous release

If simultaneous release is the second-stage equilibrium, the producers invest  $b_1 = b_2 = v_1/\gamma$  and their profits are

$$\pi_1^{im} = \pi_2^{im} = \left(1 + (1 - \beta) \frac{v_1}{\gamma}\right) v_1 - \frac{\gamma}{2} \left(\frac{v_1}{\gamma}\right)^2.$$

Two conditions are needed for this to be a subgame-perfect equilibrium. First, it must be that  $(b_1, b_2) = (v_1/\gamma, v_1/\gamma)$  does indeed lead to  $(t_1, t_2) = (1, 1)$  in the second stage. We see from Figure 1 that this is always true for  $\beta_0 < \beta \leq 1$  as the main diagonal is included in the area where  $(t_1, t_2) = (1, 1)$  is the second-stage equilibrium.

The second condition is that no firm finds it profitable to trigger a change of second-stage equilibrium from simultaneous to staggered release. Without loss of generality, consider producer 1. If the second-stage equilibrium is  $(1, 1 + s)$ , then producer 1's maximization program is  $\max_{b_1} (1 + b_1)v_1 - (\gamma/2)b_1^2$ . So, the unconstrained optimum is  $v_1/\gamma$  but this value does not satisfy the constraint that must be met to be in the  $(1, 1 + s)$  zone.<sup>23</sup> So, producer 1 chooses the smallest value of  $b_1$  that meets the constraint, i.e.,

$$b_1^d = \frac{\beta_0}{\beta} \left(1 + \frac{v_1}{\gamma}\right).$$

<sup>22</sup>We show in Appendix 6.3 that this assumption is consistent with the observation that the first week of exploitation of a movie accounts, on average, for almost 40% of the total box-office revenues (Einav, 2007, p. 129).

<sup>23</sup>We need  $\beta b_1 \geq (1 + b_2)\beta_0$ . With  $b_1 = b_2 = v_1/\gamma$ , the condition becomes  $v_1/\gamma \geq \beta_0/(\beta - \beta_0)$ , which is impossible under our assumptions that  $\beta < 2\beta_0$  and  $v_1/\gamma < 1$ .

The corresponding profit is computed as

$$\pi_1^d = \left(1 + \frac{\beta_0}{\beta} \left(1 + \frac{v_1}{\gamma}\right)\right) v_1 - \frac{\gamma}{2} \left(\frac{\beta_0}{\beta} \left(1 + \frac{v_1}{\gamma}\right)\right)^2.$$

Comparing  $\pi_1^{im}$  and  $\pi_1^d$  allows us to state the following result.

**Lemma 3** *If  $\beta_0 < \beta \leq 1$ , the subgame-perfect equilibrium is  $(b_1^*, b_2^*; t_1^*, t_2^*) = (v_1/\gamma, v_1/\gamma; 1, 1)$ , involving simultaneous release, if and only if*

$$\frac{v_1}{\gamma} \leq \beta_0 \frac{\beta\sqrt{2\beta} - \beta + \beta_0}{\beta^2(2\beta - 1) + \beta_0(2\beta - \beta_0)}. \quad (2)$$

It is clear that the LHS of condition (2) decreases if  $v_1$  decreases (which can result from an increase in  $\alpha$ ) or if  $\gamma$  increases. As for the RHS, simple derivations show that it increases if  $\beta$  decreases or if  $\beta_0$  increases. Recalling that  $\beta_0 = 1 - v_s/v_1$ , we have that an increase in  $\beta_0$  is caused by a decrease in the ratio  $v_s/v_1$  (which can itself be caused by an increase in  $\alpha$ ). We can therefore conclude that an equilibrium with simultaneous release is more likely (i) the larger  $\gamma$ , (ii) the smaller  $\beta$ , and (iii) the larger  $\alpha$ . All these results confirm the intuition: (i) if it is more costly to produce and promote a good (larger  $\gamma$ ), forcing the rival to delay the release of its good becomes less profitable; (ii) if goods are less similar (smaller  $\beta$ ), being sold at the same time hurts less; (iii) if demand decays faster (larger  $\alpha$ ), simultaneous release is more attractive even if it implies being sold at the same time.

### 3.3.2 Equilibrium with staggered release

Suppose that producer 1 releases its good at  $t_1 = 1$ , and producer 2 at  $t_2 = 1 + s$ . As long as these release dates are maintained, it is easily seen that the two producers will choose their budget as  $(b_1, b_2) = (v_1/\gamma, v_s/\gamma)$ , leading to the following profits:

$$\pi_1^{st} = \left(1 + \frac{v_1}{\gamma}\right) v_1 - \frac{\gamma}{2} \left(\frac{v_1}{\gamma}\right)^2, \pi_2^{st} = \left(1 + \frac{v_s}{\gamma}\right) v_s - \frac{\gamma}{2} \left(\frac{v_s}{\gamma}\right)^2.$$

For these strategies to be part of a subgame-perfect equilibrium, it must first be the case that the budgets  $(b_1, b_2) = (v_1/\gamma, v_s/\gamma)$  generate  $(1, 1 + s)$  as second-stage equilibrium. From Proposition 1, this is so as long as

$$\frac{v_1}{\gamma} \geq \frac{\beta_0}{\beta} \left(1 + \frac{v_s}{\gamma}\right). \quad (3)$$

Second, we must check that no producer has an incentive to choose a budget that would lead to another second-stage equilibrium. It is first easy to show that the producer that releases its good first does not have any profitable deviation. This result is not surprising as releasing its good at date  $t = 1$  and facing no competition appears as the best possible scenario. Consider now the producer that releases its good at date  $t = 1 + s$  (producer 2 here). Referring to Figure 1, we see that two deviations are theoretically possible: producer 2 can change the equilibrium release dates either to  $(1, 1)$  or to  $(1 + s, 1)$ . However, we show in the appendix that the latter option is never feasible. As for the deviation to  $(1, 1)$ , we show that it is not only feasible but it can also be profitable. To make this deviation not profitable, condition (4) must be imposed, which is more stringent than condition (3). The next lemma summarizes our results.

**Lemma 4** *If  $\beta_0 < \beta \leq 1$ , the subgame-perfect equilibrium is  $(b_i^*, b_j^*; t_i^*, t_j^*) = (v_1/\gamma, v_s/\gamma; 1, 1 + s)$ , involving staggered release, if and only if*

$$\frac{v_1}{\gamma} \geq \frac{2\beta_0}{\beta_0^2 + 2(\beta - \beta_0)}. \quad (4)$$

In terms of comparative statics, we expect the opposite results than in the previous case: the factors that make staggered release more likely should be those that make simultaneous release less likely. That is, staggered release should be more likely if (i) producing a good is less costly, (ii) goods are closer substitute, and (iii) demand does not decay too fast. The first conjecture is clearly verified: if  $\gamma$  decreases, the LHS of condition (4) increases, which makes the condition more likely to be satisfied. The second and third conjectures are also verified.<sup>24</sup>

Combining Lemmata 3 and 4, we can now fully characterize the subgame-perfect equilibrium (in pure strategies) of the two-stage game.

**Proposition 2** *Suppose that producers choose first the budget for their good and then decide when to release it. The subgame-perfect equilibrium (in*

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<sup>24</sup>Note first that as we assume that  $\gamma > v_1$ , condition (4) can only be satisfied if its RHS is smaller than unity. Some lines of computations establish that two necessary conditions are  $\beta_0 < 2 - \sqrt{2} \simeq 0.586$  (which is equivalent to  $v_s/v_1 \geq \sqrt{2} - 1 \simeq 0.414$ ) and  $\beta > (\beta_0/2)(4 - \beta_0)$ ; that is, staggered release can only emerge if demand does not decay too fast and if goods are similar enough. Moreover, one also observes that the RHS of condition (4) decreases with  $\beta$  and increases with  $\beta_0$ , which reinforces the previous findings.

pure strategies) of this game is as follows. (a) If  $\beta \leq \beta_0$  or if  $\beta_0 < \beta \leq 1$  and condition (2) is satisfied, then both producers invest  $v_1/\gamma$  and release their good immediately. (b) If  $\beta_0 < 2 - \sqrt{2}$ ,  $(\beta_0/2)(4 - \beta_0) < \beta \leq 1$  and condition (4) is satisfied, then one producer invests  $v_1/\gamma$  and releases its good immediately, while the other producer invests  $v_s/\gamma < v_1/\gamma$  and releases its good just after the life cycle of the first good is over.

Figure 2 depicts the results for  $\beta_0 < \beta \leq 1$ . It can be shown that the RHS of condition (4) is always larger than the RHS of condition (2), as represented on Figure 2. Hence, there exist configurations of parameters where a subgame-perfect equilibrium in pure strategies fails to exist. This corresponds to intermediate values of  $v_1/\gamma$ ; that is, values of  $v_1/\gamma$  that are too large for simultaneous release to prevail (e.g., because promotion is rather cheap, which induces producers to invest more so as to force the other producer to delay), and too small for staggered release to prevail (e.g., because the audience is too condensed at the start of the life cycle). This potential absence of pure-strategy equilibria can be seen as an indication of the instability of competition in cultural goods markets.

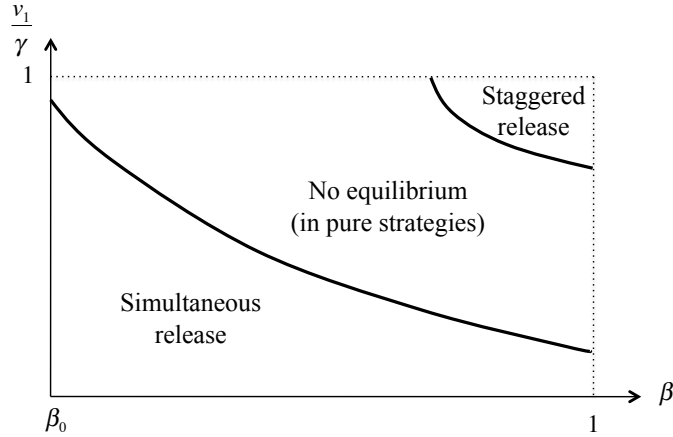


Figure 2: Subgame-perfect equilibrium (in pure strategies)

## 4 Empirical analysis

We choose to apply our theoretical model to the movie industry. This choice is motivated by data availability and by our desire to contribute to an ex-

isting body of empirical papers (see the discussion in Section 2).

The main testable empirical hypothesis that we can draw from our model is that movie studios may decide to increase their budget as a way to secure release close to demand peaks and discourage their rivals from doing the same. We should therefore observe that:

**(H1)** *Higher budgets explain release dates closer to demand peaks.*

The model also shows that the interplay between budgets and release dates strongly depends on the degree of substitutability between the movies: the more similar the movies, the higher the incentive to increase the budget so as to secure the earliest release date, leading to the following hypothesis:

**(H2)** *The release date of a given movie is more sensitive to the budgets of close competitors (movies of the same genre) than of distant competitors (movies of other genres).*

Finally, the model also suggests that studios set the same high budget in the simultaneous release equilibrium, while they set different budgets in the staggered release equilibrium (with the follower investing less). This finding leads us to formulate a third hypothesis:

**(H3)** *The distribution of budgets is characterized by both a higher mean and a higher standard deviation in weeks closer to a demand peak.*

We now want to test these hypotheses in depth on our entire data set. In the rest of this section, we first describe the data that we use to perform our empirical analysis; we then present our empirical strategy and describe our results; finally, we discuss our results.

## 4.1 Data

The data (collected on the website *Box Office Mojo*) refers to American movies released in ten countries<sup>25</sup> between January 1, 2001 and December 31, 2013 for which production budgets are available. Our final database comprises 1564 movies and 12904 valid observations (see Table 3). For each of the 1564 movies, we know (i) the production budget, (ii) the official release dates (for the countries where the movie was released), (iii) the genre to which the movie belongs, (iv) whether or not the movie is a sequel of (a) previous movie(s), and (v) the studio producing and distributing the movie.

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<sup>25</sup>Australia, France, Germany, Italy, Japan, New Zealand, South Africa, Spain, USA/Canada, and United Kingdom.

Three comments are in order regarding the data. First, the “production budget refers to the cost to make the movie and it does not include marketing or other expenditures.”<sup>26</sup> Unfortunately, broadly available measures of movies’ advertising expenditures are notoriously hard to find (see, e.g., Moul, 2008, p. 973). The absence of such data can be seen as a limitation to test our hypotheses. In our model, we consider indeed budgets as instruments to attract more viewers and, arguably, the main channel to do so is to increase marketing and advertising expenditures. We believe, however, that production budgets are a reasonable proxy for our purposes, as they comprise expenditures (such as cast, director, special effects) that are as relevant as marketing expenditures to increase the expected viewership of a movie. Moreover, it is generally estimated that marketing budgets tend to represent a constant proportion (about 50%) of production budgets.<sup>27</sup>

Second, to form sub-samples of relatively comparable sizes, we have grouped movies in five main “genres”, namely *Drama*, *Action*, *Suspense*, *Comedy*, and *Other*.<sup>28</sup>

Third, we construct eight binary variables to control for movie studios (i.e., the seven major film studios and a composite variable, named *Others* that comprises the smaller distributors).<sup>29</sup>

Tables 1 and 2 provide some descriptive statistics of the major variables. In Table 1, we report the main characteristics of the 1546 movies in our sample. The mean and standard deviation of the (inflation-adjusted) production budgets are \$54.4 million and \$53.1 million, respectively. Comparing movie genres, we observe that movies in the Action category present the highest mean and standard deviation for the production budgets. We also observe

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<sup>26</sup>See [www.boxofficemojo.com/about/boxoffice.htm](http://www.boxofficemojo.com/about/boxoffice.htm).

<sup>27</sup>According to The Motion Picture Association (2003), quoted by Hanson and Xiang (2011, p. 21), “for the average US movie in 2003 65% of total costs were due to film production and 35% were due to marketing, which includes making film prints; advertising on radio, TV, newspapers and other media; and promotional activities.” See also [http://en.wikipedia.org/wiki/Film\\_promotion](http://en.wikipedia.org/wiki/Film_promotion) or <http://entertainment.howstuffworks.com/movie-cost1.htm>.

<sup>28</sup>*Drama* corresponds to Mojo category ‘Drama’, *Action* merges Mojo categories ‘Action’, ‘Adventure’, and ‘Western’, *Suspense* merges ‘Thriller/Suspense’ and ‘Horror’, *Comedy* merges ‘Comedy’, ‘Romantic Comedy’, ‘Black Comedy’ and ‘Cartoons’, and *Other* merges ‘Musical’, ‘Documentary’, and ‘Concert/Performance’.

<sup>29</sup>*Box Office Mojo* reports the following market shares (in box office revenues) for 2013: Warner Bros. (17.1%), Walt Disney (15.7%), Universal (13.1%), Sony/Columbia (10.5%), Lions Gate (9.8%), 20th Century Fox (9.7%), Paramount (8.8%), and others (15.3%)

in Table 2 that the market for American movies varies in size across countries. Only a little more than 50% of the American movies in our sample are released in Japan, while this proportion is at least as large as 73% in the other countries. Interestingly, the average production budget is larger for movies released outside the U.S and Canada, suggesting that studios choose not to release small-budget movies abroad (probably because they fear that they will not be profitable enough).

		Obs	%	Mean	Std. Dev.	Min	Max
Genre	Drama	378	25	30.6	29.3	0.17 (Once)	206.34 (A Christmas Carol)
	Action	417	25	100.9	66.3	4.85 (Night Watch)	336.9 (Pirates of the Caribbean 3)
	Suspense	262	17	36	31.7	0.16 (Paranormal Activity)	170.88 (Inception)
	Comedy	463	29	45.4	38.4	0.19 (Tadpole)	200 (Monsters University)
	Others	44	4	23.5	28.3	0.08 (Super Size me)	96.12 (The Nutcracker)
Studio	Fox	194	12	51.9	47.7	0.17 (Once)	257.4 (Avatar)
	Liongate	113	7	28.7	27.8	0.32 (Lovely and Amazing)	132 (The Twilight Saga 4)
	Others	218	14	25.1	26	0.08 (Super Size Me)	183.9 (Die Another Day)
	Paramount	171	11	70.1	54.7	0.16 (Paranormal Activity)	228 (Transformers 2)
	Sony	263	17	52.4	50.3	0.46 (Quinceanera)	289.7 (Spider-Man 3)
	Universal	196	13	58.3	49.2	.52 (Brick)	246.9 (King Kong (2005))
	Walt-Disney	177	11	72.7	69.8	0.19 (Tadpole)	336.9 (Pirates of the Caribbean 3)
	Warner	232	15	70.3	59.45	2.46 (Before Sunset)	271.5 (Harry Potter 6)
Sequel	194	12	95.9	73.6	2.46 (Before Sunset)	336.9 (Pirates of the Caribbean 3)	
Titles	1564	100	54.4	53.1	0.08 (Super Size me)	336.9 (Pirates of the Caribbean 3)	

Table 1: Production budgets per genre and per studio

Country	Obs	% wrt titles	Average budget	Std. Dev.
US / Canada	1564	100%	54.4	53.1
Australia	1374	88%	58.7	55.5
France	1316	84%	60,0	55.3
Germany	1337	85%	59.7	55,0
Italy	1308	84%	60.1	55.2
Japan	798	51%	78.8	60,0
N. Zealand	1223	78%	61.8	56.4
S. Africa	1152	74%	64.2	56.5
Spain	1401	90%	58.2	54.3
UK	1431	91%	56.9	54.2
Total	12904			

Table 2: Production budgets per country of release

Casual observation of our data lends credence to our hypotheses, as illustrated by Figure 3. This figure plots release dates (on the horizontal axis) against production budgets (on the vertical axis) for movies released

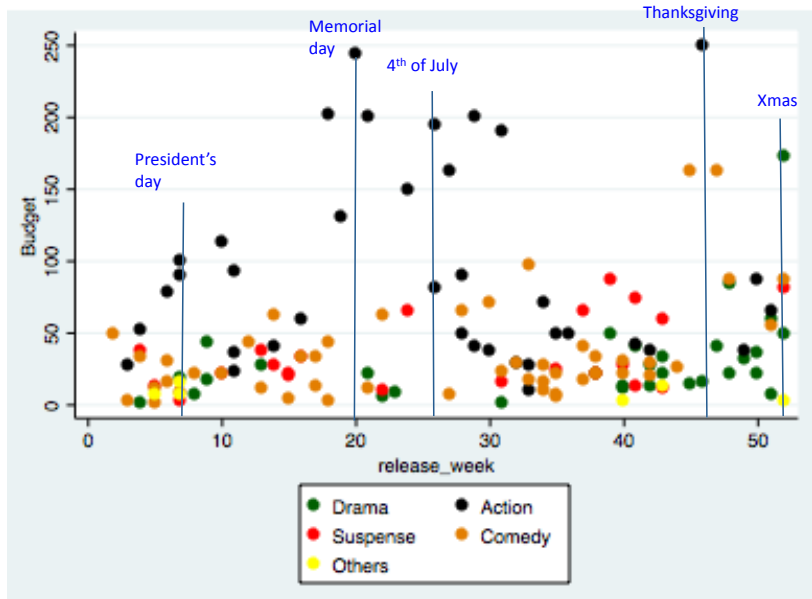


Figure 3: Budgets per week and per genre (USA, 2008)

in the US/Canada in 2008; each dot corresponds to one movie and the color of the dots indicates to which genre the movie belongs; the vertical lines correspond to the seasonal peaks. We observe that the movies with the larger budgets are indeed released close to the peaks; we also see that when several movies are released close to a peak, they usually belong to different genres and have different budgets (the dots have different colors and are scattered).

## 4.2 Specification and results

In the theoretical model of Section 3, we assumed for simplicity that everything was starting at some date  $t = 1$ , corresponding to a peak in demand. In this context, we modeled the trade-off facing studios as choosing between meeting the demand (i.e., immediate release) and avoiding head-to-head competition (i.e., delayed release). In reality (as illustrated in the introduction), there is another way to avoid competition, which is to release a movie *before* the peak. In our empirical model, we thus need to consider a symmetric version of our theoretical model, where movies can be released at a peak or any time before and after. Accordingly, we define our dependent



variable as the *number of weeks (in absolute value) between the release date of a movie and the closest demand peak*:

$$t_{ik} = \min |peakweek_k - releaseweek_{i,k}|,$$

where  $i$  identifies the movie and  $k$  the country.<sup>30</sup>

#### 4.2.1 Seasonal peaks

We identify the seasonal peaks in the demand for movies in the various countries using the following three-step procedure. First, following Mojo, we consider five seasons: Winter, Spring, Summer, Fall, and the Holiday Season.<sup>31</sup> Second, we use the weekly box office revenue data in each country to find the share of each week’s revenues in the total annual revenues. Third, we define a peak as a week that reaches a sum of box-office revenues that is above the 70th percentile of the seasonal distribution. Table 4 in Appendix 6.7 reports the weeks identified as peaks (by season and by country); note that it is not rare that two or three consecutive weeks qualify as peaks.

Clearly, this procedure raises an endogeneity issue for our estimations as shares are equilibrium outcomes that depend both on demand and supply behavior. Take for instance the summer period. Two reasons may explain why box-office revenue are higher during this period: people may be more willing to go to the movies because they are on vacation or long for air-conditioning (demand effect) and/or because it is precisely the period when studios have decided to release their more popular movies (supply effect). In other words, it is not clear whether it is the box-office revenue that drives

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<sup>30</sup>By taking the absolute value, we implicitly assume that studios find it equivalent to release a movie  $x$  weeks before or  $x$  weeks after a given peak. Arguably, it may be more profitable to release a movie before a peak rather than after as the movie will still be on screen when the demand is the highest (even if the attractiveness of the movie itself will have faded). On the other hand, there may be very little demand in the weeks immediately preceding a peak; think, e.g., of the last week of June, preceding the peak of the 4th of July in the US. As these forces may counterbalance each other, we believe that our assumption of symmetry around a peak is reasonable.

<sup>31</sup>*Winter* goes from the first day after New Year’s week or weekend through the Thursday before the first Friday in March; *Spring* goes from the first Friday in March through the Thursday before the first Friday in May; *Summer* goes from the first Friday in May through USA Labor Day Weekend; *Fall* goes from the day after USA Labor Day Weekend through the Thursday before the first Friday in November; the *Holiday Season* goes from the first Friday in November through New Year’s week or weekend.

the choice of release dates, or the other way round. Yet, we have two reasons to believe that endogeneity is not a real concern in our case. First, previous research has shown that the demand effect largely dominates.<sup>32</sup> Second, by summing box-office revenues for a particular week over 13 years (or less, depending on data availability), we reduce (if not eliminate) any endogeneity problem that may exist. Reassuringly, we find the same pattern of movie sales as Einav (Figure 4, p. 139, 2007) for US/Canada, and as Hand and Judge (Figure 2, p. 83, 2011) for UK data (see Figure 6 in Appendix 6.7).

#### 4.2.2 Test of hypotheses (H1) and (H2)

To estimate the effects of production budgets and competition on the release date of a movie, we estimate the following specification:

$$t_{ik} = \alpha_k + T_{ik} + \beta_1 budget_i + \beta_2 n_{ik} + \beta_3 m_{ik} + \beta_4 sequel_i + \beta_5 X_{i,k} + \varepsilon_{ik}, \quad (5)$$

where the indices  $i$  and  $k$  refer, respectively, to movies ( $i = 1 \dots 1564$ ) and countries ( $k = 1 \dots 10$ ),  $\alpha_k$  is a country fixed effect,  $T_{ik}$  is a dummy for the year of release in country  $k$ ,  $budget_i$  is the production budget of film  $i$ ,  $n_{ik}$  (resp.  $m_{ik}$ ) is the sum of the production budgets of other movies of the same (resp. a different) genre as movie  $i$  and released during the the same week as movie  $i$  in country  $k$ ,  $sequel_{ik}$  is a dummy variable that takes value one if movie  $i$  is a sequel of a previously released movie, and  $X_{i,k}$  is a matrix of controls (season, year, country and studio). The variable  $sequel_{ik}$  is meant to capture the fact that sequels benefit from the popularity acquired by the previous movies in the same series, which may scare off the competition by itself, regardless of the size of the production budget.

Recalling that a *decrease* in  $t_{ik}$  means that the release date moves *closer* to the nearest peak, the theoretical prediction stated in hypothesis (H1) lead us to expect a negative value for  $\beta_1$  (a higher budget is used as a commitment to release near a demand peak, implying a smaller  $t_{ik}$ ), and negative values for  $\beta_2$  and  $\beta_3$  (an increase in the total budgets of contemporaneous movies is taken as a proxy for an increase in the competitive pressure, which should lead the studio to release the movie closer to the peak, i.e., to a smaller  $t_{ik}$ ).

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<sup>32</sup>Einav (2007) disentangles the endogeneity implicit in the data for the US movie market and finds that the behavior of demand accounts for about two-thirds of the seasonal variation in total sales. Cartier and Liarte (2012) perform a similar exercise. Hand and Judge (2011) find the same evidence for the UK market.

Moreover, according to hypothesis (H2), we should observe  $|\beta_2| > |\beta_3|$ , as the competitive pressure stemming from movies of the same genre should be felt more strongly.

We report the results of the OLS estimation of specification (5) in the first two columns of Table 3, with the variables  $n_{ik}$  and  $m_{ik}$  being excluded in Column (2). We see that the estimated coefficient of  $budget_i$  has the expected negative sign in both specifications; the estimated coefficients of  $n_{ik}$  and  $m_{ik}$  also have the expected sign in specification (2); moreover, all coefficients are statistically significant at the 1% level. We also observe in the first specification that  $|\beta_2| > |\beta_3|$ ; that is, the aggregate budgets of movies in the same genre ( $n_{ik}$ ) exert a stronger effect on the release date of a given movie, compared to the aggregate budgets of all the other movies ( $m_{ik}$ ). A  $t$ -test conducted between the two variables confirms that the difference is statistically different from zero at the 1% level. We can thus safely say that hypotheses (H1) and (H2) are verified.

	(1) OLS	(2) OLS (no $n_{ik}$ , $m_{ik}$ )	(3) Poisson	(4) OLS (yearly peaks)	(5) OLS (USA)	(6) OLS (no outliers)
Budget	-0.0037 *** (-7.88)	-0.0028 *** (-6.08)	-0.0015 *** (-7.79)	-0.0067 *** (-8.56)	-0.0019 * (-1.82)	-0.00402 *** (-6.51)
$n_{ik}$	-0.0037 *** (-8.09)		-0.0015 *** (-7.30)	-0.0065 *** (-8.35)	-0.003 *** (-2.94)	-0.0032 *** (-7.65)
$m_{ik}$	-0.0029 *** (-11.62)		-0.001 *** (-10.00)	-0.0055 *** (-12.09)	-0.003 *** (-6.39)	-0.0028 *** (-10.56)
Sequel	-0.0054 (-0.09)	0.286 (0.45)	-0.011 (-0.05)	-0.044 (0.41)	0.089 (0.63)	0.0032 (-0.05)
Drama	0.147 ** (2.53)	0.149 ** (2.56)	0.597 ** (2.65)	-0.494 *** (-5.00)	-0.288 (-0.23)	0.128 ** (2.14)
Action	0.254 (0.43)	0.415 (0.71)	0.144 (0.61)	0.107 (1.04)	-0.222 * (-1.71)	-0.0072 (0.12)
Suspense	0.265 *** (4.12)	0.329 *** (5.10)	0.098 *** (4.16)	0.97 (0.89)	-0.127 (-0.94)	0.278 *** (4.21)
Others	0.133 (1.08)	0.164 (1.33)	0.54 (1.07)	0.399 * (1.80)	-0.494 ** (-2.13)	-0.165 (4.21)
Comedy	(omitted)	(omitted)	(omitted)	(omitted)	(omitted)	(omitted)
Constant	2.544 *** (24.71)	2.08 *** (21.36)	0.893 *** (21.173)	4.99 *** (31.07)	3.307 *** (31.07)	2.554 *** (23.45)
Controls (season, year, studio)	YES	YES	YES	YES	YES	YES
Country Fixed Effects	YES	YES		YES		YES
R-squared	0.1195	0.1077		0.1058	0.3346	0.1193
Adj R-squared	0.1173	0.1056		0.1039	0.3246	0.1169
Pseudo R-squared			0.0309			
Prob > chi2			0.000			
Number of observations	12904	12904	12904	12904	1564	11615

\*  $0.05 < p < 0.1$ ; \*\*  $0.01 < p < 0.05$ ; \*\*\*  $p < 0.01$

Table 3: Estimation results

Noteworthy is the fact that the coefficient of the variable  $sequel_{ik}$  is never significant. We interpret this finding as follows: even if sequel movies

may benefit from a head start in terms of popularity, releasing them near demand peaks still requires studios to increase their production and promotion budgets.<sup>33</sup>

To provide some economic significance to our estimated coefficient of interest, we compute from estimation (1) that, everything else constant, a studio should increase its budget by \$38.6 million if it wanted to move the release date of its movie one day closer to the nearest demand peak.

### 4.2.3 Robustness checks

We check the robustness of our results in various ways. First, it could be argued that production budgets may be a proxy for studios' size and/or reputation. This could be a concern for our analysis insofar as size and reputation (which are omitted from the regression model) could affect both studios' ability to release movies closer to demand peaks and the way studios set production budgets. Another argument could be that the largest studios strive to release movies around demand peaks every year so as to assert their presence on the market, irrespective of the movies' budgets. It is to assess this possibility that we have introduced eight binary variables to control for movie studios in our regressions. It turns out that the effects of these controls are not significant, which leads us to think that they have no impact on the dependent variable.<sup>34</sup>

Second, we propose a Poisson regression model (Maddala, 1983). Poisson distributed data is intrinsically integer-valued, which makes sense for count data as in our case. Since the dependent variable has a restricted support, OLS regression could predict values that are negative and non-integer values, which have no sense. Furthermore, OLS assumes that true values are normally distributed around the expected value. So, Poisson regression models perform better in far from normal distributed data. We present the results of this estimation in the third column of Table 3. We observe that the Poisson regression of Column (3) and the OLS regression of Column (1) give very similar results.

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<sup>33</sup>We observe in Table 1 that sequel movies are characterized by rather large budgets: the mean budget for sequel movies is \$95.9 million, whereas the mean budget for all movies in our sample is \$54.4 million.

<sup>34</sup>We also run our main OLS regression after dropping the group of small studios; we did not observe any significant change in our results.

As a third robustness check, we modified our dependent variable by identifying demand peaks in a different way: a week is now defined as a peak if it reaches a sum of box-office revenues that is above the 70th percentile of the distribution of a given *year* instead of a given *season*. This changes the distribution of peaks in two conflicting ways: when compared over a whole year, some ‘big’ weeks within ‘small’ seasons go out (e.g., in the spring), whereas some ‘big’ weeks within ‘big’ seasons come in (e.g., in the summer). These changes are depicted for each country in Table 5 in Appendix 6.7. We regress the newly defined dependent variable over the same set of independent variables as in specification (5). The results are reported in the fourth column of Table 3. We observe that all the coefficients of interest continue to have the expected sign and remain highly significant. The relationship between budgets and release dates seems thus to exist irrespective of the way we define the demand peaks. This suggests that studios compete in terms of release dates not only within each season but also over the whole year.

Finally, we ran the OLS regression only for the US to control for the possibility that the release date in other countries could be a function of the viewership (or profits) in the US given the release date chosen there. Apparently, this is not so as the results in Column (5) of Table 3 are qualitatively similar to those reported in Column (1). We also repeated our main OLS regression after winsorizing our data (we dropped the movies corresponding to the lowest 5% and highest 5% in the budget distribution); the estimated coefficients, reported in Column (6) of Table 3, are qualitatively similar to those reported in Column (1), which indicates that our results are not driven by outliers.

#### 4.2.4 Test of hypothesis (H3)

As suggested in Figure 3, the distribution of movie budgets seems to vary a lot week per week. In particular, for weeks at or near a demand peak, the largest budget is higher and the distribution is more dispersed. This observation is consistent with the predictions of our model: higher budgets allow studios to release their movies closer to a peak and to scare off the competition. It is thus unlikely to observe two movies with high budgets released around a peak (especially if they belong to the same genre). As a result, movies coexisting in weeks near a peak should have very dissimilar

budgets (very high or very low). Conversely, in weeks further away from peaks, the distribution of budgets should be more concentrated and with a lower mean.

To check this hypothesis, we have categorized movies (across countries and years) according to the number of weeks that separate their release from the nearest peak. We have then computed the mean and the standard deviation of the production budgets for the movies within each category. To verify hypothesis (H3), we should observe that both the mean and the standard deviation decrease as we move to categories of movies that are more distant from a peak.

Figure 4 plots the mean of the standard deviation of the production budgets (vertical axis) against the number of weeks separating the release date from the nearest peak (horizontal axis); the latter variable takes values from 0 to 9. As expected, we observe that both variables decrease as movies are released further from a peak. This observation suggests that hypothesis (H3) is verified.

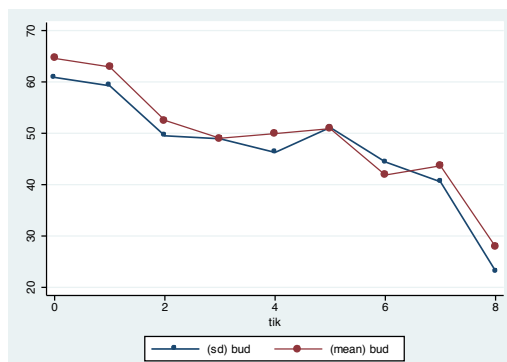


Figure 4: Mean and standard deviation of budgets according to release date

### 4.3 Discussion

We discuss here a number of concerns that our approach could raise. We also indicate how we have already addressed some of them and how we plan to address others in future work.

**Movies released by the same studio.** Major film studios typically release about 15 to 20 movies per year. Inevitably, several movies are then

released within a given season, and these movies may be of the same genre and have similar budgets. This is illustrated on Figure 5, which depicts the movies that 20th Century Fox released in the U.S. in 2008 (weeks are reported on the horizontal axis and genres on the vertical axis; the size of a dot is proportional to the size of the budget of the corresponding movie).

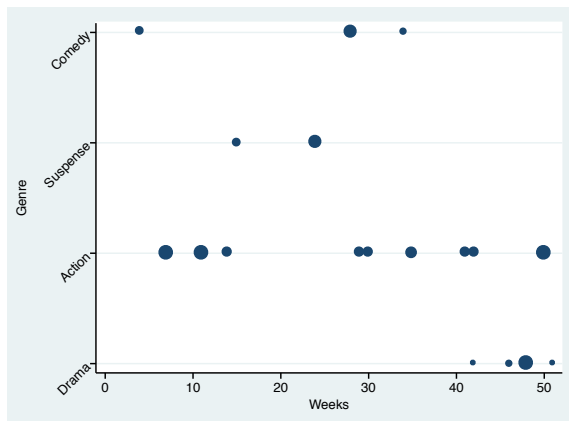


Figure 5: Movie releases by Fox in the U.S. in 2008

Clearly, each studio coordinates the budget and release decisions for its movies. We need thus to assess how this possibility affects our analysis. From a theoretical viewpoint, we can analyze the promotion and release decisions of a monopoly studio that produces and distributes two movies, and compare the results to the ones that we obtained in the duopoly model of Section 3. In Appendix 6.6, we show that simultaneous release emerges for a wider configuration of parameters under a multi-movie monopoly than under a duopoly. Moreover, when the monopoly studio decides to release both movies at date  $t = 1$ , we show that it chooses a lower budget than independent studios do (i.e.,  $b_i = (1 - \beta)v_1/\gamma$  instead of  $b_i = v_1/\gamma$ ). In contrast, when the monopoly studio opts for staggered releases, the chosen dates and budgets are exactly the same as in the duopoly case. The previous analysis suggests that the difference between coordinated (i.e., multi-movie monopoly) and independent (i.e., duopoly) decisions should only be minor and observed for a restricted set of parameters. Moreover, if we transpose these results to an oligopoly setting, i.e., if we add to our setting the competition resulting from other (multi-movie) studios, the impact of coordinated decisions can only be weaker. We therefore believe that the fact that the

same studio releases several movies during a given season does not affect our results in any significant way.

**Rescheduling.** In our model, studios choose the release date of their movie once-and-for-all at the start of the game. The choices are supposed to be simultaneous, which is to say that no studio can observe the choice of the other studio before making its own. This is clearly a simplification as in reality, it happens that studios modify their initial decision and reschedule the release of their movies. For instance, Einav (2010, p. 380) observes that in his dataset,<sup>35</sup> “more than 60% of the movies changed their release dates at least once.” Although some of these changes may be due to internal reasons (e.g., unforeseen production delays), it is widely believed that most of them are done for strategic reasons, i.e., as a reaction to current or expected competition. In support for this view, Dürr *et al.* (2014) estimate<sup>36</sup> that “movies which have been rescheduled and therefore observed the market conditions very carefully, were able to avoid competition and thus achieved better results at the box office.” This finding suggests the presence of a second-mover advantage that our simple model fails to capture. Yet, the key concern for our analysis is whether sequential release decisions would challenge our result that higher production budgets are used to scare off competition and secure the most profitable release dates. Einav (2010, p. 380) gives us some reassurance in this regard by noting that: “The likelihood of a movie changing its release date is not significantly correlated with the movie’s size, measured by its production cost.” Our analysis appears thus as a reasonable approximation. It would, however, be interesting to enrich our model by allowing studios to change their release date at some cost.<sup>37</sup>

**International differences.** Our dataset spans 10 countries but focuses on the release of American movies only. As a result, in non U.S. markets, we miss the competition that (unobserved) popular local movies exert on (observed) American movies. As anecdotal evidence, it appeared that Chinese authorities delayed the release of *Skyfall* (a James Bond movie) by more

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<sup>35</sup>His dataset contains all movies released in the U.S. between 1985 and 1999.

<sup>36</sup>Their dataset contains 634 movies released in the U.S. between 2007 and 2013.

<sup>37</sup>According to Einav (2010, p. 380), the costs associated with changing a release date can stem from “committed advertising slots, the implicit costs of reoptimizing the advertising campaign, reputational costs, etc.”



than three months with respect to the original release date, because an earlier release could have overshadowed the release of two big-budget Chinese films.<sup>38</sup> To account for such local competition we should definitely extend our dataset. For now, the potential influence of local movies is picked up in our regressions by the country fixed effects. Countries also differ according to the distribution of peaks along the year (because holidays, weather conditions and/or patterns of movie consumption vary across countries). However, this does not affect our estimations as peaks are defined country per country, which takes care of local specificities.

Note that all our specifications are based on the assumption that country effects are fixed through the whole analysis period. As this could be seen as a restrictive assumption, we also tried an alternative model with different effects per country and per year. Yet, we did not observe any significant difference in the estimated parameters.<sup>39</sup>

**Definition of genres.** The degree of substitutability across movies (measured by the parameter  $\beta$ ) plays an important role in our theoretical model. We approach it in the empirical analysis by classifying movies into different genres. There are two potential weaknesses in this strategy. First, our classification may be a bit arbitrary as we have merged distinct Mojo genres to form categories of relatively equal sizes. Although we have merged genres that looked relatively similar, we are not sure that the degree of substitutability is always higher across than within our categories. Second, and perhaps more importantly, recent developments in the motion picture industry indicate that the boundaries between various genres may start to blur. In particular, genres that used to be rather immune to competition like animated films are increasingly facing the competition of other genres, for instance superhero films.<sup>40</sup> Finally, as suggested by Cartier and Liarte (2012), demand peaks may also differ across genres (for instance, the demand for animated movies is more likely to peak during the Festive Season, when more families with young children go to theaters). In future work, we plan to check if our results still hold if we run our estimations under different

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<sup>38</sup>See [www.hollywoodreporter.com/news/skyfall-china-release-date-pushed-389769](http://www.hollywoodreporter.com/news/skyfall-china-release-date-pushed-389769), last consulted March 2015.

<sup>39</sup>The estimation results of this model are omitted here for the sake of brevity.

<sup>40</sup>See, e.g., <http://tinyurl.com/mdmqpdt> (last consulted March 2015) where Jeffrey Katzenberg explains how Marvel is Dreamworks new competition.

groupings of the MOJO genres, or if we estimate demand peaks per genre.

## 5 Concluding remarks

In this paper, we analyzed how producers of cultural goods can use strategically the size of the promotion budget of their good to scare off competition so as to secure a release date close to a demand peak. To this end, we built a simple game-theoretic model where two producers compete along two dimensions: promotion budget and release date. We showed that two types of subgame-perfect equilibria can emerge: simultaneous release (both producers choose high promotion budgets and release their good at the start of the period, which corresponds to the peak of demand) or staggered release (one producer chooses a high promotion budget and releases its good at the start of the period, while the other producer chooses a lower budget and releases its good later). The latter equilibrium is more likely when goods are close substitutes (e.g., because they belong to the same genre).

We then applied the model to the motion picture industry, using a dataset of 1564 American movies released in 10 countries from 2001 to 2013. This allowed us to verify the predictions that we could draw from the theoretical model, namely that (i) higher budgets explain release dates closer to a demand peak, (ii) release dates are more sensitive to the budgets of close competitors than of distant competitors, and (iii) the mean and standard deviation of the budget distribution are both higher in weeks closer to a demand peak.

Besides the extension already mentioned in the previous section, it would be interesting in future research to test the predictions of our theoretical model for other cultural goods (e.g., books or video games).

## 6 Appendix

### 6.1 Proof of Lemma 1

We show that the segments  $\pi_a$ ,  $\pi_b$ , and  $\pi_d$  decrease with  $t_i$ , while segment  $\pi_c$  reaches its largest value at one of the extremities of the zone where it is defined (i.e., at either  $t_i = t_j$  or  $t_i = t_j + s$ ).

$$\pi'_a = \pi'_d = (1 + b_i) (-t_i^{-\alpha} + (t_i + s)^{-\alpha}) < 0,$$

$$\pi'_b = -(1 + b_i) t_i^{-\alpha} + (1 + b_i - \beta b_j) (t_i + s)^{-\alpha} < 0.$$

As for segment  $\pi_c$ , we compute:

$$\begin{aligned} \pi'_c &= -(1 + b_i - \beta b_j) t_i^{-\alpha} + (1 + b_i) (t_i + s)^{-\alpha}, \\ \pi''_c &= \alpha \left( (1 + b_i - \beta b_j) t_i^{-\alpha-1} - (1 + b_i) (t_i + s)^{-\alpha-1} \right). \end{aligned}$$

If  $\pi'_c = 0$ , then  $(1 + b_i - \beta b_j) = (1 + b_i) (t_i + s)^{-\alpha} t_i^\alpha$ . We have then that  $\pi''_c = \alpha s (1 + b_i) (t_i + s)^{-\alpha-1} / t_i > 0$ . Hence, either  $\pi_c$  decreases or increases with  $t_i$  on the whole range  $t_i \in [t_j, t_j + s]$ , or it has an interior minimum. That is, the largest value of  $\pi_c$  is reached either at  $t_i = t_j$  or at  $t_i = t_j + s$ . In the former case, the whole profit function reaches its maximum at  $t_i = 1$ ; in the latter case, it reaches its maximum at either at  $t_i = 1$  or at  $t_i = t_j + s$ .

## 6.2 Proof of Lemma 2

From Lemma 1,  $t_i^*(t_j) = 1$  or  $t_i^*(t_j) = t_j + s$ . As  $t_j \geq 1 + s$ , the former option brings producer  $i$  in profit segment  $\pi_a$ . To establish the result, we thus need to show that  $\pi_a(1, t_j) > \pi_c(t_j + s, t_j)$ . Developing the latter inequality, we have

$$\begin{cases} \frac{1}{1-\alpha} \left( (1+s)^{1-\alpha} - 1 \right) > \frac{1}{1-\alpha} \left( (t_j+2s)^{1-\alpha} - (t_j+s)^{1-\alpha} \right) & \text{for } \alpha \neq 1, \\ \ln(1+s) > \ln(t_j+2s) - \ln(t_j+s) & \text{for } \alpha = 1. \end{cases}$$

Let  $x \equiv t_j + s$ ,  $f(x) \equiv \frac{1}{1-\alpha} \left( (x+s)^{1-\alpha} - x^{1-\alpha} \right)$ , and  $g(x) \equiv \ln(x+s) - \ln x$ . We compute that  $f'(x) = (x+s)^{-\alpha} - x^{-\alpha} < 0$  and  $g'(x) = -s/(x(s+x)) < 0$ , which implies that the above inequality is correct and completes the proof.

## 6.3 Justification of $\beta_0 > 1/2$

On average, it is reported that 40% of box-office revenues are secured during the the first week of exploitation of a movie. In our setting, this observation translates into

$$\int_1^2 \tau^{-\alpha} d\tau = \frac{4}{10} \int_1^{1+s} \tau^{-\alpha} d\tau \Leftrightarrow 1 + s = \left( \frac{10}{4} \left( 2^{1-\alpha} - \frac{6}{10} \right) \right)^{\frac{1}{1-\alpha}}.$$

It is also reported that a movie is exploited during 6 to 8 weeks on average. Let us thus solve the above equation for  $s \in \{6, 7, 8\}$ . This will give us a value of  $\alpha$  that we can then use, with the corresponding value of  $s$ , to compute  $\beta_0$ . The results of these computations are reported in the following

table, where it is observed that the value of  $\beta_0$  is larger than  $1/2$  in all three instances. That allows us to conclude that the observation of 40% of revenues during the first week safely allows us to reject values of  $\beta_0$  lower than  $1/2$ .

$s$	$\alpha(s)$	$\beta_0$
6	1.193	0.753
7	1.281	0.796
8	1.344	0.826

#### 6.4 Proof of Lemma 3

We compute:

$$\pi_1^{im} - \pi_1^d = \frac{\gamma}{2\beta^2} \left( - \underbrace{(\beta^2(2\beta - 1) + \beta_0(2\beta - \beta_0))}_{+} \frac{v_1^2}{\gamma^2} - 2\beta_0 \underbrace{(\beta - \beta_0)}_{+} \frac{v_1}{\gamma} + \beta_0^2 \right)$$

So,  $\pi_1^{im} \geq \pi_1^d$  if the polynomial in  $v_1/\gamma$  in the bracket is positive. Given the signs of the different terms and given that

$$(\beta_0(\beta - \beta_0))^2 + (\beta^2(2\beta - 1) + \beta_0(2\beta - \beta_0))\beta_0^2 = 2\beta^3\beta_0^2,$$

we have that the polynomial is positive if

$$\frac{v_1}{\gamma} \leq \frac{\beta_0(\beta - \beta_0) - \sqrt{2\beta^3\beta_0^2}}{-(\beta^2(2\beta - 1) + \beta_0(2\beta - \beta_0))} = \beta_0 \frac{\beta\sqrt{2\beta} - (\beta - \beta_0)}{\beta^2(2\beta - 1) + \beta_0(2\beta - \beta_0)},$$

which completes the proof.

#### 6.5 Proof of Lemma 4

We first show that if condition (3) is met, then producer 1's best response to  $b_2 = v_s/\gamma$  is  $b_1 = v_1/\gamma$ . We already know that  $b_1 = v_1/\gamma$  is a best response locally (i.e., as long as  $(1, 1+s)$  remains the ensuing equilibrium). Clearly, producer 1 cannot increase its profit by forcing the second-stage equilibrium to become  $(1+s, 1)$ . The only meaningful deviation is to reduce  $b_1$  so that the second-stage equilibrium becomes  $(1, 1)$ . In that case, producer 1's problem is

$$\max_{b_1} \left( 1 + b_1 - \beta \frac{v_s}{\gamma} \right) v_1 - \frac{\gamma}{2} b_1^2 \text{ s.t. } b_1 \leq \frac{\beta_0}{\beta} \left( 1 + \frac{v_s}{\gamma} \right).$$

The optimum is  $b_1 = v_1/\gamma$ . Although we know that this value does not meet the constraint, let us suppose that it does for the sake of the demonstration. In this hypothetical case, producer 1's achieves the largest possible deviation profit, given by

$$\pi_1^d = \left(1 + \frac{v_1}{\gamma} - \beta \frac{v_s}{\gamma}\right) v_1 - \frac{\gamma}{2} \left(\frac{v_1}{\gamma}\right)^2.$$

Clearly, the deviation is not profitable even in this best-case scenario. We compute indeed that

$$\pi_1^{st} - \pi_1^d = \beta v_1 \frac{v_s}{\gamma} > 0.$$

Consider now producer 2. As indicated in the text, a first condition for  $(b_1, b_2) = (v_1/\gamma, v_s/\gamma)$  to lead to second-stage equilibrium release dates  $(t_1, t_2) = (1, 1 + s)$  is condition (3), which can be rewritten as (by using  $v_s = (1 - \beta_0) v_i$  and solving)

$$\frac{v_1}{\gamma} \geq \frac{\beta_0}{\beta} \left(1 + \frac{v_s}{\gamma}\right) \Leftrightarrow \frac{v_1}{\gamma} \geq \frac{\beta_0}{\beta_0^2 + \beta - \beta_0} \quad (6)$$

As shown on Figure 3, a condition for the deviation to  $(1, 1 + s)$  to be feasible is  $\beta_0/\beta < (\beta - \beta_0)/\beta$ , which is equivalent to  $\beta > \frac{1}{2}(1 + \sqrt{5})\beta_0 \simeq 0.618\beta_0$ . We therefore distinguish between two cases.

**(A)** If  $\beta_0 < \beta \leq \frac{1}{2}(1 + \sqrt{5})\beta_0$ , the only possible deviation for producer 2 is to change the second-stage equilibrium to  $(1, 1)$ . The necessary condition for such deviation is  $(1 + b_2) \beta_0 \geq \beta \frac{v_1}{\gamma}$ , or  $b_2 \geq \frac{\beta}{\beta_0} \frac{v_1}{\gamma} - 1$ . If the ensuing equilibrium is  $(1, 1)$ , producer 2 would optimally choose  $b_2 = v_1/\gamma$ . This value meets the latter condition if and only if  $\frac{v_1}{\gamma} \geq \frac{\beta}{\beta_0} \frac{v_1}{\gamma} - 1$  or  $\frac{v_1}{\gamma} \leq \frac{\beta_0}{\beta - \beta_0}$ , which is compatible with condition (6). In that case, producer 2's profit is

$$\pi_2^d = \left(1 + (1 - \beta) \frac{v_1}{\gamma}\right) v_1 - \frac{\gamma}{2} \left(\frac{v_1}{\gamma}\right)^2.$$

We compute then

$$\pi_2^{st} - \pi_2^d = \frac{1}{2} v_1 \left( (\beta_0^2 + 2(\beta - \beta_0)) \frac{v_1}{\gamma} - 2\beta_0 \right).$$

Hence, the deviation is not profitable if  $\pi_2^{st} \geq \pi_2^d$  or

$$\frac{v_1}{\gamma} \geq \frac{2\beta_0}{\beta_0^2 + 2(\beta - \beta_0)}. \quad (7)$$

where we check that the latter fraction is smaller than  $\frac{\beta_0}{\beta - \beta_0}$  and larger than the RHS in (6). It is thus a necessary condition for a subgame-perfect equilibrium with staggered release.

Suppose now that  $\frac{v_1}{\gamma} > \frac{\beta_0}{\beta - \beta_0}$ . Producer 2 is constrained; the best it can choose is  $b_2^d = \frac{\beta}{\beta_0} \frac{v_1}{\gamma} - 1$ . The deviation profit becomes

$$\pi_2^{db} = \left(1 + \left(\frac{\beta}{\beta_0} \frac{v_1}{\gamma} - 1\right) - \beta \frac{v_1}{\gamma}\right) v_1 - \frac{\gamma}{2} \left(\frac{\beta}{\beta_0} \frac{v_1}{\gamma} - 1\right)^2$$

We compute

$$\pi_2^{st} - \pi_2^{db} = \frac{1}{2} \frac{(-\gamma\beta_0 + \beta v_1 - \beta_0 v_1 + \beta_0^2 v_1)^2}{\gamma\beta_0^2} > 0,$$

which shows that the deviation is not profitable in this case.

**(B)** Consider now the case where  $\frac{1}{2}(1 + \sqrt{5})\beta_0 \leq \beta \leq 2\beta_0$ . Condition (7) remains necessary to make sure that producer 2 does not deviate so as to change the second-stage equilibrium to  $(1, 1)$ . Compared to the previous case, there is now an additional possibility of deviation, which consists in changing the second-stage equilibrium to  $(1 + s, 1)$ . For this deviation to be feasible, it must be the case (see Figure 3) that  $v_1/\gamma < (\beta - \beta_0)/\beta_0$ . But, we have just argued that condition (7) remains necessary. We now show that if (7) is satisfied, then  $v_1/\gamma > (\beta - \beta_0)/\beta_0$ , making the deviation to  $(1 + s, 1)$  impossible. Suppose not. Then

$$\frac{\beta - \beta_0}{\beta_0} > \frac{2\beta_0}{\beta_0^2 + 2(\beta - \beta_0)},$$

which implies that

$$\beta > \frac{1}{4} \left(4 - \beta_0 + \beta_0 \sqrt{\beta_0^2 + 16}\right) \equiv \hat{\beta}.$$

But that leads to a contradiction as  $\hat{\beta} > 1$  for all admissible  $\beta_0$  and  $\beta \leq 1$  by definition.

We therefore conclude that only the deviation to  $(1, 1)$  is feasible and it is not profitable if condition (7) holds, which completes the proof.

## 6.6 Multiproduct monopoly

To be able to compare the monopoly and duopoly situations, we continue to assume an exogenous degree of substitutability between the two goods (i.e.,  $\beta$ ).<sup>41</sup> Clearly, the monopolist chooses to release at least one good at date

<sup>41</sup>Arguably, a monopoly producer is also able to choose the degree of good differentiation, insofar as it can avoid to release goods of the same genre during the same period.

$t = 1$  (there is indeed nothing to be gained by delaying the release of the two goods). By the same token, the producer will release the second good no later than date  $t = 1 + s$ . The monopolist's problem is thus to choose  $b_1$ ,  $b_2$  and  $t_2$  so as to maximize its total profits on the two goods:

$$\begin{aligned}\Pi^m &= \int_1^{t_2} (1 + b_1) \tau^{-\alpha} d\tau + \int_{t_2}^{1+s} (2 + (1 - \beta)(b_1 + b_2)) \tau^{-\alpha} d\tau \\ &\quad + \int_{1+s}^{t_2+s} (1 + b_2) \tau^{-\alpha} d\tau - \frac{\gamma}{2} (b_1^2 + b_2^2),\end{aligned}$$

$$\text{s.t. } 0 \leq b_1, b_2 \leq 1 \text{ and } 1 \leq t_2 \leq 1 + s.$$

Deriving profit with respect to  $b_1$  and  $b_2$  gives

$$\begin{aligned}\frac{\partial \Pi^m}{\partial b_1} &= \int_1^{t_2} \tau^{-\alpha} d\tau + (1 - \beta) \int_{t_2}^{1+s} \tau^{-\alpha} d\tau - \gamma b_1 = 0 \\ \Leftrightarrow b_1^*(t_2) &= \frac{1}{\gamma} \left( \frac{t_2^{1-\alpha} - 1}{1-\alpha} + (1 - \beta) \frac{(1+s)^{1-\alpha} - t_2^{1-\alpha}}{1-\alpha} \right) \\ \frac{\partial \Pi^m}{\partial b_2} &= (1 - \beta) \int_{t_2}^{1+s} \tau^{-\alpha} d\tau + \int_{1+s}^{t_2+s} \tau^{-\alpha} d\tau - \gamma b_2 = 0 \\ \Leftrightarrow b_2^*(t_2) &= \frac{1}{\gamma} \left( \frac{(t_2+s)^{1-\alpha} - (1+s)^{1-\alpha}}{1-\alpha} + (1 - \beta) \frac{(1+s)^{1-\alpha} - t_2^{1-\alpha}}{1-\alpha} \right)\end{aligned}$$

Deriving profit with respect to  $t_2$  gives

$$\begin{aligned}\frac{\partial \Pi^m}{\partial t_2} &= (1 + b_1) t_2^{-\alpha} + (1 + b_2) (t_2 + s)^{-\alpha} - (2 + (1 - \beta)(b_1 + b_2)) t_2^{-\alpha} \\ &= \beta (b_1 + b_2) t_2^{-\alpha} - (1 + b_2) (t_2^{-\alpha} - (t_2 + s)^{-\alpha}).\end{aligned}$$

Substituting  $b_1^*(t_2)$  and  $b_2^*(t_2)$  for  $b_1$  and  $b_2$ , we have an expression that depends only on  $t_2$  and on the parameters. Deriving again with respect to  $t_2$ , we can try to establish the sign of  $\partial^2 \Pi^m / \partial t_2^2$ . Unfortunately, we have not found any simple analytical way to do so. However, a large number of numerical simulations consistently show that  $\partial^2 \Pi^m / \partial t_2^2 > 0$ , suggesting that the producer's profit is convex in  $t_2$ . If so, the optimal release date for the second good is either  $t_2 = 1$  or  $t_2 = 1 + s$ . Let us compare the two options. If  $t_2 = 1$ , then  $b_1^*(1) = b_2^*(1) = \frac{1}{\gamma} (1 - \beta) v_1$  and  $\Pi^m(1) = (v_1/\gamma) (2\gamma + v_1 (1 - \beta)^2)$ . If  $t_2 = 1 + s$ , then  $b_1^*(1 + s) = \frac{1}{\gamma} v_1$ ,  $b_2^*(1 + s) = \frac{1}{\gamma} v_s$  and  $\Pi^m(1 + s) = (1/2\gamma) (v_1^2 + v_s^2 + 2\gamma v_1 + 2\gamma v_s)$ . Then, the optimum is  $t_2^* = 1$  if and only if  $\Pi^m(1) \geq \Pi^m(1 + s)$ , which is equivalent to

$$\frac{v_1}{\gamma} \leq \frac{2\beta_0}{2\beta(1 - \beta) + 2(\beta - \beta_0) + \beta_0^2}.$$

It can be shown that the RHS of the latter condition is larger than the RHS in Condition (2), meaning that *simultaneous release emerges for a wider configuration of parameters under a multi-good monopoly than under a duopoly.*

## 6.7 Additional tables and figures

	Winter (1-8)	Spring (9-17)	Summer (18-34)	Fall (35-42)	Holiday (43-52)
Australia	1/2	15/16	26/27/28	39/40	52
France	7/8	9	28/29	42	51/52
Germany	1/2 - 5/6/7	9	20/21 - 29/30	40	51/52
Italy	1/2/3	10/11	20	37 - 42	51/52
Japan	4	16	18 - 28/29/30/31/32/33	37	50/51
New Zealand	1/2	16	26/27/28/29	40	47 - 52
South Africa	1	12/13/14/15	26/27/28/29	39/40	48/49/50/51
Spain	1 - 6/7	10	32	41	47/48/49 - 51/52
US / Canada	7	14	21 - 26/27/28	35	51/52
UK	1 - 7	14	21 - 28/29/30	42	43/44 - 46/47

Table 4: Weeks qualifying as peaks (seasonal basis)

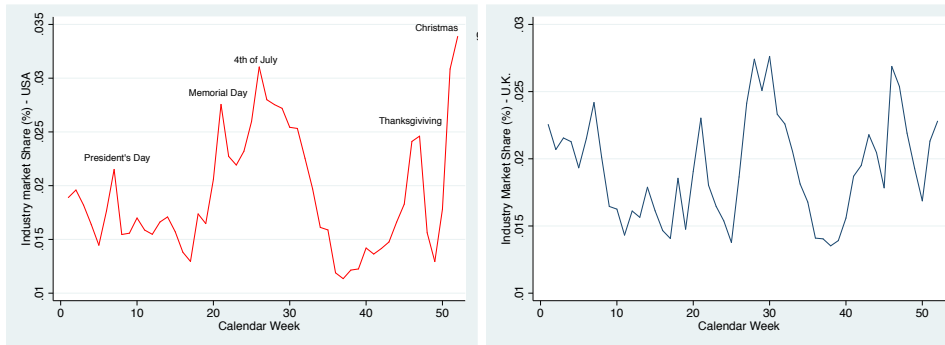


Figure 6: Estimated seasonal peaks (left: US/Canada (left); right: UK)



	Winter (1-8)	Spring (9-17)	Summer (18-34)	Fall (35-42)	Holiday (43-52)
Australia	1/2/3/4		23 - 26/27/28/29	40	52
	1/2	15/16	26/27/28	39/40	52
France	5/6/7/8/9				43/44 - 48/49 - 51/52
	7/8	9	28/29	42	51/52
Germany	1		20/21 - 29/30/31	40	46/47 - 51/52
	1/2 - 5/6/7	9	20/21 - 29/30	40	51/52
Italy	1/2/3/4/5	10			44 - 47/48 - 51/52
	1/2/3	10/11	20	37 - 42	51/52
Japan		16	18 - 27/28/29/30/31/32/33		50/51
	4	16	18 - 28/29/30/31/32/33	37	50/51
New Zealand	1/2	16	21 - 25/26/27/28/29/30		52
	1/2	16	26/27/28/29	40	47 - 52
South Africa	1	14	18 - 26/27/28/29/30	39	48 - 51
	1	12/13/14/15	26/27/28/29	39/40	48/49/50/51
Spain	1 - 4/5/6/7			41	47/48/49 - 51/52
	1 - 6/7	10	32	41	47/48/49 - 51/52
US / Canada			21 - 25/26/27/28/29/30/31		47 - 51/52
	7	14	21 - 26/27/28	35	51/52
UK	7		21 - 27/28/29/30/31/32		46/47
	1 - 7	14	21 - 28/29/30	42	43/44 - 46/47

For each country, the first (second) line indicates the weeks qualified as peaks on a yearly (season) basis

Table 5: Weeks qualifying as peaks (yearly basis)

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