ROBERT E. KRIDER and CHARLES B. WEINBERG*

The extremely short life cycle and the rapid decay in revenues after opening coupled with the rapid and frequent introduction of new competitive products makes the timing of new product introductions in the motion picture industry critical, particularly during the high-revenue Christmas and summer seasons. Each studio wants to capture as much of the season as possible by opening early in the season. At the same time, each wants to avoid head-to-head competition. The authors model competition between two motion pictures in a share attraction framework and conduct an equilibrium analysis of the product introduction timing game in a finite season. The following three different equilibrium configurations emerge: (1) a single equilibrium with both movies opening simultaneously at the beginning of the season, (2) a single equilibrium with one movie opening at the beginning of the season and one delaying, and (3) dual equilibria, with either movie delaying opening. A key factor is the product life cycle, which can be captured well with a two-parameter exponential decline. The authors relate the life-cycle parameters to these possibilities with the general result that the weaker movie may be forced to delay opening. These results are related to case studies of the opening of recently released movies. A statistical analysis of the 1990 summer season in North America provides support for the conclusions and suggests that current release timing decisions can be improved. The authors discuss the rationale of "avoiding the competition" in the general context of product introduction timing.

Competitive Dynamics and the Introduction of New Products: The Motion Picture Timing Game

Rapid new product development and distribution characterize the $6 billion U.S. motion picture industry. Studios' major investments are in the continual production, marketing, and wide release of new films. When a studio has a substantial investment in a picture's production, the typical strategy is to market it heavily then release it simultaneously on hundreds, often thousands, of screens. The associated revenues are highest at the beginning of a movie's run.[1] This is particularly true for the high-revenue summer and Christmas seasons, when studios release most of their potential blockbusters. In the weeks preceding the high seasons, the media interest in movie budgets, release dates, potential box office, and general gossip reaches a fever pitch, creating large potential audiences eagerly awaiting releases.

According to Daniel Rosen (1993), Vice President of Market Research at Warner Brothers, in an American Marketing Association Marketing Research Conference presentation that focused on that year's summer movies, "all of the

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[1]Of the top 100 movies released between December 1989 and April 1991, 94 had their highest weekend box office in the first three weeks of release, and 76 in the first weekend. The first weekend on average accounts for 25% of the total box office. As suggested by the label "sleeper," a slowly building revenue pattern leading to a hit movie is not only rare, but also generally unexpected, rather than the result of a strategic release decision relying on word of mouth.

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studios, including Warner Brothers, are constantly moving their opening dates, and we shift the pictures around the calendar in an effort to find the ideal release date for each picture on our schedule. Because the opening weekend is so critical, it is even more critical that we find exactly the right date for each movie." Although different movies appeal to different audiences, there are always movies that are substitutes, so a primary concern in setting the release date is "to stay away from movies that have the same target audience as the pictures that we are trying to [determine a release] date for" (Rosen 1993). As we discuss in the model development section, the early part of a run has the most drawing power, so that "staying away" is most important for the beginning of movies' runs. High seasons complicate this decision. All studios have pictures (for example) for summer release and wish to have these movies running during as much of the summer season as possible. Because a typical run is three or four months, this leads to the interesting strategic problem we address here: the trade-off between the pressure to open early and be available for all of the summer season and the pressure to avoid whatever movie might be competing for the same target audience.

As an example to highlight the "timing games" that studios play, consider the jostling for Christmas release dates of *A Few Good Men* and *Hoffa*, direct competitors for a similar target audience in that both dealt with powerful establishment characters operating outside the law and starred Jack Nicholson: "[Columbia moved up its] release date for *A Few Good Men* from Dec. 18 to Dec. 11—the same night that Fox had planned to open another Nicholson film, *Hoffa*. Fox backed down: *Hoffa* now will open on Dec. 25" (Grover 1992, p. 38). Why did Fox "back down?" The analysis we present subsequently suggests that the answer lies in the dynamics of drawing power of the two movies: *Hoffa*'s initial attractiveness was less, and its expected decline faster than *A Few Good Men*, and for this situation the equilibrium outcome is that *Hoffa* should delay. We return to and discuss this scenario after presenting our results.

That these timing games are critical becomes clear when the stakes are considered. The average cost for producing and marketing a major movie in 1992 was $40 million (Magiera 1993, p. 20), and "blockbuster" returns can exceed $100 million. As is the case in any industry in which survival depends on continual new product development and introduction, the risks are also huge: Roughly seven in ten movies fail to recoup their investment (Rosen 1993).

In this article, we use a game-theoretic model to analyze the high-season release timing of two motion pictures with different drawing power that are competing directly for the same target audience (and indirectly and nonstrategically with all other available movies). Each movie's revenue depends on the external forces of competition and primary demand in the high-season window and on its intrinsic drawing power. We show that the industry's practice of describing drawing power as consisting of two components, *marketability* (the generation of audience interest before release based on factors such as actors, directors, story line, and special effects) and *playability* (the ability of the movie to keep audiences after release and have a long run relying on good word of mouth), can be conveniently—and remarkably precisely—captured in a parsimonious two-parameter dynamic attraction model. Previous models of motion picture revenue generation have relied on diffusion of innovations (e.g., Jones and Ritz 1991; Mahajan, Muller, and Kerin 1984) or an individual-level adoption process (e.g, Sawhney and Eliashberg 1996) for dynamics. None of these has examined competition, for which our model is designed. It requires only two parameters to describe each movie, which is essential for tractability and interpretability of the competitive timing game. The gain in parsimony comes with some loss in richness because of the inapplicability to platform-release strategies.[2] For major, wide-release movies, the model mirrors the industry's description of movie attraction, describes the major movies' revenues very well (see Appendix B), and is consistent with how certain segments of the market describe movie choice in focus groups we conducted.[3]

We first prove that there are at most two equilibria in the pair of release timings and that at least one movie must open at the beginning of the high season. We map the equilibria in parameter space and find that when one movie is much stronger than the other, whether on the marketability or playability dimensions, there is a unique equilibrium with the stronger movie claiming the early release time and the weaker one delaying. If the movies are more similar in attractiveness, two equilibria become possible, with either movie opening first. However, the equilibrium with the stronger movie opening first is Pareto dominant and therefore more likely to occur. As the movies become more similar still, the Pareto dominance of one equilibrium disappears and the game becomes one of asymmetric "chicken" (see, e.g., Rasmusen 1989, p. 73). In this latter case, the weaker movie has the most to lose from a head-on collision at the beginning of the season and should delay. In cases in which both movies have high playability—that is, if the movies generate positive audience reactions, leading to good word of mouth and hence long runs, or "legs"—the equilibrium might be for both movies to open simultaneously at the beginning of the season. These configurations lead to specific hypotheses about how the realized revenue patterns should be related to particular release timings. We test the hypotheses on a set of summer movies and find partial support.

Our general approach could have applications elsewhere. Hanson and Jeuland (1987) observe that there is relatively

[2]A platform release strategy refers to slowly increasing the number of screens exhibiting the movie and relying on word of mouth more than heavy advertising. For such a strategy, the early part of the movie is much less important in its contribution to total revenues than for mass-appeal, wide-release movies. Platform release strategies rarely lead to multi-thousand screen release and blockbuster hits (the exception being "sleepers"). It is a strategy generally employed by smaller independent distributors (Sawhney and Eliashberg 1996) that typically target different audiences; *The Economist* (1996, p. 94) recently (over) stated, "To find movies for anyone with a mental age over 12, you must look not to big-studio products but to independent films." The intense competition for the mass market that concerns the majors and this article is therefore less of an issue for independents. Minimal competition with mass-market movies, heavier reliance on word of mouth, and less reliance on opening week make the release timing decision far less critical for these movies.

[3]Focus group participants suggest that the heavy concentration of advertising and publicity just prior to release, as well as a desire of some moviegoers to be market mavens, can cause a mediocre but newly released picture to be preferred to a "good" movie that is, say, four weeks old. This helps explain the rapid decay over time of most mass-appeal movies. The distribution strategy of releasing mass-market pictures as widely as possible becomes clear in this context: It is essential to make the movie available to the large segments that value the "newness" of a movie highly before it becomes "old" and to capitalize on the prerelease hype.

little marketing literature addressing product categories in which a specific product (or "brand") is purchased only once but repeat purchases are made in the same product category. These products do not fit into the usual dichotomy of infrequently purchased durables or repeat-purchase consumer products. In addition to movies, leisure products such as plays, concerts, music recordings, novels, computer games, and fashion products fall into this class. Some consumers' utilities for consumption of these products also may have a "newness" component that new product introduction decisions should take into account.

The majority of the theoretical and empirical research devoted to the entry timing decision is concerned with the trade-off between the risks associated with being a pioneer and those of missed opportunity through delay (e.g., Carpenter and Nakamoto 1989; Kalish and Lilien 1986; Kalyanaram and Urban 1992; Lilien and Yoon 1990). Another consideration is cannibalization of a firm's existing products, particularly in technological markets (Moorthy and Png 1992; Norton and Bass 1987). There is also a large body of literature in industrial organization on the relation between timing of research and development investments and timing of new product release (for a review, see Reinganum 1989). These issues are secondary in the motion picture release decision,[4] in which the trade-off is one of trying to capture as much of the revenues during the season as possible while avoiding the competition, which is trying to do the same.

The remainder of the article is organized as follows. In the next three sections, we develop the model, describe the solution method, and give the detailed results. Following that, we conduct a test of implications on the summer movies of 1990. We end with a discussion of limitations and further research opportunities.

MODEL

We use a share attraction framework (e.g., Bell, Keeny, and Little 1975; Cooper and Nakanishi 1988) to capture competition with explicit time dependence. The revenues per unit time, $R_i(t)$, of the i^{th} motion picture at time t depend on its attraction, $A_i(t)$, primary demand per unit time, $D(t)$, and competitors' attractions, $A_j(t)$, according to Equation 1:

$$R_i(t) = D(t)\frac{A_i(t)}{\sum_{j \in J_t} A_j(t)}, \tag{1}$$

where J_t is the set of movies playing at time t. The total revenues (or box office receipts) for each picture are

$$R_i = \int_{t_{oi}}^{t_c} R_i(t)dt, \tag{2}$$

where t_{oi} and t_c are opening and closing times, respectively.

We restrict the $A_i(t)$ in Equation 1 to be zero before release and exponentially declining after release, with parameters $\alpha_i, \beta_i \in R^+$:

$$A_i(t) = e^{\alpha_i - \beta_i(t - t_{0i})}, \quad t \geq t_{0i} \tag{3}$$

$$= 0 \qquad , t < t_{0i}.$$

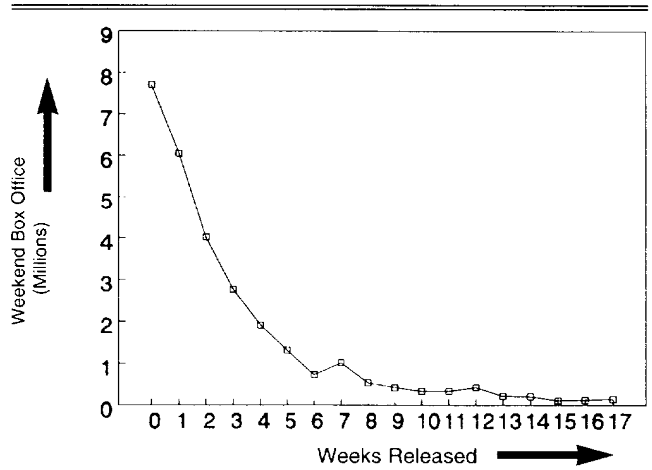
The intuition of the revenue model is straightforward. With no time dependence in competition or primary demand, each movie's revenues will decline smoothly with its attraction. However, changes in the competitors' attractions or in primary demand will moderate the exponentially declining revenue curve. In Appendix B, we empirically show that this formulation describes the revenue time curve for major movies extremely well. Here, we describe two examples in the context of the model.

Disney's *Jungle Book* (Figure 1) shows the typical pattern of a summer movie when primary demand is relatively strong and stable. Box office receipts rapidly decline with some deviations. In weeks 4, 5, and 6, such movies as *Air America* and *Darkman* were released, coinciding with a depression in the revenue curve. In weeks 7 and 8, there were no major releases, and *Jungle Book*'s revenues recover.

Edward Scissorhands (Figure 2), released just before the Christmas peak, shows both the distribution effect of a one-week test market and the primary demand boost at Christmas. *Edward Scissorhands* is one of the few major movies examined (in Appendix B) that did not achieve peak revenues in the first two weeks of wide release. Nevertheless, its largest share of the market, 13%, is in its first week of wide release.

Note that at opening time t_{oi}, $A_i(t_{oi}) = \exp[\alpha_i]$, so that α_i naturally captures the factors that affect opening strength. According to Rosen (1993), "almost all the effort in marketing a movie is directed at one specific objective, and that is

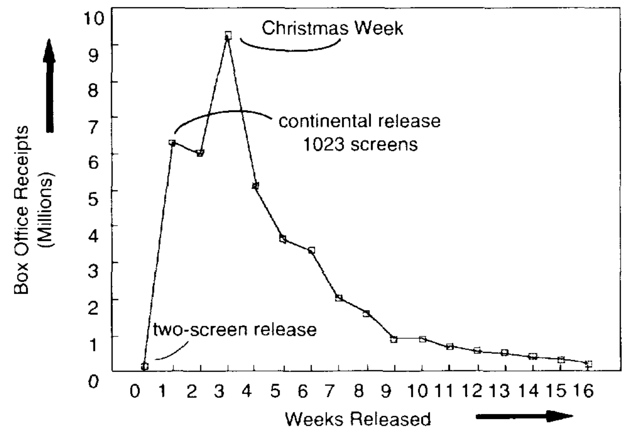
Figure 1
WEEKLY REVENUES OF *THE JUNGLE BOOK*[a]



[a]The *Jungle Book*, opening mid-July, shows the typical declining pattern of major summer movie releases and dips associated with competitor releases.

[4]Pioneering advantage considerations can apply to themes, because Hollywood often experiences bandwagon effects. A few years ago, the theme of adults and kids swapping bodies was popular: *Like Father, Like Son; Eighteen Again; Vice Versa;* and *Big*. Cannibalization is important because each studio releases many movies and therefore tries to avoid overlap, but there is no issue of delayed purchases due to expectations of technological advance.

Figure 2
WEEKLY REVENUES OF *EDWARD SCISSORHANDS*



Note the test market and the Christmas season primary demand effect.

the movie's opening weekend." We therefore refer to α as the marketability parameter. After the movie opens, its performance "is much more a function of the movie itself rather than anything we can do with advertising. If a movie is an enjoyable, satisfying experience for opening weekend patrons, they will spread positive word of mouth." Good word of mouth slows the decline rate of the movie, but, as Rosen states, "it's unusual for a picture to increase its business after the opening weekend, and this usually never happens except for very rare exceptions," so that the decline almost always remains exponential. The intrinsic features of a movie that determine its decay rate and run length are captured by β_i, which we therefore refer to as the playability parameter. In the language of innovation diffusion, α_i is essentially the response to external influence, and β_i to internal influence.[5]

High Seasons

The high-season phenomenon is illustrated by the North American weekend box office receipts for 70 weeks, from December 1989 to April 1991, in Figure 3. Strong fluctuations in industry revenues are apparent. The two important "seasons" are the 14-week summer plateau between May 25 and September 5, which has no "slow weeks," and the shorter Christmas season. For our requirements of focusing on competing high-season pictures and for tractability, we stylize the primary demand as being constant for a fixed number of weeks, similar to the summer plateau.

Release Timing Game

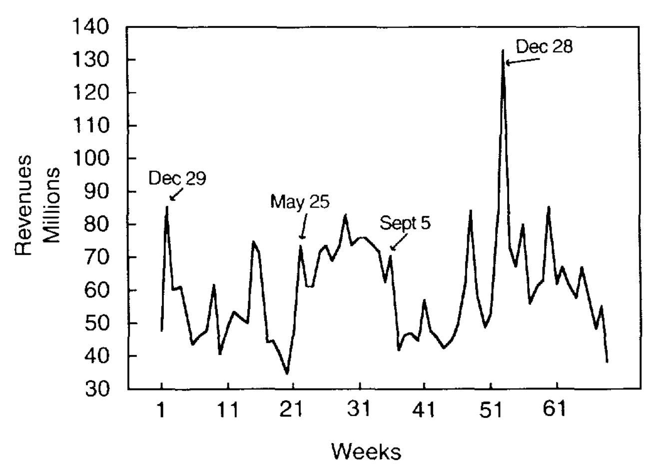
Equations 1 through 3 provide a compact but accurate and useful description of competition among major motion pictures. Using these, we next formalize the timing decision problem. We separate the competition (the denominator in Equation 1) into two strategic competitors, each with its own attraction life cycle and a uniform "generic" or background competition. This models the situation in which two movies compete directly (because of similar themes, genres, or stars) with each other, as well as indirectly with the entire spectrum of offerings that are continually available. Not only does this aid in tractability of the analysis and interpretability of the solutions, but it also has face validity. It would be difficult to argue that all movies compete with one another with equal intensity. *Braveheart* might compete directly with *Rob Roy* (both are Scottish hero sagas) and both therefore must consider carefully their respective release times accordingly; neither would be expected to worry much about the release timing of *Babe* or *Pocahontas*, even though these movies and many others undoubtedly provide a source of indirect competition. (One of the goals of the intensive market research conducted prior to setting release dates is to determine to which market segments that each movie slated for the season will appeal so that the direct competition can be identified.) The model thus captures the different intensities, or directness, of competition for a movie by two levels: a direct competitor and a mass of indirect competition.

We stylize the decision as one determining the revenue-maximizing opening time, given marketability and playability parameters, in a finite, constant primary demand season. To capture the importance of seasonal primary demand, we consider a fixed season $T = \{t \in R: 0 \leq t \leq t_f\}$ ending at time t_f, during which there is constant market demand expressed as an available revenue density. Let the available constant revenue density during this season be 1, without loss of generality. Two movies with attraction life cycles $A_i(t)$, $i \in \{1,2\}$, compete with each other and with a constant background attraction. The constant attraction captures the cumulative effect of all other motion pictures available. Without loss of generality, we set this constant "background" attraction equal to one, thus scaling the $A_i(t)$.

The total revenues (or box office receipts) for each picture are

Figure 3
NORTH AMERICAN BOX OFFICE RECEIPTS[a]

December 1989 to April 1991



[a]The seasonal fluctuations in movie revenues, showing the 1990 summer plateau and the Christmas peak.

[5]It is interesting to note the implication that external influence operates mainly before release and internal influence mainly after. Although Rosen might have understated the actual (and certainly the potential) influence of marketing after the movie's opening, the sequential view appears to be appropriate. Marketability is reflected in opening strength, and playability in run length, or legs.

$$R_i = \int_{t_{0i}}^{t_f} \frac{A_i(t)}{A_1(t) + A_2(t) + 1}\, dt, \tag{4}$$

where $t_{0,i}$ is the opening time of movie i, $t_{0i} \in T$, and, as in Equation 3, A_i is zero before opening.

We abstract from studio costs and exhibitors' charges and concentrate on the opening time decision with a revenue maximization objective. This is reasonable because studio production and marketing costs are incurred before release (see Vogel 1994, p. 69). The exhibitor can have a variety of contracts with the distributor but typically takes a sliding percentage that increases with time (Vogel 1994, p. 73). The effect of exhibitors' charges on release timing is discussed in the conclusions. We also assume, consistent with the institutional evidence (Grover 1992; Rosen 1993), that neither firm can commit credibly before the season to an opening date, so that firms simultaneously choose an opening time. We return to this point subsequently.

A final assumption is complete information: Both players know the marketability and playability—that is, α and β—of both movies. At the point the timing decision must be made, the studios have conducted extensive market research on both their own and the competitions' upcoming releases. A movie's marketability depends on factors that must be highly visible to the potential audience before release. These factors, such as stars, genre, special effects, and prerelease "hype," therefore must be equally visible to the competition. Although playability is perhaps less certain, scenario descriptions and test screenings attempt to determine in advance what the word of mouth will be. To quote Warner's Vice President of Market Research once again, "These competitive positioning studies are *very good* at identifying each picture's target audience and *the strength of its appeal* to that audience" (Rosen 1993, emphasis added). For example, National Research Group, Hollywood's main research company, produces "Summer Competitive Positioning Studies" each year. In 1992, this study provided forecasts of opening weekend box office for the 35 movies slated for the summer and selected *Lethal Weapon 3*, *Batman Returns*, and *Patriot Games* as numbers one, two, and three, respectively (Dutka 1992). These turned out to be the top three, though not in the same order. That the strength of the movies is common knowledge at the time release decisions are being made is illustrated by the following:

> Back in mid-November, when film distributors *were still jostling for opening dates* for their Christmas movies, I polled a range of Hollywood insiders and theatre exhibitors for the early line on how the 17 major studio pictures being released during the holidays would ultimately fare at the box office.... With one spectacular exception,[6] and a couple of minor ones, the November poll was *strikingly accurate*. Only one of the top seven films in that ranking finished lower than seventh, and that one is ninth. Twelve of the 17 films finished within three spots of their pre-opening positions, and eight were either right on the number or one removed (Mathews 1993, p. c8, emphasis added).

[6]The exception was *The Bodyguard*, which was ranked preseason at fourteenth and finished fourth.

We must clarify that there are always big-budget flops and small-budget successes. However, by the time the release decision is made, the movie is finished, the market research is complete, and the studios are confident they know the parameters. In short, though there is always some uncertainty of how well a movie will do, big surprises are rare, and the insights gained from a complete information game will be applicable.

Under these conditions, the Nash equilibrium is the appropriate model for the outcome of competition in opening times. A Nash equilibrium is a pair of opening times $\{t_{01}^*, t_{02}^*\}$ such that neither firm has an incentive to deviate given the other firm's choice of opening time. Share attraction and Nash equilibria have been used previously to model competitive outcomes (e.g., Gruca, Kumar, and Sudharshan 1992; Karnani 1985). Our model differs in that the marketing mix variable of interest, the release timing decision, enters the formulation as a limit on the time integral of the instantaneous share of attraction, rather than as a determinant of the attraction function. Therefore, the exponential form of the attraction function does not preclude equilibrium analysis (Gruca and Sudharshan 1991). The equilibrium opening times are, formally, the solution to

$$t_{01}^* = \underset{t_{01} \in T}{\operatorname{argmax}}\ R_1(t_{01}, t_{02}^*) \tag{5}$$

$$t_{02}^* = \underset{t_{02} \in T}{\operatorname{argmax}}\ R_2(t_{02}, t_{01}^*),$$

where R_i is defined in Equation 4.

SOLUTION METHOD

We first characterize the possible equilibria.

> P_1: If the attractions of the competing movies are less than the background attraction, then either (1) there is no equilibrium (i.e., there is no solution to Equation 5), (2) there is a unique equilibrium with at least one of the movies opening at the beginning of the season, or (3) there are two equilibria: one equilibrium with one of the movies opening first and a second equilibrium with the other movie opening first.

We prove P_1 in Appendix A and show that the conditions on relative strength are not restrictive. The proposition plays the same role as the usual uniqueness proposition in eliminating multiple equilibria, except that rather than a "no-more-than-one" result, it allows "no-more-than-two." Beyond uniqueness, it provides a further restriction in eliminating the possibility of equilibria with both movies delaying and, more important, guarantees that straightforward (though tedious) procedures will provide an exhaustive set of equilibria.

The first-order conditions for the maximization problem do not have analytic solutions. We therefore find numerical solutions. For given α_i, β_i, we assume one movie starts at the beginning of the season; that is, $t_{01} = 0$. We then find the unique optimal opening time t_{02} of the second movie given that the first opens at $t_{01} = 0$. We then check that t_{01} is Movie 1's optimal opening time given t_{02}. If it is, we have found an equilibrium pair $\{t_{01}^*, t_{02}^*\}$. We then reverse the roles of Movie 1 and Movie 2 and repeat the process. Provided the

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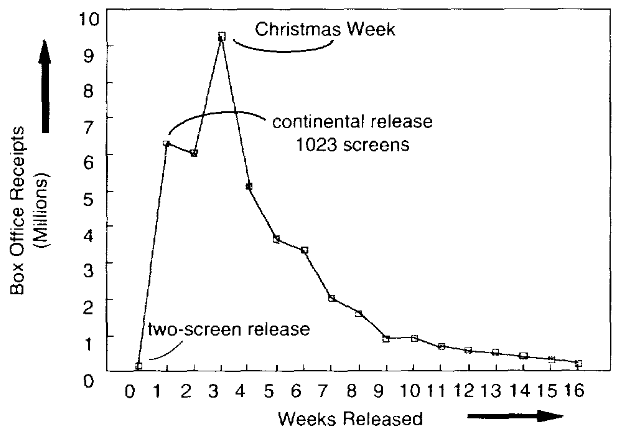

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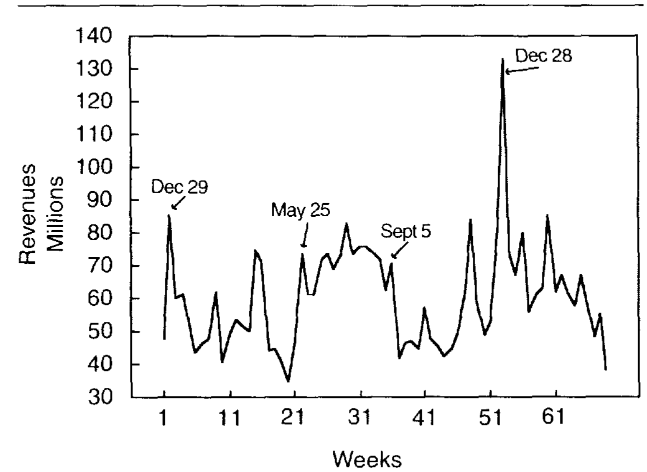

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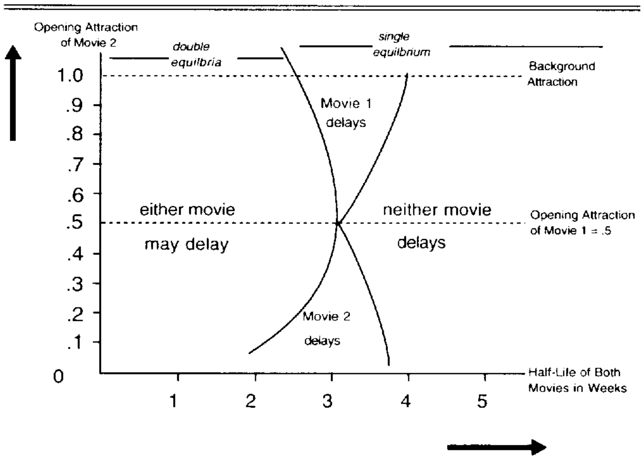
third movie will increase the delay of the last-opening movie.

To summarize, we can state that two movies with high playability (long legs) will compete head-to-head rather than try to avoid each other, unless they are very different in marketability. In that case, the weaker movie will prefer to delay and avoid the stronger movie. As the playability decreases, head-to-head competition becomes less desirable, and a relatively small difference in marketability will lead the weaker movie to delay. As playability of both movies decreases further still, a point is reached at which head-to-head competition never is preferred, regardless of relative marketability. This is also the point at which double equilibria appear: When the movies are similar or identical in marketability, but simultaneous opening and head-to-head competition is not an equilibrium, then either movie delaying is a Nash outcome. Finally, if the movies are sufficiently different on marketability, even in this case of weak playabilities, only one equilibrium, with the weaker movie on playability delaying, occurs.

Figure 5

TYPES OF EQUILBRIA IN PARAMETER SPACE[a]



[a]Different Marketability, Equal Playability. The figure shows when the various classes of equilbria described in the text occur. Half-lives of the two movies are equal, but range from one to five weeks, and Movie 2's opening attraction varies, whereas Movie 1's opening attraction is fixed at .5. The two movies are identical along the dashed horizontal line at .5 and increase in playability from left to right.

Types of Equilibria in Parameter Space

The four parameters α_i, β_i, $i \in \{1,2\}$ determine the equilibrium. We now can map the regions in four-dimensional parameter space in which each of the three classes of equilibria occurs. In Figure 5, a representative two-dimensional cross section of this parameter space, we show where each class of equilibrium occurs when Movie 2's opening attraction is fixed at .5 and the half-lives of the movies are equal and vary together. Figure 4 corresponds to a vertical slice at a half-life of 3.4 weeks in Figure 5.

When both movies have long half-lives (or legs, or playability), the loss from delay exceeds the loss from competition, and both prefer to open at the beginning of the season. With short legs, it is optimal for one to delay and avoid competition. Along the horizontal line $A_2 = .5$, the movies are identical, and so only symmetric equilibria are possible. Both movies open simultaneously at the start of the season (when legs are long), or one delays (when legs are shorter). Because either of the identical movies can delay, there must be two equilibria. Away from this line, the movies have different opening attractions, and single equilibria occur in an increasingly wider "wedge." Changing the fixed attraction of Movie 2 away from .5 produces parameter space partitions that retain the shape of Figure 5 but with the cusp shifted from .5 to the new attraction.

When parameter asymmetry in opening attractions (with equal half-lives) or in half-lives (with equal opening attractions) results in a single equilibrium, the stronger movie opens first. If two equilibria are possible, the Nash outcome is insufficient to predict which movie is likely to delay. We now examine the double equilibria case in more detail.

Double Equilibria

When there are two equilibria, is there any reason for one to be preferred? We identify three subcases. First, when the movies' strengths (in terms of either marketability or playability) differ by a large amount, the equilibrium with the stronger movie opening first is Pareto dominant; because both movies have higher payoffs in this equilibrium, it is the more likely outcome. Figure 6 shows an example.

Second, when the strengths are more similar, neither equilibrium is Pareto dominant. Each movie prefers the equilibrium in which it opens first and the competitor opens second. If each firm limits its choice to one of its two possible equilibrium opening times (i.e., opening either at the beginning of the season or at the optimal delay given the other opens at the beginning), the game has the payoff structure

Figure 6

PAYOFFS TO (SMALL, LARGE) MOVIE[a]

		LARGE MOVIE	
		beginning	delay
SMALL MOVIE	beginning	.1303 , .9628	.1712 , .9857
	delay	.1753 , .9948	

[a]Payoff matrix when both movies have half-lives of one week. The large movie has opening attraction of 1, and the small movie has opening attraction of .13. Both (beginning, delay) and (delay, beginning) are Nash equilibria, and the outlined cell is Pareto dominant. Also, compared with the (begin, begin) cell, the large movie gains .0229 by delaying, and the small gains .0450 by delaying. The small movie thus has more to gain by avoiding the "collision."

condition of the proposition is satisfied, this method will locate all equilibria for given α_i, β_i.

RESULTS

At least one equilibrium is always found; case (1) in P_1 does not occur. Note that the possibility of both movies opening simultaneously at the beginning of the season is a subcase of (2) in P_1. In the following, we consider this a separate class.

We find, then, three classes of equilibria—(1) both movies open simultaneously at the start of the season, (2) one movie opens later in the season, and (3) double equilibria with either movie opening later in the season. In the first case, the gains from opening at the beginning of the season and realizing revenues for the entire season outweigh the gains from delaying to avoid competition. This occurs, for example, when both movies have long legs. In the second case, asymmetric single equilibrium, one movie can increase its revenues by delaying its opening and avoiding head-to-head opening weekend competition. In the third case, there are two possible equilibria, with either movie delaying its opening. We first show and discuss the regions in parameter space in which each of these three cases occurs and then discuss the double equilibria case in more detail.

The parameters that describe each movie are α_i, the natural logarithm of the opening attraction, and β_i, the decay rate. For ease of exposition and without loss of generality over arbitrary season lengths, t_f is taken to be ten weeks.[7]

The effects of parameters are discussed in terms of the more intuitive (1) opening attraction, $A_i(0) = \exp(\alpha_i)$, which can be compared to the unit background attraction and closely parallels the industry's concept of marketability, and (2) the half-life of the movie in weeks, $t_{1/2,i} = .693/\beta_i$. The half-life is the length of time taken for the magnitude of an exponentially decaying function to decline to one-half of its original value. We use it because it provides a more meaningful description of the rate of decline than the decay parameter. Besides being measured in units (time) that are compared easily to the length of the season, it can be interpreted directly as a measure of legs or playability: A long half-life means long legs and (as with radioactive waste) that a movie will be around for a long time.

The following example shows the progression through the three types of equilibria. Which one occurs depends on both the marketability and playability of the two competing movies. For purposes of illustration, however, we start by assuming both movies have equal playability. Subsequently, we relax this assumption.

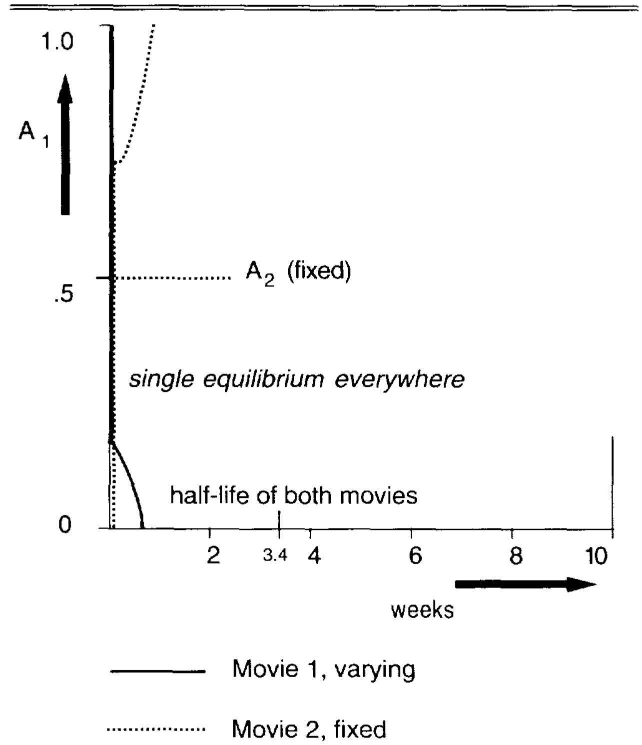
In Figure 4, we show equilibrium opening times as the opening attraction of one of the movies varies. For ease of exposition, the opening attraction (e^{α}) of Movie 2 is set equal to .5 (that is, half the general background attraction) and the attraction of Movie 1 varies between 0 and 1. In Figure 4, the half-life of both movies is set to 3.4 weeks, which represents relatively long legs. When Movie 1's attraction, $A_i(0)$, varies between .15 and .75, neither movie can gain by delaying its opening from the start of the season. However, when Movie 1 opens at an attraction of .15 or less, it should delay its opening. Similarly, if Movie 1's attraction is .75 or more, Movie 2 can benefit by delaying. The greater the difference in opening attraction between the movies, the more the delay should be. For the parameters shown in Figure 4, only single equilibria emerge.

As the half-lives of the movies decrease, the pressure to open early decreases and the region in Figure 4 in which both open at the beginning of the season narrows and eventually disappears. As the half-life decreases further, the regions (in terms of opening attraction) with a delayed opening begin to overlap, and double equilibria emerge (for movies with relatively similar opening attraction). Either movie can open at the beginning of the season, and the other movie will delay. As the legs become shorter still, the relative range of attractions in which double equilibria occur becomes wider. At a half-life of 2.5 weeks, the overlapping region of double equilibria extends from an opening attraction value for Movie 1 of .25 to beyond 1.

Note that for these parameters, which are representative of major movies, delay rarely exceeds two weeks in a ten-week season. As we show subsequently, the addition of a

Figure 4

EQUILIBRIUM RELEASE TIMING VERSUS OPENING ATTRACTION A_1[a]



[a]Equilibrium release timing as a function of opening strength of Movie 1, with Movie 2's strength fixed at half the background attraction, and both with half-lives of 3.4 weeks. Only when strengths are very different will the weaker movie delay opening from the beginning of the season.

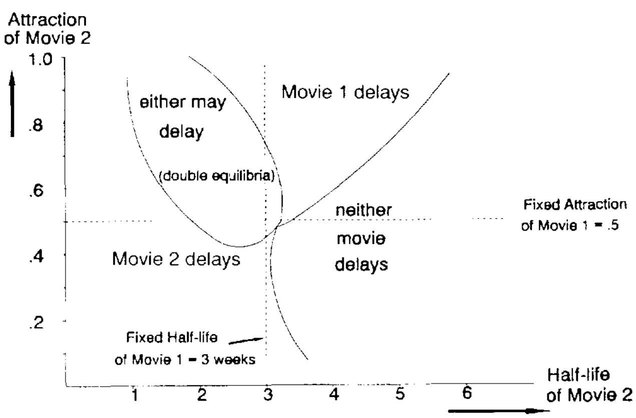
[7]We could have set this to 1 to make it clear that it is neither the absolute value of the season length nor the absolute value of the decay rates of the movies that matters, but the relation between the two that determines equilibrium outcomes. In effect, the legs are scaled to the season. However, we chose to make the analysis more intuitive by thinking in terms of a ten-week season. This is longer than the Christmas season and somewhat shorter than the summer season. To see equilibrium configurations for shorter or longer seasons, it is only necessary to examine the current equilibrium diagrams with longer or shorter legs.

movie. (This turned out to be the case: *Hoffa* ran for less than two months and grossed $23 million; *A Few Good Men* stayed seven months and grossed $141 million.) In fact, Columbia changed its release date after receiving market research data on the movies' strengths. The weaker movie, *Hoffa*, was unable to commit to the desirable early release date. To return to our analogy of the game of chicken, the driver of the Volkswagen saw the bus coming and swerved. In summary, this anecdote is consistent with the assumptions of full information and simultaneity as well as the equilibrium predictions.

To test our model further, we examined the 24 major movies released during the 1990 summer season. (These 24 movies are the summer season subset of the 102 movies analyzed in Appendix B.) On the basis of our equilibrium analyses, we expect that stronger movies—those with either higher opening strength (α) or longer legs (β)—to open earlier in the summer. Consequently, we regressed the number of weeks delay from the beginning of the season (May 25) against the opening weekend box office and the half-life. We found that opening weekend box office was highly significant as a predictor of delay ($t_{21} = -3.6$, $p < .005$); however, the half-life was not significant ($t_{21} = -.47$, $p > 0.5$). The overall F-test was significant ($F_{2,21} = 7.1$, $p < 0.005$). To check that this was not just a primary demand effect, we also ran a model with opening share rather than opening revenues with nearly identical results ($F_{2,21} = 5.6$, $p < .02$), which, given the relatively constant total revenues throughout the season (Figure 3), is to be expected.

The results support our model predictions with regard to opening weekend strength but not run length. This is consistent with the industry's intense focus on opening weekend box office, but otherwise we do not have a good explanation as to why the movies' legs are ignored. One possibility is that the opening date decision is in the hands of the marketing department, which thus concentrates on the outcomes it believes it can influence—the opening box office—rather than on the legs, or playability, which is seen as being out of its hands. Another is that the relaxation of our assumptions would render run length less important, as discussed subsequently.

Figure 8
TYPES OF EQUILIBRIA IN PARAMETER SPACE
MOVIE 1 FIXED, MOVIE 2 VARYING[a]



[a]Relative impact of marketability and playability on equilibrium class. Movie 1 is fixed on both dimensions, and Movie 2 varies on both dimensions. Movie 1 uniquely controls the beginning of the season in the lower-left quadrant, in which it is stronger in both marketability and playability. Movie 1 also controls much of the upper-left quadrant, in which Movie 2 is stronger in opening attraction (marketability). Movie 2 can occupy the opening position uniquely in only a small part of this quadrant and half of the upper-right quadrant, in which it has better marketability and playability, because the high playability of both movies forces a simultaneous opening.

Table 1
EQUILIBRIUM OPENING TIMES FOR SELECTED GROUPS OF THREE COMPETING MOVIES

	Opening Attraction	*Half-life (weeks)*	*Equilibrium Opening Time (weeks)*
Group 1:			
Equal short	.7	2	0
half-lives and	.5	2	1.7
different opening strengths	.3	2	3.7
Group 2:			
Equal opening	.5	3	0
attraction and	.5	2	1.2
different half-lives	.5	1	5.4
Group 3:			
Equal opening	.5	4	0
attractions and	.5	3.5	0
different (long) half-lives	.5	3	.9
Group 4:			
Equal opening	.5	4	0
attractions and	.5	4	0
equal longer half-lives	.5	4	0

MODEL LIMITATIONS

In this section, we review five main assumptions and discuss their implications.

No revenues are available outside the season. The availability of revenues before and after a particular season will reduce the pressure on a movie to compete head-to-head at the beginning of the season. This is particularly true of the end of the season, when only the tails of the life-cycle curve are involved. The softer ends of the real summer season, for example, would make managers less sensitive to revenue loss from delay than the model would predict and would focus their attention even more on avoiding direct competition in opening dates. This assumption would contribute to the lack of effect of playability in 1990 summer data. We expect, however, that incorporating soft seasonal boundaries would not alter the overall structure of the equilibrium patterns. We also note (see Figure 1) that the drop at the end of the season, though not to zero, is abrupt, with a revenue reduction of approximately 40% in one week.

An interesting consequence of revenues available before the season is that when the season is particularly crowded with big-budget wide-release films, such as the 1997 summer season, movies originally produced for summer release will "jump the gun" and open before the usual start of the summer season on Memorial Day weekend.[9] Still, the

[9]For a formal treatment of this issue, see Radas and Shugan (1996).

Figure 7
PAYOFFS TO (SMALL, LARGE) MOVIE[a]

		LARGE MOVIE	
		beginning	delay
SMALL MOVIE	beginning	.5678 , .8471	.7161 , .9681
	delay	.7106 , .9790	

[a]Payoff matrix when both movies have half-lives of one week. The large movie has opening attraction of 1, and the small movie has opening attraction of .67 (compared with .13 in Figure 6). The two diagonal cells are still Nash equilibria, but neither is Pareto-dominant. Compared with the (begin, begin) cell, the large movie gains .121 by delaying, and the small gains .1427 by delaying, and thus the small movie still has more to gain by avoiding the "collision."

of an asymmetric version of the classic game of "chicken" (see, e.g., Rasmusen 1989, p. 73). Consider what would be predicted to happen when, for example, a Volkswagen car and a Greyhound bus appear doomed to a head-on collision unless somebody swerves. Although either driver swerving is an equilibrium, it can be predicted that the Volkswagen driver, having the most to lose, is more likely to swerve. The analogous case for movies is illustrated in Figure 7, in which the opening attraction of Movie 1 is .67 compared with Movie 2's opening attraction of 1; neither equilibrium Pareto dominates. The payoff structure, however, is such that the smaller movie has more to lose from the collision when both movies choose to open at the beginning of the season. The weaker movie, analogous to the Volkswagen, is most likely to delay its opening ("swerve").

The third subcase is the limiting one of identical movies. Both parameters are the same (think of two identical 1956 Chevies), and the payoffs to stay/delay strategies are the same for each player. Each movie prefers the equilibrium in which it opens first, but the symmetry removes any reason for selecting one equilibrium over the other.[8]

We can summarize the previous results concisely in terms of how similar the two movies are. The double equilibria cannot be resolved when the movies are identical. As we move off the line of identity (see Figure 5), we expect the smaller movie to delay, because it has more to lose from a collision. As we move further from identical movies, the equilibrium with the small movie delaying also becomes Pareto dominant. With a still greater difference, this same equilibrium becomes the *unique* Nash equilibrium, at the point indicated by the boundary of the single-equilibrium region in Figure 5. We can generalize by saying that the greater the difference in the strength of the movie, the more reason the smaller movie has to delay its opening.

We now briefly return to the issue of the appropriateness of a simultaneous moves game as a model for the opening time decision. When both firms know it is always optimal for at least one movie to open first, each firm must decide whether to open at the beginning of the season or not. As the beginning of the season approaches, it becomes more difficult to change the decision. Because the studios are (nominally, at least) independent from the exhibitors, both firms have equal difficulty in changing. Although it is dominant for both to *announce* they want the prime release date, both are equally able (or unable) to commit to the date. Because neither is able to commit before the other, the simultaneous moves model is appropriate.

The Relative Influence of Marketability and Playability

To this point, we have confined our attention to the cases in which either marketability, expressed as opening attractions, or playability, expressed as half-lives, are the same for both movies. It is obvious in those cases which is the "stronger" movie. What happens when a movie is more marketable (stronger opening) but less playable (shorter legs) than its competitor? In Figure 8, we hold both parameters fixed (at intermediate values of opening attraction = .5 and half-life of three weeks) for Movie 1 and vary both marketability and playability of Movie 2.

For this example, the equilibria resulting follow the same general rule when it is obvious which movie is stronger (lower-left and upper-right quadrants): Either the stronger movie opens first, or they both open at the beginning of the season. If it is not obvious which is stronger (upper-left and lower-right quadrants), playability apparently has more influence than marketability in determining the equilibrium configuration. This is interesting, because the industry's marketing strategy currently appears to focus on a film's opening strength; these results suggest that more attention might be paid to a film's legs in choosing a time to release a movie.

Three Firms

In this section, we briefly consider the implications for three movies competing strategically. Although the complete solution for three movies, involving mapping equilibria in six-dimensional parameter space, was not attempted, we present results for a representative set of parameter values in Table 1. We still have the condition that at least one firm must open at the beginning. Moreover, though more equilibria are possible with three movies competing than with two, equilibria that naturally generalize the duopoly results occur. Long legs lead to simultaneous openings at the beginning of the season, shorter legs lead to competition-avoiding timing, and strength in either marketability or playability implies the ability to release in the preferred early season times.

INDUSTRY PRACTICE

The timing game between *Hoffa* and *A Few Good Men* described in the introduction now can be explained. Both studios believed that *A Few Good Men* was the stronger

[8]We note that "cheap talk" is not useful here as a coordinating mechanism, because it is dominant for both movies to announce that they will open at the beginning of the season.

Our analysis focuses on the case in which strategic competition is duopolistic. Examples shown from three-player games, however, suggest that the major insights derived from the underlying trade-offs in the two-player game still apply.[12] An interesting empirical question is how many and precisely which movies actually do compete. Although the studios attempt to determine this on the basis of prerelease audience research, we know of no econometric postrelease research that addresses this question. We suspect, however, that the actual number of direct competitors of a particular movie is low and certainly far less than the number of movies available in a high season.

Studios currently do extensive research prior to release of their products to determine the marketability and playability of their own and competitive products. An interesting avenue for further work therefore would be to combine that data with this modeling approach into a decision support system to assist in the timing decision for a studio's portfolio of upcoming movies. Aside from when to release in the high season, a related timing question is whether to release in the intensely competitive high-revenue seasons or in the low-revenue, less-competitive seasons.

APPENDIX A: PROOF OF PROPOSITION

We first prove the following lemmas:

Lemma 1: Let $S_{1,m}$ be the cumulative share of Movie 1 in the absence of Movie 2, that is, with background competition only.

$$S_{1,m} = \int_{t_{01}}^{t_f} \frac{A_1(t)}{A_1(t) + 1} dt. \tag{A1}$$

Suppose Movie 1 opens after the start of the season, that is, t_{01} strictly greater than 0. Then $S_{1,m}$ always can be increased by opening earlier; that is,

$$\frac{\partial S_{1,m}}{\partial t_{01}} < 0. \tag{A2}$$

Proof. Substituting the exponential form of the attraction in Equation A1 and integrating

$$S_{1,m} = -\frac{1}{\beta_1} \ln\left\{1 + \exp\left[\alpha_1 - \beta_1(t - t_{01})\right]\right\}\Big|_{t_{01}}^{t_f}. \tag{A3}$$

Differentiating with respect to t_{01},

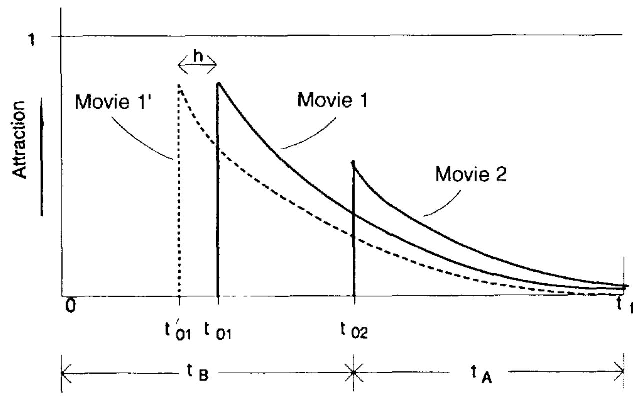
$$\frac{\partial S_{1,m}}{\partial t_{01}} = -\frac{\exp[\alpha_1 - \beta_1(t_f - t_{01})]}{1 + \exp[\alpha_1 - \beta_1(t_f - t_{01})]} < 0. \tag{A4}$$

QED.

Lemma 2: If an equilibrium (a solution to Equation 5 in the Model section) exists with $t_{01} \le t_{02}$, and if $A_1(t)^2 \le A_2(t) + 1$, $\forall t \in \mathbf{T}$, then $t_{01}^* = 0$.

[12]Increasing the number of different players might require different approaches to capture competitive interactions and resulting configurations that can occur. For analysis of such complexity in different settings, see Krider and Weinberg (1997).

Figure A1
ATTRACTION LIFE CYCLES FOR TWO COMPETING MOVIES AND NOTATION FOR PROOF



Subscript notation. Subscripts 1 and 2 identify the motion picture, subscript m refers to the "monopoly" case of Lemma 1, and subscripts B and A refer to "before" and "after" the opening of Movie 2. Note that if the movies open simultaneously, that is, $t_{01} = t_{02}$, instantaneous and cumulative shares with the "before" subscript are zero and the proof is still valid.

Proof. Proceed by contradiction. Suppose at equilibrium neither movie opens at t = 0. Then either both open simultaneously or one opens before the other. Let the movie opening first, or either movie in the case of simultaneity, be designated Movie 1, with instantaneous attraction $A_1(t) = \exp[\alpha_1 - \beta_1(t - t_{01})]$. Let $s_1(t)$ be the instantaneous share of Movie 1 and S_1 be the associated cumulative share. We consider separately times before and after the opening of the second movie, designated t_B and t_A,; that is, $0 \le t_B < t_{02} \le t_A \le t_f$. Referring to Figure A1, we note that before the opening of the second movie, the shares of the first are the same as in the "monopoly" case of Lemma 1:

$$s_1(t_B) = s_{1,m}(t_B) = \frac{A_1(t)}{A_1(t) + 1}. \tag{A5}$$

Similarly, let $S_{1,B}$ and $S_{1,A}$ be the cumulative shares of Movie 1 before and after the opening of Movie 2.

Now examine the changes when Movie 1 opens a small amount of time h earlier, at time $t'_{01} = t_{01} - h$. Let $s'_1(t_B)$, $S'_{1,B}$, $s'_1(t_A)$, and $S'_{1,A}$ be the new shares for Movie 1. Using the same primed notation for the "monopoly" case, we can express Lemma 1 as $S'_{1,m} > S_{1,m}$. Splitting this expression at t_{02},

$$S'_{1,m,B} + S'_{1,m,A} > S_{1,m,B} + S_{1,m,A}. \tag{A6}$$

The cumulative shares before t_{02} are the same for both the monopoly and competitive case: $S'_{1,m,B} = S'_{1,B}$ and $S_{1,m,B} = S_{1,B}$. We substitute accordingly:

$$S'_{1,B} + S'_{1,m,A} > S_{1,B} + S_{1,m,A}. \tag{A7}$$

Also from Lemma 1 (set $t_{02} = t_f$), we have movie expected to be strongest, Universal's *The Lost World*, controlled the preferred Memorial Day opening date.

Movie parameters are known in advance with certainty. A common complaint in the industry is the unpredictability of movie success. Every year has its big-budget bombs and small-budget sleepers. At the point the timing decision has to be made, however, the studios have conducted extensive market research on both their own and the competition's upcoming releases. As discussed previously, a full-information model therefore seems reasonable. A model incorporating uncertainty would be an interesting, but challenging, next step.

Primary demand is constant within the season. Primary demand fluctuates strongly over the year (see Figure 1), and the studios want to have their peak selective demands coincide with peak primary demands. Our assumption of constant primary demand within the season, coupled with the first assumption of no revenues outside the season, stylizes these broad fluctuations so that we can examine the implications of seasonal variation parsimoniously and derive interpretable results. From Figure 1, for example, we can see that these two assumptions approximate the summer season quite well. In any case, we expect that the general implications of the model—for example, that stronger movies can occupy the preferred positions—will hold.[10]

Exogenous primary demand. It is likely that the movies available affect primary demand, a factor we do not incorporate. How much effect each movie has on expanding primary demand and if there are some complementarity effects are interesting and open empirical questions. The greater the proportion of a movie's revenues derived from an audience that would otherwise not see any movie (i.e., own market expansion), the less the incentive to avoid competition and the stronger the force to open at the beginning of the season. Similar to the first assumption—which operates in the opposite direction—this should perturb the results but not change the general pattern. In any case, all of the institutional evidence and the fact that we see strong separation in the opening times of movies suggest that competition for market share dominates any market expansion effects.

The maximization objective is box office revenues, neglecting exhibitors charges. The exhibitor receives a percentage of the box office revenues that increases over time. The studio's actual revenues, therefore, decline more rapidly and have shorter half-lives than the box office. The effect of a shorter half-life is to increase the importance of avoiding the competition relative to the importance of opening first. Maximizing box office revenues therefore will give results that slightly understate the pressures on the studio to avoid the competition. To the extent that the actual revenues remain exponential, however, the same analysis would apply, and equilibrium configurations would be similar. Note that this would contribute to the failure to observe a playability effect in the data.

DISCUSSION

Similar to many other new product introduction timing decisions, release dates are a critical marketing mix decision for the multibillion dollar motion picture industry. As in other industries, product life cycle, seasonal primary demand, and competition affect the decision. In this article, we use the surprisingly systematic nature of the life cycle of major motion pictures in an equilibrium analysis of the release timing decision.

One force on the timing decision is to avoid the competition, particularly at the dominant early part of a motion picture's run. A second force is to capture as much of the peak primary demand times as possible. This results in a battle for early release dates in the season, with each firm deciding whether to attempt to occupy an early date or avoid head-to-head competition by delaying.

The half-life of the decaying life cycle reflects the playability of the movie. As the playability increases, the pressure to open early increases. Less playability, conversely, gives the movie more mobility in release timing. Opening strength, before any word of mouth begins to operate, reflects the marketability of a movie. The greater the half-life and the more similar the opening strength, the more likely are simultaneous openings at the beginning of the season. If the movies have shorter half-lives but remain similar in opening strength, we have two possible equilibria, with either movie delaying. As the opening strengths differ by increasing amounts, it becomes more likely that the weaker movie will delay, up to the point at which only a single equilibrium exists, with the weaker movie delaying.

When half-lives are different, we again have the general result that the stronger movie will occupy the lead position, with the weaker movie either delaying or competing head-to-head, depending on its strength. Generally, for two movies with similar opening strengths and half-lives greater than three weeks in a ten-week season, neither movie can gain from delay. These, however, would be unusually successful movies. For the shorter half-lives typical of major movies, it is more likely that one movie would delay. Similarly, during the shorter Christmas season, simultaneous early openings are more likely than they are during the longer summer season, given movies with the same legs.

Empirically, opening strength, measured by either revenues or share, is related inversely to opening delay. Conversely, we do not find half-life related to delay and offer possible explanations. Although further research is required, an opportunity might exist for management to improve release timing decisions by paying more attention to a movie's legs.

Our focus groups suggest that some consumers are market mavens who regularly view movies early and enjoy disseminating information to others.[11] The outcome of the timing game could benefit such consumers who have high utility for viewing a motion picture early in its run. As noted previously, simultaneous openings are rare, allowing these consumers a steady diet of openings, rather than clusters of openings alternating with long dry spells. Stated more generally, timing of product release could be a strategic way of avoiding ruinous head-to-head competition between similar products while, in at least some cases, providing added consumer value.

[10]Similarly, we also assume that available opening times are continuous, whereas movies typically open just before the high-revenue weekend. Again, this should not change the result that stronger movies are expected to open earlier.

[11]This is consistent with Neelamegham and Ostrom (1997), who find two segments of moviegoers: one primarily influenced by reviews and word of mouth and one more by expectations of the movie.

Proof. Designate the competing movies as Movie 1 and Movie 2. If an equilibrium exists with Movie 1 opening first (or simultaneously), then by Lemma 2, it must open at the beginning of the season. Movie 1's attraction is less than the background attraction, so its share is less than .5. From Lemma 3, there is then a unique optimal opening time for Movie 2, and therefore the equilibrium with Movie 1 opening first is unique. Reversing the subscripts completes the proof.

APPENDIX B: EMPIRICAL JUSTIFICATION OF EXPONENTIAL SHARE ATTRACTION MODEL

Because revenues are easily measurable, we consider the implications of the exponential share attraction model for revenues. Casual inspection of revenues such as in Figures 1 and 2 show approximate exponential decline with time. In the model, revenues will be more nearly exponential in decline as primary demand and competition is more nearly constant with time and as $A_i(t)$ is small compared with $\Sigma A_j(t)$. For the latter condition, Equation 1 can be written as

$$R_i(t) \approx A_i(t) \frac{D(t)}{\sum_{\substack{j \in J_t \\ j \neq i}} A_j(t)}. \qquad \text{(B1)}$$

Equation B1 is a multiplicative separation into factors intrinsic to the movie itself (the attraction) and factors extrinsic to the movie. If there is no systematic relation between the opening times of movies and the variation either in primary demand or in competition, we can average many revenue curves so that these two extrinsic factors will be averaged to their (time constant) mean. Because each movie has its own unique marketability and playability (α and β), which scale the extrinsic factors' impact on each movie's revenues, we first must shift and scale all curves to a standard curve (i.e., to a standard α and β) before averaging them.

Specifically, we choose a standard α and β of 0 and .6931, respectively (which values conveniently give unit opening revenues and time unit equal to one half-life), before averaging. This is operationalized by (1) dividing each movie's revenue curve by its own opening box office and (2) estimating a revenue decay parameter β_i for each movie by regression and then rescaling the time coordinate. The new time coordinate t_i' is related to the old coordinate t by $t_i' = \beta_i(t - t_{0i})/.6931$. The logarithm of each standardized curve then is resampled by linear interpolation at constant intervals of .05 half-lives. If the extrinsic modulators are delayed randomly from opening times of each movie, the curve constructed from the means of these resampled values should be monotonically declining, and the smaller the own-attraction relative to the overall competition, the more nearly the curve should be a straight line. This means we expect more (negative) departure from a monotonically decreasing linear relation at larger revenues.

Data

Weekend box office receipts for 70 weeks (December 1990 to April 1992) of North American movie releases were collected from *Variety* magazine. Each week the 50 to 60 top-grossing movies are reported for a total of 3640 data points for 359 movies. Total revenues in the data set are $4.17 billion.

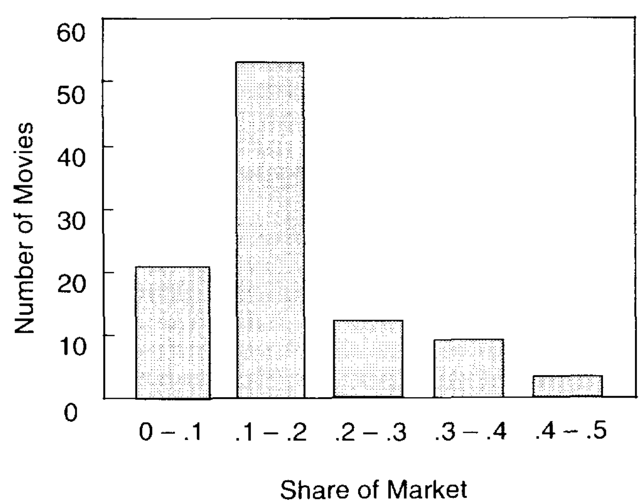
Many of the movies are obscure, with limited release and short runs. We confine our attention to major movies, defined as movies that enter the top five for at least one week; that is, we are looking at mass-market movies. Because we estimate two parameters per movie, we also drop movies with only one week of data. This provides us with a data set consisting of 104 movies and 1499 data points.

Although most of these 104 major movies have standard continent-wide releases, every season there are a few exceptions—the "sleepers." These start with limited distribution and, as they build an audience, gradually increase to wide release, becoming mass-market movies. In our data set, only two—*Driving Miss Daisy and Reversal of Fortune*—were found and excluded from further analysis. As with *Edward Scissorhands*, a few movies are given limited release (in less than 5% of the theatres in which they are eventually shown) before they get continent-wide release. Again this is unusual, applying to only 9 movies in our data set and for only one to three weeks. These observations, but not the movies, are dropped from our data set. (Inclusion of these data points had little overall effect on the empirical results.) The final data set consists of 102 movies (including the previously mentioned 9) and has total revenues of $3.33 billion. This is 80% of the revenues of the original data set; the 20% of revenues we do not consider belong to productions with limited audiences and distribution, which are not our main interest here.

Analysis

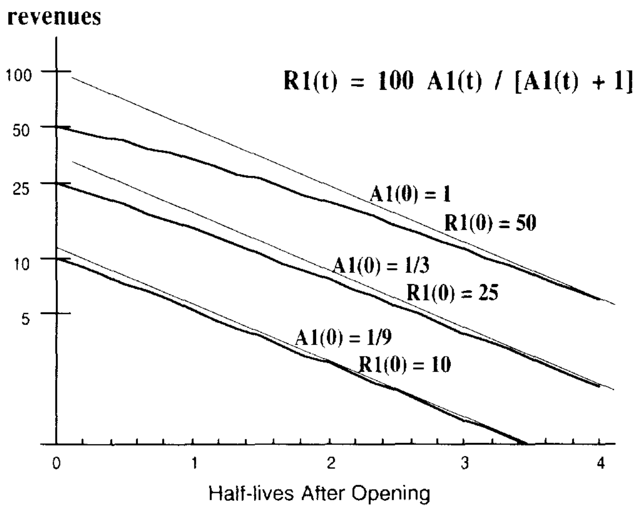
Because largest shares occur during opening week, the distribution of opening shares provides an indication of how good the assumption of small shares is. In Figure B1, we show the distribution of opening shares in the data set. Only three movies had more than a 40% share, and *Hunt For Red October* had the highest share of 49.4%. Typically, how-

Figure B1
DISTRIBUTION OF OPENING SHARES[a]



[a]The distribution of the actual opening weekend shares for 102 major movies.

Figure B2
THEORETICAL REVENUES FROM SHARE ATTRACTION MODEL WITH CONSTANT COMPETITION AND PRIMARY DEMAND[a]



[a]Logarithmic plot of theoretical revenues, given exponential attraction and primary demand of 100 units, for opening attractins of 1, 1/3, and 1/9, and unit competitive attraction, corresponding to opening shares of .5, .25, and .1. Deviation from simple exponential decline (upper tangents) is small and decreasing as attraction and therefore share decrease.

Figure B3
COMPOSITE OF ACTUAL REVENUES[a]

[a]Mean standardized log revenue curve constructed from 102 movies, each resampled at .05 half-lives. The tangent line provides a reference to highlight the near-linearity of the data and the slight deviation at large shares. The shape is precisely what would be expected given exponential attraction and the share distribution shown in Figure B1.

ever, opening shares are less than 20%, and subsequent week shares much less. Using this share range, we calculate reference curves on the basis of the model with constant competition and primary demand for comparison with the empirical curve. For example, if we set the primary demand to 100 and the combined attraction of the competitors to 1 and examine opening attractions exp[α_1] of 1, 1/3, and 1/9 (giving opening shares of 50%, 25%, and 10%, which covers the range of shares in the data set), Figure B2 shows a logarithmic plot of the resulting theoretical revenue curves, $R_1(t) = 100A_1(t)/[A_1(t) + 1]$. There is only slight deviation from the tangent line, $100A_1(t)$, also shown in Figure B2, at the early larger opening shares. We therefore expect that if our model is reasonable an average standardized curve also should be nearly linear on a log scale.

Figure B3 shows the mean standardized log revenue curve constructed as described previously. It is very nearly linear, deviating slightly at early stages when opening attraction is higher, consistent with the model of revenues arising from an exponential attraction in a share attraction framework. We take Figure B3 as strong support for our general model.

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