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

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Series No. MKTG 95.030
February, 1995

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First Draft: Please Do Not Cite

The authors gratefully acknowledge Eitan Muller for early discussions and insights on this research.

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Abstract

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 introduction in the motion picture industry critical, particularly in the high-revenue Christmas and summer seasons. Each studio would like to capture as much of season as possible, by opening early in the season. At the same time, each would like to avoid head-to-head competition. A key factor is the product life cycle which can be captured very well with a two-parameter exponential decline. We 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. Three different equilibrium configurations emerge. These are: 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. We 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 provides partial support for the conclusions.

COMPETITIVE DYNAMICS AND THE INTRODUCTION OF NEW PRODUCTS: THE MOTION PICTURE TIMING GAME

Rapid new product development and introduction characterizes the highly competitive motion picture industry. Although studios have steady sources of income, such as those derived from their film libraries, the major investments and potential returns are in the constant production and release of new films. For example, the average cost for producing and marketing a major movie in 1992 was forty million dollars (Advertising Age, Sept 29, 1993, p20). "Blockbuster" returns, however, can exceed one hundred million dollars. As is the case in any industry where survival depends on continual product development and introduction, the risks are also huge: roughly seven in ten movies fail to recoup their investment (Rosen, 1993).

Perhaps even more so than in other new product categories, the timing of the product introduction is a critical marketing mix variable. The marketing campaign for each movie is conducted primarily before the product is released. The product life cycle is so short -- typically a few weeks -- that there is very little opportunity to fine-tune a campaign once the product is released (and no opportunity to fine-tune the product). This, and the intense competition, makes the release timing critically important. Daniel Rosen, Vice-President of Market Research at Warner Brothers, recently stated at the 1993 AMA Marketing Research Conference,

> ... we often don't even know what our competition is going to be up until a very short time before we release a picture. All of the 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.

Variety magazine, (May 16, 1994, p36), under the subheading "Fateful Release", amplifies and notes the importance of the seasonal nature of the market:

> Release dates are critical, says Duband [Wayne Duband, Warner Bros. Intl. president], noting: "Some movies don't work because you go head-to-head against a movie which you did not think would be serious competition -- like 'Cool Runnings.' It's becoming even more difficult for family pictures which you have to release during the holidays or summer."

In this paper, we analyze the release timing decision in a game theoretic context. We model three determinants of release timing: seasonality, product life cycle, and competition. We first discuss similarities and differences between motion picture release and other new product introductions. We then characterize the revenue life cycle as consisting of an exponentially decaying function of time arising from factors intrinsic to the movie itself, and from the market factors of seasonal primary demand and competitive forces. Within this framework, we model duopolistic competition in release timing in a fixed season, and characterize the classes of equilibrium outcomes as a function of the life cycle parameters. Finally, we test the general outcomes of the analysis on the 1991 summer movie releases.

MARKET ENTRY TIMING, SEASONALITY, AND PRODUCT LIFE CYCLE

Much theoretical and empirical research has been devoted to the entry timing decision. The majority of this work is concerned with the tradeoff between the risks associated with being a pioneer, and the risks of missed opportunity through delay (Lilien and Yoon, 1990; Kalyanaram and Urban, 1992; Kalish and Lilien, 1986; Carpenter and Nakamoto, 1989). Another consideration is cannibalization of a firm's existing products, particularly in technological markets (Norton and Bass, 1987; Moorthy and Png, 1992). These issues are secondary in the motion picture release decision[1]. In contrast, the primary issue here 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). "Staying away" here refers to the very early part of a movie's run, and arises from what is perhaps the most striking difference between motion pictures and most new products: the product life cycle is very short, and extremely skewed. On average, 25% of a major picture's revenues are taken *in the opening weekend*; viewed alternatively, in a sample of 102 major movies (as discussed below), all but 8 had their highest sales in their first or second weekend. The constraint on avoiding the competition is that movies are targeted for particular seasons, such as the big summer season from mid-May to the beginning of September, and the smaller Christmas season. Thus the tradeoff here is one of trying to capture as much of the revenues in the season as possible, while avoiding the competition, which is trying to do the same.

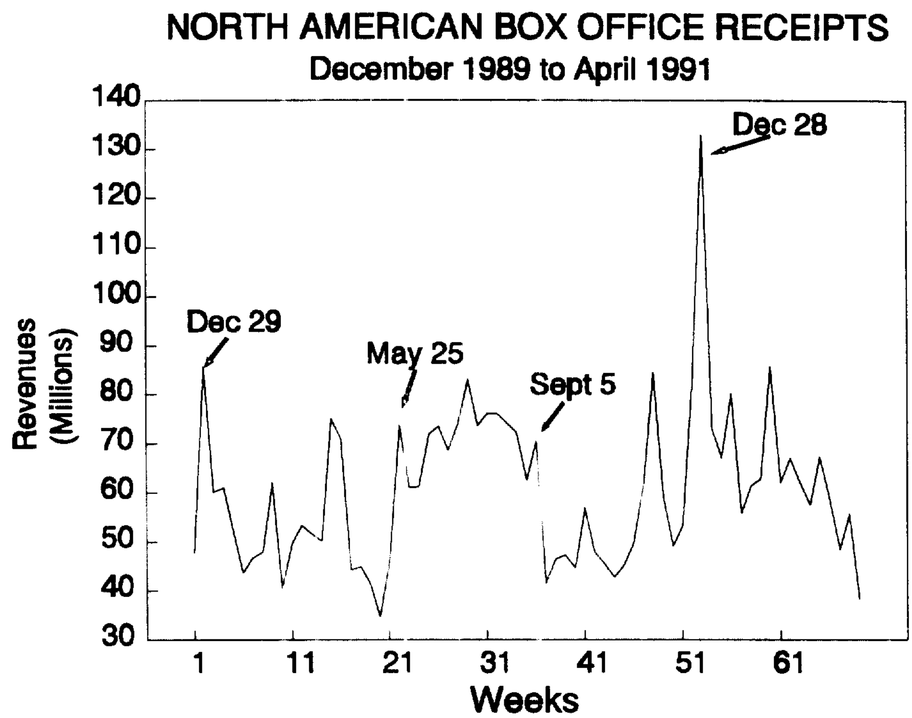

Figure 1: The seasonal fluctuations in movie revenues, showing the 1990 summer plateau and the Christmas peak.

The seasonal phenomena can be illustrated by examining the North American weekend box office receipts for 70 weeks, from December 1989 to April 1991, as shown in Figure 1. Strong fluctuations in industry revenues are apparent. The two important "seasons" are the long 14-week high-revenue summer season, and the shorter Christmas season. Motion pictures compete for this primary demand, over their product life cycle.

We have already noted that the very early part of a movie's run is the most important, and it is interesting to observe this, and the various influences on the shape of the life cycle, in specific cases.

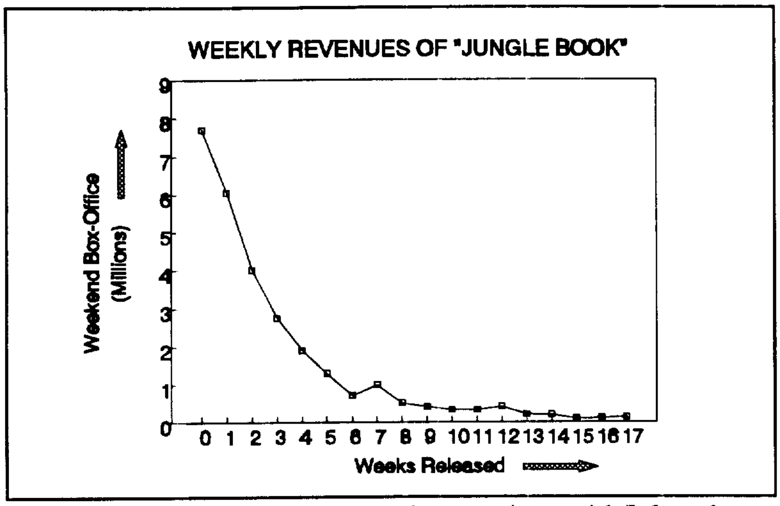

Figure 2: The Jungle Book, opening mid-July, shows the typical pattern of major movie releases, with dips associated with competitor releases.

Disney's *Jungle Book* 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, *Air America, Flatliners, Exorcist III*, and *Darkman* were released. In weeks 7 and 8, there were no major releases, and *Jungle Book*'s revenues appear to recover slightly.

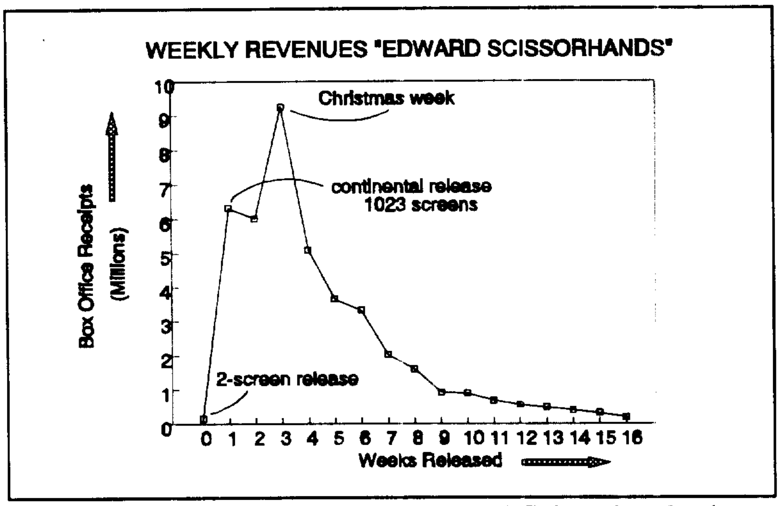

Figure 3: The revenues of Edward Scissorhands shows a testmarket and the primary demand effect of the Christmas season.

Edward Scissorhands, released just before the Christmas peak, shows both the distribution effect of a 1-week test market, and the primary demand boost at Christmas. *Edward Scissorhands* is unusual in being one of only 8 (of 102) major movies examined that did not achieve peak revenues in the first two weeks of wide release. Nevertheless, its largest share of market, 13%, is in its first week of wide release.

The intrinsic features of a motion picture which affect its revenues (such as stars, directors, and expenditures) are summarized by the industry as the movie's "marketability" and its "playability". In a diffusion of innovations context, the marketability can be considered the movie's susceptibility to external influence, and the playability, its susceptibility to internal, or word of mouth, influence. However, motion pictures are unique in yet another way: the two influences are separated in time. According to Rosen (1993), "almost all the effort in marketing a movie is directed at one specific objective, and that is the movie's opening weekend." Once 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...". While Rosen may have understated the actual (and certainly the potential) influence of marketing after the movie's opening, the sequential viewpoint appears to be appropriate-- external influence operates up to the opening of the movie, and internal influence after. Therefore marketability is reflected in opening strength, and playability in run length, or "legs".

Revenues are also affected by the extrinsic (to the movie) factors of primary market demand, which fluctuates widely from week to week, and the competition from current releases. Once production is complete, and intrinsic characteristics are set, management must decide on release timing. This decision depends on those fixed characteristics, the seasonal demand (Figure 1), and the competition. In the next section, we show that for the vast majority of movies, the impact of the intrinsic characteristics on the product life cycle is very systematic. With few exceptions, the life cycle, in the absence of primary demand effects and competitive releases, follows an exponential decline. The parameters for this curve parallel the industry jargon of "marketability" and "playability".

THE INTRINSIC PRODUCT LIFE CYCLE

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 fifty to sixty 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 dollars.

Many of the movies are obscure, with limited release and short runs. We confine our attention to major movies, defined as a movie which enters the top 5 for at least one week. Since we are estimating two parameters per movie, we also drop movies with only 1 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. In our data set, only two--"Driving Miss Daisy" and "Reversal of Fortune" --were found , and were 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 1 to 3 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 dollars, 80% of the revenues of the original data set.

To illustrate the systematic nature of the intrinsic dynamics, we remove the effects of competition and primary demand from the revenue curve by constructing a *mean standardized* revenue curve for the 102 movies as follows. Assuming that the intrinsic life cycle follows a decaying exponential function completely specified by an intercept and a decay parameter, we estimate these parameters for each movie. We then scale the data by the estimated parameters to standardize the curve, and average the result across movies. Specifically, for the i^{th} movie, we estimate

$$\ln(revenues_i) = \alpha_i - \beta_i * weeks\ released_i + \epsilon_i$$

The fit for the majority of movies was very good (median R^2 of .96, with a range from .46 to 1.00). Figure 4 show the distribution of the e^{α}, the exponential of the intercept, which may be interpreted as the estimate of the "intrinsic" opening weekend box office. For each movie, we divide the revenues by this intrinsic opening revenue value and take the logarithm, to create a new log normalized revenue variable, $\ln(revenue_i) - \alpha_i$. The estimated decay rate β_i is converted to half-life, $t_{1/2,i} = .693/\beta_i$. The half-life provides

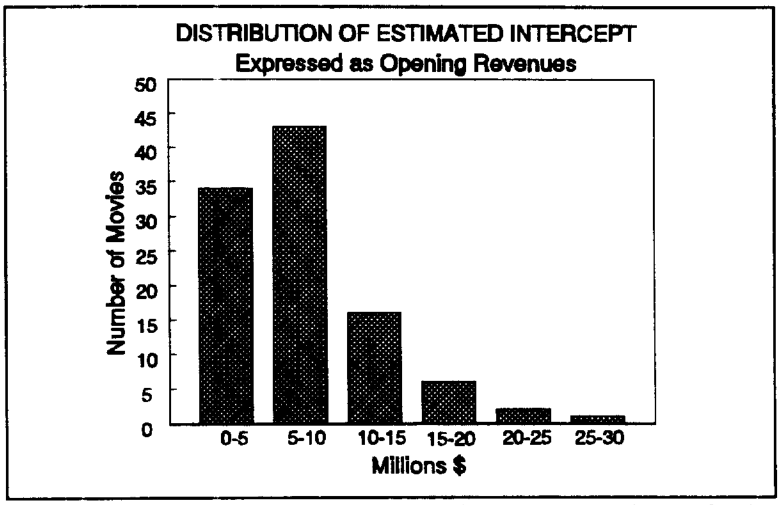

Figure 4: The distribution of the exponential of the estimated intercept, corresponding to the intrinsic opening weekend box office, for 102 major movies.

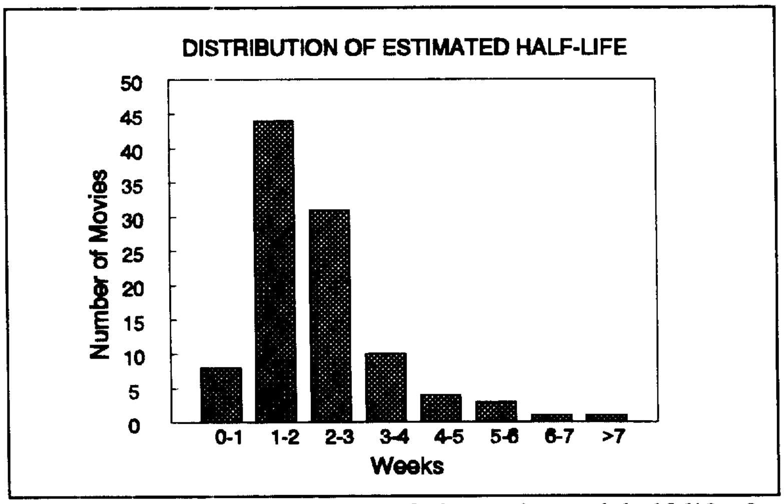

Figure 5: The distribution of the estimated half-life for 102 movies.

a measure of the number of weeks before a movie reaches half of its opening box office (Figure 5 shows the half-life distribution). We then rescale in the time domain by resampling the data at intervals of 0.1 $t_{1/2}$. The resulting standardized curve for each movie can now be averaged across movies.

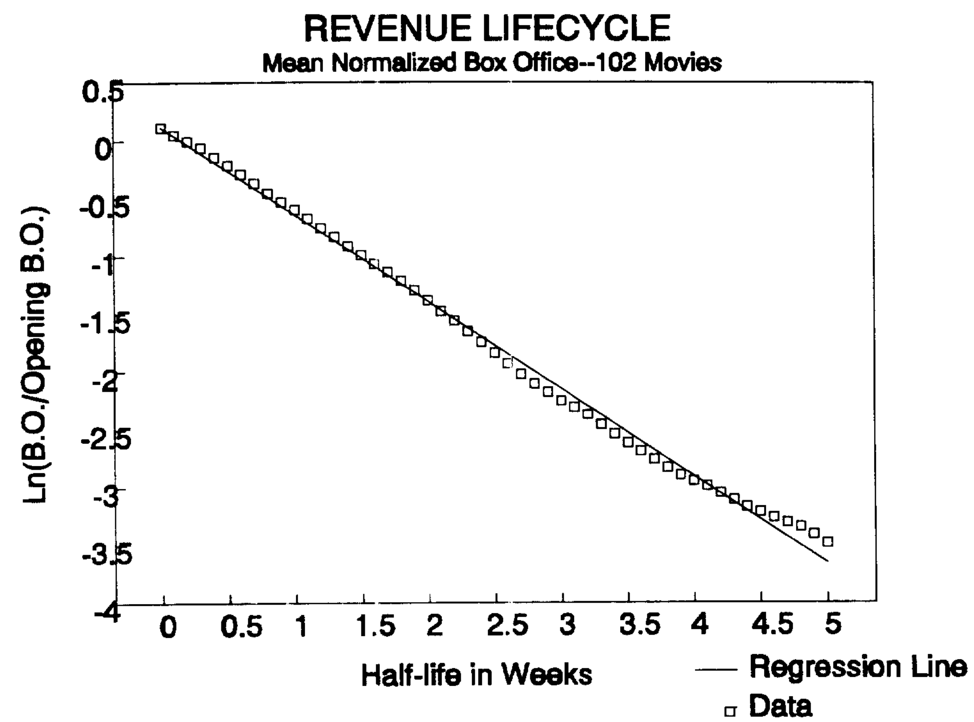

Figure 6: Each movie's sales are normalized to its opening box office and resampled at intervals of 0.1 of its own half-life. The mean of 102 such curves deviates negligibly from exponential decay.

Figure 6 shows the mean standardized curve. Over 5 half-lives, corresponding to reduction in revenues by a factor of 32, the log-linear plot is nearly perfectly straight. The R^2 value of the superimposed regression line is .996. Combined with the empirical results shown earlier, the results shown in Figure 6 provide compelling evidence that the intrinsic product life cycle for the motion pictures studied here is an exponential decline. Each movie can be very well described by two parameters: opening strength and decay rate. In analogy with industry jargon, we refer to the opening strength as "marketability", and decay rate, or preferably half-life, as "playability."

One of the interesting consequences of this skewed life cycle is that, even though there are many movies available at any one time, major movies on opening week command substantial market share. Figure 7 shows the distribution of opening week share for the 102 movies. Three movies had more than a 40% share, and *Hunt For Red October* had the highest share, 49.4%.

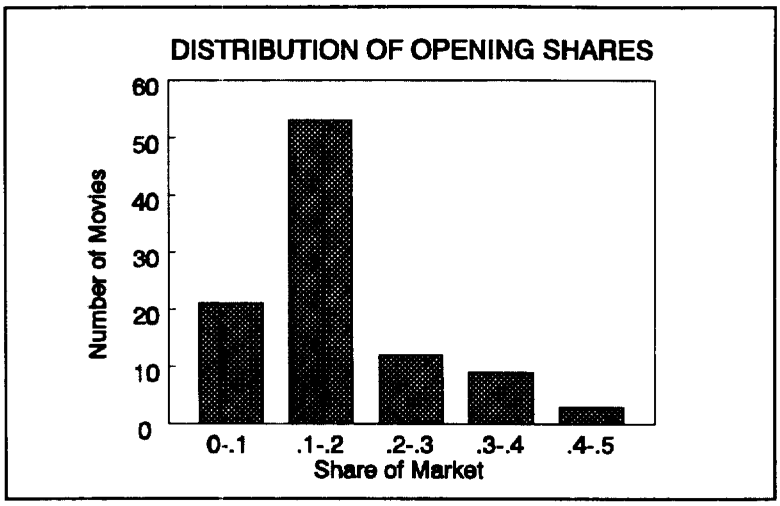

Figure 7: The distribution of the actual opening weekend shares for 102 major movies.

We have characterized the nature of the product introduction timing decision in the motion picture industry as one of choosing a release date in a given season, where management has a reasonably good idea of the strength of its own and potential competitors' movies, and where strength is captured by the exponentially decaying "intrinsic product life cycle." In the next section, we formalize this characterization for a duopoly in the presence of "generic" or background competition. We use a share attraction framework (Bell, Keeney, and Little, 1976) to model competition, and the Nash equilibrium to model outcomes. We capture the intrinsic product life cycle effects by assuming that the attraction is dynamic, and that it follows an exponentially declining pattern over time. Revenue deviations from this decline thereby arise strictly from competition and seasonal primary demand. For simplicity, we stylize the decision as one of determining the revenue-maximizing opening time, given marketability and playability parameters, in a finite, constant primary demand, season.

MODEL

Consider a fixed season $\mathbf{T} = \{t \in \mathbf{R}: 0 \leq t \leq t_f\}$, 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. In a share attraction framework, two movies with attraction life cycles $A_i(t)$, $i \in \{1,2\}$, compete with each other, and with a constant attraction which 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

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

where $t_{0,i}$ is the opening time of movie i, $t_{0i} \in \mathbf{T}$. On the basis of the previous empirical results, we restrict the $A_i(t)$ to exponentially declining functions with parameters α_i, $\beta_i \in \mathbf{R}^+$, assumed to be common knowledge (as discussed earlier):

$$\begin{aligned} A_i(t) &= e^{\alpha_i - \beta_i (t - t_{0i})}, \quad t \geq t_{0i} \\ &= 0 \qquad\qquad\quad , \quad t < t_{0i} \end{aligned} \tag{2}$$

We abstract from the exhibitors' charges and concentrate on the opening time decision with a revenue maximization objective. We also assume, consistent with the institutional evidence (Rosen 1993; Business Week, November 2, 1992), that neither firm can credibly commit before the season to an opening date. We will return to this point later. The firms therefore simultaneously choose a time t_{0i}^* which maximizes revenues.

We use the Nash equilibrium to model the outcome of competition in opening times. For the game described, 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 (eg., Karnani, 1985; Gruca, Kumar, and Sudharshan 1992). 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. Hence the exponential form of the attraction function does not preclude equilibrium analysis (Gruca and Sudharshan, 1991). In equilibrium, then

$$\begin{aligned} t_{01}^* &= \underset{t_{01} \in T}{argmax}\, R_1(t_{01}, t_{02}^*) \\ t_{02}^* &= \underset{t_{02} \in T}{argmax}\, R_2(t_{02}, t_{01}^*) \end{aligned} \qquad (3)$$

Intuitively, it would seem that at least one movie must open at the beginning of the season. This depends, however, on the background competition. A movie could have near zero attraction late in its run. With no outside competition, because of the share attraction framework, this movie would capture nearly all of the market provided only that the second movie had an even lower level of attraction late in its run. This unrealistic heavy weighting of the tail of the movie affects the equilibria, and is the main reason that the background competition must be included in the share attraction model. As long as the movies' attractions are not too large compared to the background competition, the intuition that one movie must open at the start of the season is true. The following proposition formalizes the intuition, which is useful for the subsequent analysis.

PROPOSITION 1: SUFFICIENT CONDITIONS FOR AT LEAST ONE MOVIE TO OPEN AT THE BEGINNING OF THE SEASON IN EQUILIBRIUM.

If an equilibrium (a solution to eq. 3) exists, designate, without loss of generality, the movie which opens earlier in equilibrium as movie 1. If the square of the attraction of movie 1 is less than or equal to the attraction of movie 2 plus the background attraction during the season, then movie 1 will open at the beginning of the season in equilibrium. Formally, if $A_1(t)^2 \leq A_2(t) + 1$, $\forall t \in \mathbf{T}$, *then* $t_{01}^* = 0$.

Proposition 1 is proven in Appendix A.

Corollary: *If the opening attraction of both movies is less than or equal to the background attraction, at least one must open at the beginning of the season in equilibrium.*

Proof: The inequality of Proposition 1 is satisfied if $A_1(t) \leq 1$, $\forall t \in \mathbf{T}$ (the background attraction is 1). Also, $A_1(0) \geq A_1(t)$, $\forall t \in \mathbf{T}$. Hence the inequality is satisfied if $A_1(0) \leq 1$. Reversing the subscripts completes the proof, as one movie must open first, or both open simultaneously. QED.

The Corollary provides a stronger condition than the Proposition. It is, however, easier to check than the condition in the Proposition, and is still not highly restrictive. In Figure 7, we showed the distribution of opening weekend shares, for 102 movies released in 1990 and early 1991. Only one approaches 50% share, suggesting that background attraction is greater than A(t) for all movies in that data set.

The first order conditions for the maximization problem do not have analytic solutions. We therefore find numerical solutions, making use of Proposition 1. For given α_i, β_i, we assume one movie starts at the beginning of the season, ie., $t_{01} = 0$. We then perform a grid search to find the optimal opening time t_{02} of the second movie given the first opens at $t_{01} = 0$. Given this optimal opening time, we then allow t_{01} to vary to find the optimal opening time, given the previously optimal t_{02}. If this search gives $t_{01} = 0$, 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 condition in Proposition 1 is satisfied, and our grid search is fine compared to the variation in the revenue function with opening times, this method will locate all equilibria for given α_i, β_i.

RESULTS

Depending on the parameter values, we find 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 will first show and discuss the regions in parameter space where each of these three cases occur, and then discuss the double equilibria case in more detail.

The parameters which describe each movie are α_i, the natural logarithm of the opening attraction, and β_i, the decay rate. The season length, t_f, is taken to be 10 weeks[2]. 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 with the unit background attraction, and (2) the half life of the movie in weeks, $t_{1/2,i} = 0.693/\beta_i$, which can be compared to the season length of 10 weeks. These quantities parallel the industry's concepts of "marketability" and "playability" (or "legs").

The following two examples show the progression through the three types of

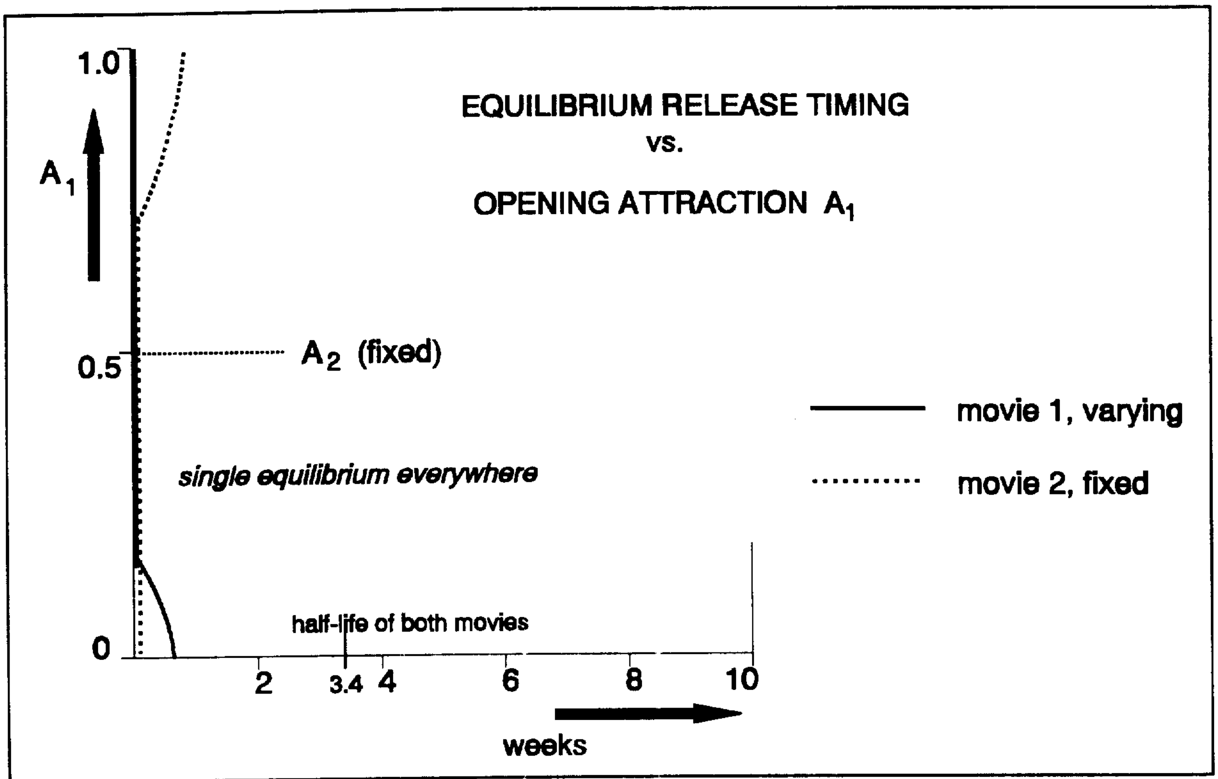

Figure 8: Equilibrium opening times when both movies' half-lives are 3.4 weeks. For very different attractions, the smaller movie will delay release; otherwise, both open at the beginning of the season.

equilibria. Which one occurs depends on both the "playability" and "marketability" of the competing movies. However, for purposes of illustration, we will start by assuming both movies have equal legs (or betas). Later we will relax this assumption.

Figures 8 and 9 show equilibrium opening times as the opening attraction of one of the movies varies. When both movies have long legs (long half-lives), neither movie can gain by delaying its opening from the start of the season. As the half life decreases, one movie (the one with the weaker opening attraction delays its opening. Figure 8 illustrates this case when the half-life of the movie is 3.4 weeks. In Figure 8, the opening attraction (e^{α}) of Movie 2 is set equal to 0.5. When Movie 1 opens at an attraction of 0.15 or less, then it should delay its opening. Similarly, if Movie 1's attraction is 0.75 or more, Movie 2 should delay its opening. The greater the difference in opening attraction between the movies, the more the delay should be.

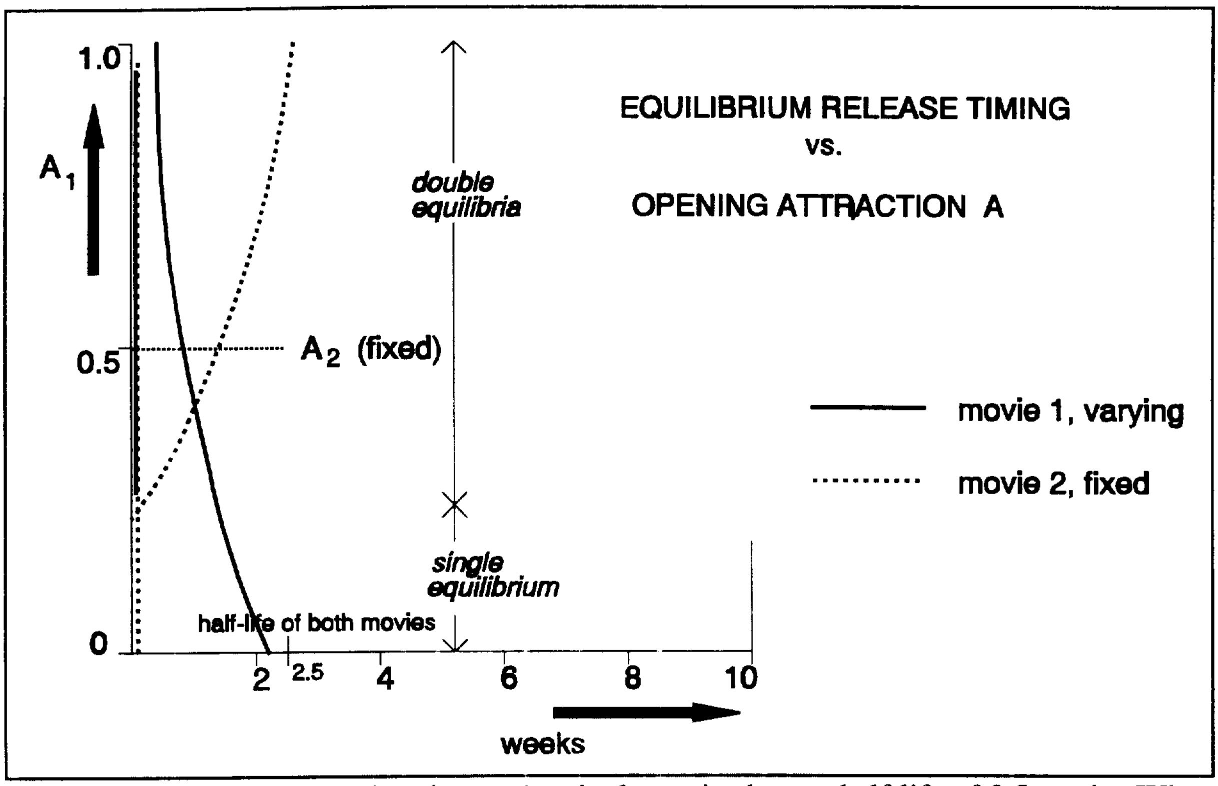

Figure 9: Equilibrium opening times when both movies have a half-life of 2.5 weeks. When the smaller movie is more than half the larger (attraction of 0.5) movie, there are two equilibria.

As the half-lives of the movies decrease, the pressure to open early decreases, and the region in Figure 8 where 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). As the legs become shorter still, the relative range of attractions where double equilibria occur becomes wider. As shown in Figure 9, 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.

Types of Equilibria in Parameter Space

The four parameters α_i, β_i, $i \in \{1,2\}$, determine the equilibrium. Continuing the case described in Figures 8 and 9, Figure 10 shows where each type of equilibrium occurs when Movie 2's opening attraction is fixed at 0.5, and the half-lives are equal ($\beta_1 = \beta_2$). The

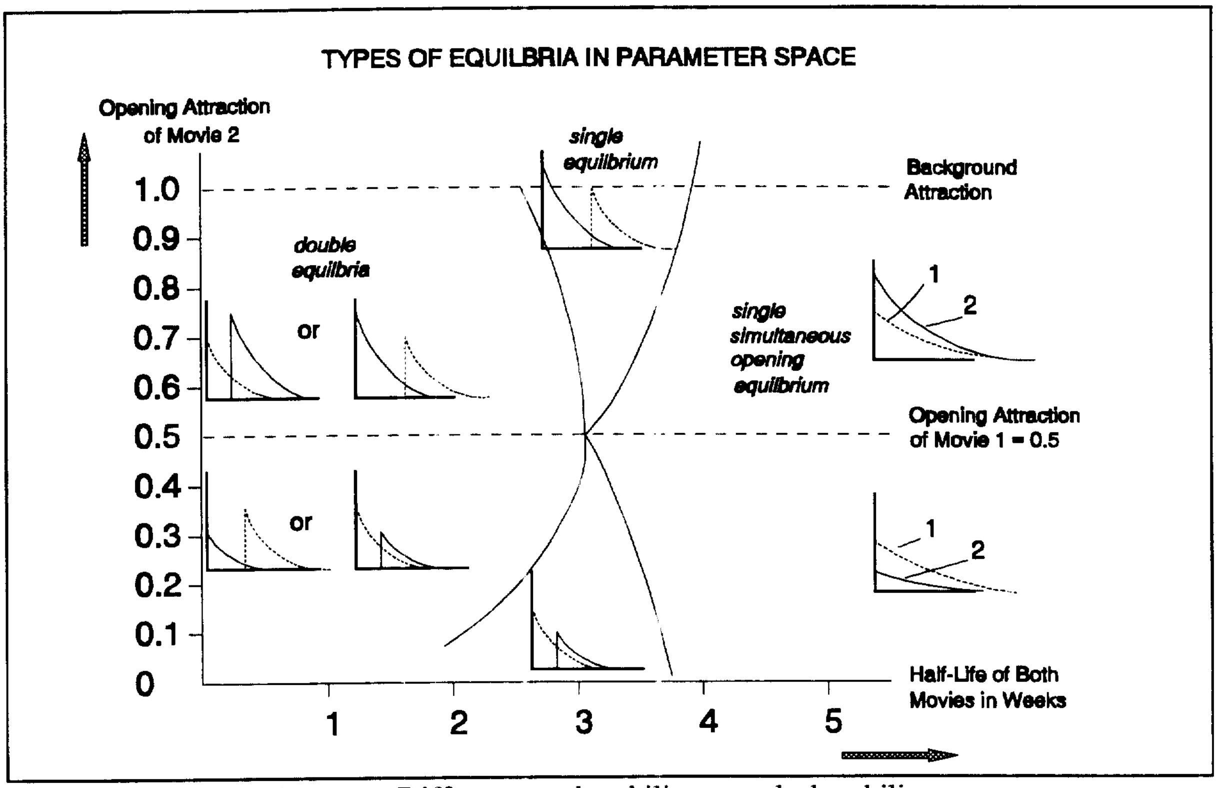

Figure 10: Equilibria map: Different marketability, equal playability.

opening attraction (marketability) of Movie 1, and the half-lives (playability) of both, are varied. Figures 8 and 9 correspond to vertical slices at half-lives of 2.5 and 3.4 weeks in Figure 10.

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 $A_2 = 0.5$, the movies are identical, and so only symmetric equilibria are possible. Since at least one of the identical movies must open at the beginning of the season, we can have either simultaneous opening equilibria (when legs are long), or, if one movie delays, double equilibria (when legs are short), since either of the identical movies must be able to delay.

As we move away from this line, the movies have progressively more different opening attractions, and *asymmetric single* equilibria occur in an increasingly wider "wedge".

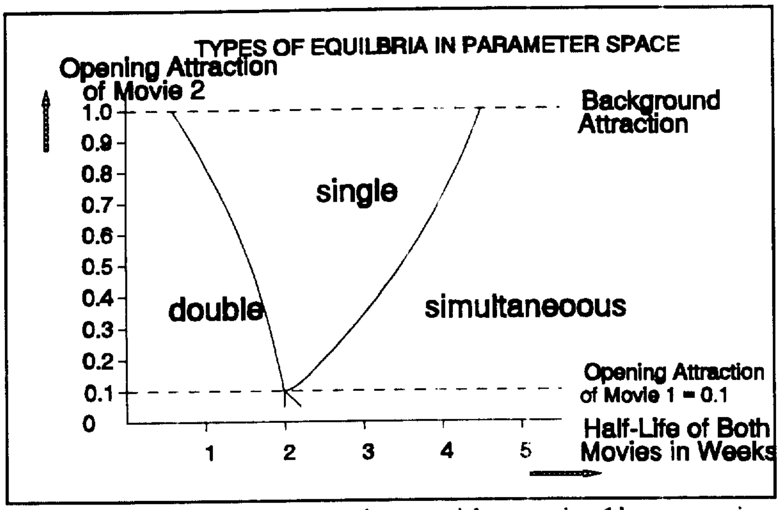

Figure 11:Equilibrium regions with movie 1's attraction fixed at 0.1.

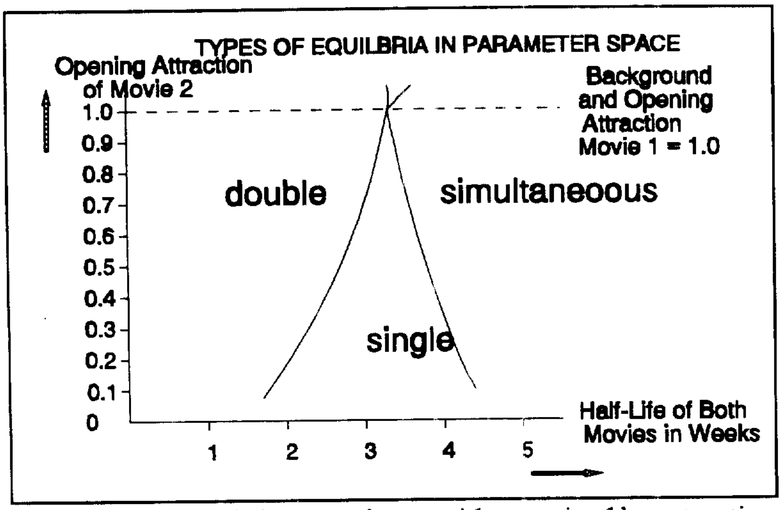

Figure 12:Equilibrium regions with movie 1's attraction fixed at 1.0.

Figures 11 and 12 are similar to Figure 10, except that the fixed attraction is now 0.1 and 1.0, respectively. Parameter space partitions retain their shape, shifted upwards or downwards following the symmetry line, with the transition from single to double equilibria occurring at slightly longer half-lives with larger attractions.

Figures 10, 11, and 12 provide a map of equilibrium outcomes when the competing movies are equally "playable". In Figures 13 and 14, we look at outcomes when the competitors differ on playability, or half-lives, but have the same opening attraction. Again we have a similar pattern: long half-lives force both movies to open first, short, similar half lives allow either movie to delay, and asymmetry in half-lives leads to a single asymmetric equilibrium. The difference between Figures 13 and 14 is that the equal opening attractions has doubled, from 0.5 to 1.0, in Figure 14. There is only a slight shift in the parameter space with this change, indicating that when opening attractions are equal, the type of equilibria depend primarily on the movies' legs.

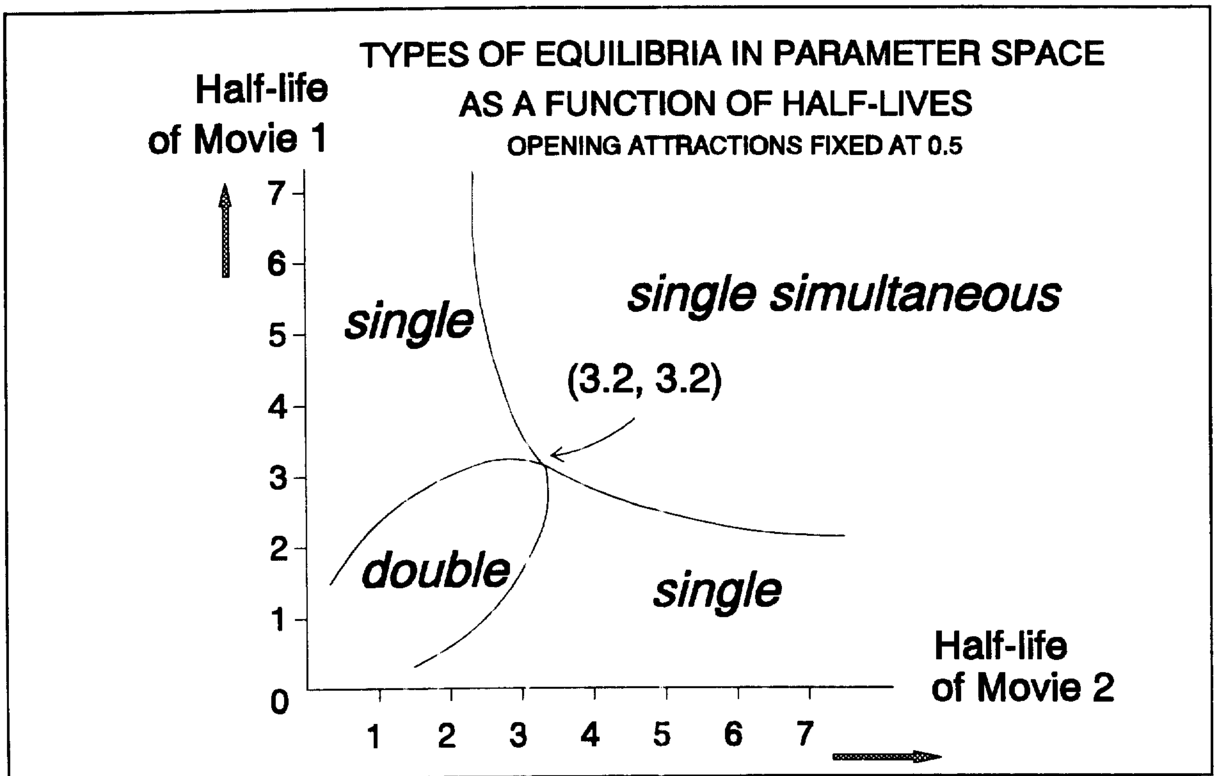

Figure 13: Equilibrium regions when both movies' opening attractions fixed at 0.5.

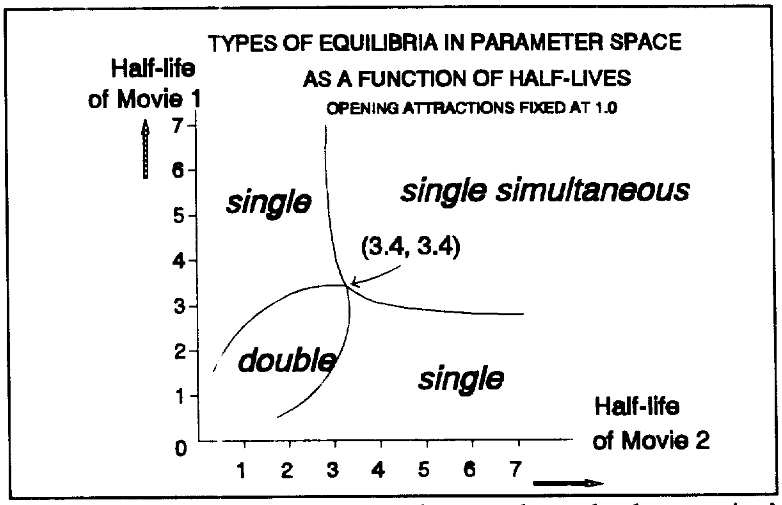

Figure 14: Equilibrium regions when both movies' opening attractions fixed at 1.0.

When there is a single asymmetric equilibrium, whether the parameter asymmetry is in opening attractions (with equal half-lives) or in half-lives (equal opening attractions), the *stronger movie opens first.* (See, for example, Figures 8 and 9). When there are two possible equilibria, either the stronger or the weaker movie can open first. We now examine the double equilibria case in more detail, and show that the stronger-first equilibrium is preferred.

Double Equilibria

Confining our attention to the previously discussed cases, i.e., either α or β equal for the two movies, we identify three subcases. 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, and should be the one chosen.

When the strengths are more similar, the second subcase occurs, where neither equilibria is Pareto dominant. Each movie prefers the equilibrium where 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., either opening at the beginning of the season, or at the optimal delay given the other opens at the beginning), the game has the payoff structure of an asymmetric version of the classic game of "chicken" (see, for example, Rasmusen, 1989, p73). 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. While either driver swerving is an equilibrium, one would feel comfortable predicting that the VW driver, having the most to lose, is more likely to swerve. The weaker movie is analogous to the VW and is more likely to delay its opening ("swerve") than the bus. We now explicitly illustrate these cases.

Payoff matrices, when the half-lives are equal and the opening attraction of Movie 2 (large movie) is fixed at 1, are shown below. In the first case (Figure 15), the opening attraction of Movie 1 is .13, much less than for Movie 2, and the equilibrium with Movie 1 delaying Pareto dominates. In the second case (Figure 16), the opening attraction of Movie 1 is .67, and neither equilibrium Pareto dominates. In both cases, however, the smaller movie has more to lose from the collision when both movies choose to open at the beginning of the season.

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

payoffs to (small,large)

Figure 15: Payoff matrix when both movies have half lives of 1 week. Large movie has opening attraction of 1, and 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 to 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".

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

payoffs to (small,large)

Figure 16: Payoff matrix when both movies have half lives of 1 week. Large movie has opening attraction of 1, and small movie has opening attraction of **.67** (compared to .13 in Figure 15). The two diagonal cells are still Nash equilibria, but neither is Pareto-dominant. Compared to 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".

The third subcase is the limiting one of identical movies: both parameters are the same, and the payoffs symmetric. If the payoffs are symmetric, there is no reason to prefer one equilibrium over the other[3].

In summary, the double equilibria cannot be resolved when the movies are identical. As we move off the line of identity in Figures 8 to 13, we expect the smaller movie to chicken out and delay, because it has more to lose from a collision. As we get further away, and closer to the region where there is only a single equilibrium, the small-delayed equilibrium also becomes Pareto dominant. This same equilibrium becomes the *only* Nash equilibrium when we cross the boundary into the single equilibrium region. We may 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. Since the studios are (nominally, at least) independent from the exhibitors, both firms have equal difficulty in changing. While it is dominant for both to *announce* they want the prime release date, both are equally able (or unable) to commit to the date. Since 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 when either marketability, expressed as opening attractions, or playability, expressed as half-lives, are the same for both movies. When discussing the type of equilibrium in terms of the relative sizes of the parameters which differ, it is natural to speak of the "stronger" movie. We may, however, have a movie that is more marketable (stronger opening) but less playable (shorter legs) than its competitor. In Figure 16, we vary both marketability and playability of *one* movie, while holding both parameters fixed (at intermediate values of opening attraction = 0.5, and half-life of three weeks) for the other, so that we can see the tradeoffs between marketability and playability in terms of the equilibria map.

When movie 2 is smaller than movie 1 on both parameters, (lower left quadrant in Figure 16) there is, for most parameter combinations, only a single equilibrium with movie

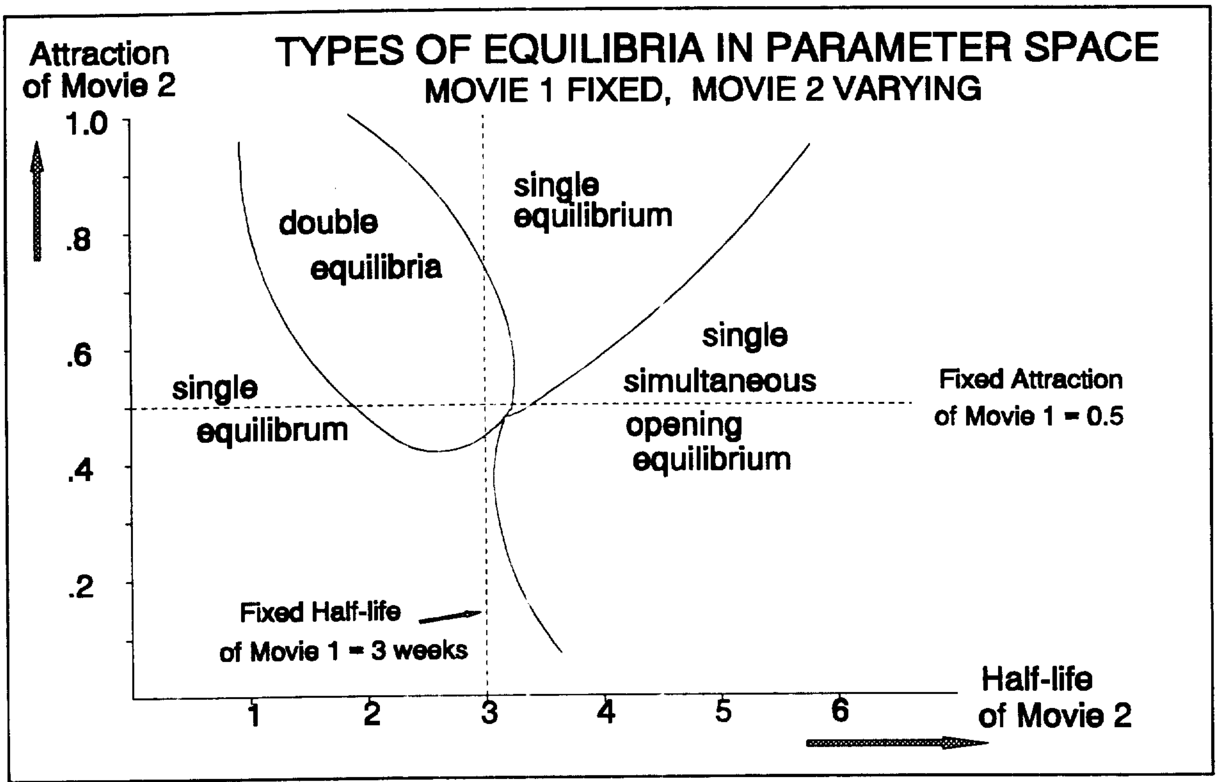

Figure 16: Equilibrium map in parameter space. In the upper right hand quadrant, movie 2 is stronger on both parameters. In the lower left, it is weaker on both parameters.

2 delaying. When movie 2 is larger on both parameters (upper right quadrant), it may open first uniquely, or share the beginning-of-season slot with movie 1.

As we move from the lower left to the upper left quadrant, and movie 2's attraction exceeds that of movie 1, but its legs are shorter, it will still delay if its legs are very short. It cannot capture the preferred opening position uniquely (the single equilibrium at the top of the diagram) unless it has a much larger attraction than, and nearly similar half-life to, movie 1. As its legs increase from this position, into the upper right quadrant, it will stay at the beginning of the season; movie 1, however, will at some point prefer head-to-head competition, as movie 2 is not decaying rapidly enough to justify movie 1's delaying.

In most of the lower right quadrant, where movie 2 has longer legs but less opening attraction, the simultaneous opening is optimal.

For this particular example, where one movie is fairly strong on both marketability and playability, the equilibria resulting from a competing movie follows the same general rule: either the stronger movie opens first, or they both open at the beginning of the season. Where it is not obvious which is "stronger", playability has more influence than marketability in determining the equilibrium configuration. This is consistent with Figures 10 to 13, where the configuration changes more with half-life than opening attraction.

Model Limitations

In this section we discuss four potentially limiting assumptions of the model: 1) no revenues are available outside the season, 2) movie parameters are known in advance with certainty, 3) primary demand is constant within the season, and 4) the true oligopolistic nature of the competition is captured as a duopoly plus background.

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, where 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. We would 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, even though not to zero, is abrupt, with a revenue reduction of approximately 40% in one week.

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. Production costs are committed or sunk, so that even if the studios know they have a problem movie, it is too late to stop. To quote Warner's Vice-President of Market Research, "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). The recent interest of marketing academics in predicting movie success will decrease uncertainty further (eg., Eliashberg and Sawhney, 1994; Neelamegham, 1995). Sleepers and bombs, however, are unlikely to be eliminated. (We would be disappointed if they were).

Primary demand, of course, fluctuates strongly (see Figure 1), and this is a driving force behind this paper: the studios would like to have their peak secondary 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 the broad fluctuations so that we may examine the implications of seasonal variation parsimoniously, and derive interpretable results. From Figure 1, we can see that these two assumptions are not well satisfied for the Christmas season; they are a much better description of the summer season. In any case, we expect that the general implications of the model--for example, that stronger movies can occupy the preferred positions--should hold.

Results from the duopoly model, assumed for tractability and interpretability, may not hold in an oligopolistic setting. Twenty-four major (i.e., in the top five for at least one week) movies were released in the 1990 summer season. Two factors, however, must be considered in interpreting this number. First, these movies do not necessarily all compete with each other. The studios' competitive positioning studies used in the timing decision are geared at finding out which movies are going to compete within the same segments. And second, the large studios will release several movies, and presumably will avoid cannibalization. They would be unlikely to release all targeted to the same segment. It is therefore probable that the number of movies directly competing in any one segment is much less than 24. Generalization to the oligopoly case and to firms having multiple product entries would be worthwhile future research. Similarly, more research to empirically detail the structure of competition is needed.

INDUSTRY PRACTICE

Industry practice appears to be consistent with the main implications of our model. For instance, the recent "timing game" concerning the release dates of *A Few Good Men* and *Hoffa* is particularly relevant:

> With as much as 25% of the annual box office at stake during the annual six-week [Christmas] holiday season, the studios are scrambling to get noticed. As Columbia's Canton observes: "This is not a time to lay back." To prove it, Canton moved up his 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. "The way we look at it, if *A Few Good Men* is as strong as we think it'll be, we'll get a lot of publicity for our own very good Jack Nicholson film," says Fox Executive Vice-President Tom Sherak. (Business Week, Nov 2, 1992).

In this situation, both studios believed the Jack Nicholson movies would be direct competitors, and the analysis of a duopoly with background competition would seem to apply. The first point to note is that both studios apparently believed that *A Few Good Men* was the stronger movie, which turned out to be the case *Hoffa* opened with $6 million, ran until February 2, and grossed $23 million; *A Few Good Men* opened at $15 million, stayed until July 27, and grossed $141 million. The second point is the inability of the weaker movie, *Hoffa*, to commit to the desirable early release date. To return to our analogy of the game of chicken, the Volkswagen swerved--the weaker movie opened second. The third point is Fox's reason for backing off, "to get a lot of publicity for our very own good movie". On the basis of our preceding analysis, we would suggest this is a largely a face-saving statement that downplays the fact that Hoffa is the weaker movie. Publicity or not, if Fox knows Hoffa is weaker, then to delay is the equilibrium outcome in the competitive game.

To test our analysis further, we examined the 24 major movies released during the summer season. The distribution of opening shares and half-lives is similar to the overall data set (Figures 5 and 7). In particular, the median half-life is 2.4 weeks, and the longest half-life (*Ghost*) is 5.9 weeks. The second longest is 3.3 weeks. From the parameter space maps, we can see that, in a ten week season, in general at least one of the movies needs a half-life of 3 weeks or more for the simultaneous-opening equilibrium to occur. Given a 14-week summer season, and the availability of revenues after the season, the pressure to open at the beginning of the season should be even less. We therefore hypothesize that delayed opening equilibria apply, with weaker movies delaying. Strong movies generally occupying the earlier positions in the season would, therefore, provide further support for our analysis.

Using the 24 major movies released during the 1990 summer season, 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 halflife was not significant (t=-.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 = 5.6, p<.02), which, given the relatively constant total revenues throughout the season (Figure 1), 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. In fact, there seems to be the belief that the opening weekend *determines* everything else that happens, hence the importance of building the demand for that weekend.

We do not have a good explanation as to why the movies' legs are ignored. Possibilities include: 1) the opening date decision is in the hands of the marketing department, who thus concentrate on the outcomes they believe they can influence -- the opening -- rather than on the legs, or playability, which is seen as being out of their hands; 2) the relaxation of our assumptions would render run length less important; and 3) the opening strength is much more predictable than the run of a movie, which depends heavily on word of mouth.

DISCUSSION

A movie's release date, like many other new product introduction timing decisions, is a critical marketing mix decision for the multi-billion dollar motion picture industry. As in other industries, the decision is affected by product life cycle, primary demand changes over time, and competition. The motion picture industry, however, has some unique characteristics, notably the extremely short and skewed life cycle of its products. In this paper, we first show the surprisingly systematic nature of the life cycle -- an exponential decline-- and then use this knowledge to construct a duopoly equilibrium analysis of competition for revenues in a fixed season, with opening time as the decision variable.

One force on the timing decision is to avoid the competition, most particularly at the dominant early part of a motion picture's run. A second force is 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 to delay, thereby avoiding head-to-head competition, but foregoing the revenues available in the early portion of the season.

The "playability" of a movie, conceptualized as its susceptibility to internal or word-of-mouth influence, is reflected in the half-life of the life cycle. As the playability increases, the pressure to open early increases. The "marketability" of a movie, conceptualized as its susceptibility to external, or marketing mix, influence, is reflected in its opening strength, before any word-of-mouth begins to operate. The greater the half-life, and the more similar the opening strength, the more likely both movies are to open 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, until we reach a point where there is only a single equilibrium 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. For example, for two movies with similar opening strengths and half-lives greater than three weeks in a ten week season, it is optimal for both to open at the beginning of the season. We note, however, that these would represent unusually successful movies. For the parameter ranges of the movies in our data set, it is more likely that one movie would delay.

If one movie is stronger in marketability and the other in playability, it is more likely that the movie that is stronger in playability will occupy the early position.

We offer anecdotal and statistical evidence supporting our analysis. Anecdotally, the jostling for opening dates as release time approaches closely follows the pattern we predict. We also show that opening strength, both in revenues and share, is a highly significant predictor of opening delay in the 1990 summer season. We do not find that half-life predicts delay well, and offer possible explanations. While further research is required, there may be an opportunity for management to improve their release timing decision by assessing the impact of "playability" in more detail.

While some movie consumers may be largely indifferent to opening times, there may be others for whom the outcome of the timing game is beneficial. Comparing the parameter ranges of the movies in the data set with the equilibria maps suggests that simultaneous openings will be rare. For consumers who have high utility for viewing a motion picture on its opening weekend, this staggering of opening dates allows them a steady diet of openings, rather than clusters followed by long dry spells. That some portion of the audience does indeed value early viewing is suggested by the shape of the life cycle. Presumably there is a substantial portion of the audience persuaded by advertising in advance of release, who eagerly await the opportunity to see the movie. This is also consistent with Neelamegham (1995), who has found two segments of movie-goers, one primarily influenced by advertising and critics reviews, and one influenced primarily by word-of-mouth.

ENDNOTES

1. Pioneering advantage considerations may apply to themes, as 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*. More recently, Disney's *Tombstone* and Warner's *Wyatt Earp* went head to head. (GQ magazine, November 1994). Cannibalization is important since 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.

2. We could have set this to 1. 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. We do not vary the season, as the effect of a shorter season will be similar to the effect of slower decay of movie revenues.

3. 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.

APPENDIX A

Proof of Proposition 1

Subscript notation: Subscripts 1 and 2 identify the motion picture; subscript m refers to "monopoly" case of Lemma 1; and subscripts B and A relate to "before" and "after" the opening of movie 2.

We first prove the following preliminary result:

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.*

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

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

$$\frac{\partial S_{1,m}}{\partial t_{01}} < 0 \qquad (2)$$

Proof: Let the instantaneous share be $s_{1,m}(t) = A_1(t)/[A_1(t) + 1]$. By Leibnitz' Rule,

$$\frac{\partial S_{1,m}}{\partial t_{01}} = \int_{t_{01}}^{t_f} \frac{\partial s_{1,m}(t)}{\partial t_{01}} dt + s_{1,m}(t_f) \frac{\partial t_f}{\partial t_{01}} - s_{1,m}(t_{01}) \frac{\partial t_{01}}{\partial t_{01}} \qquad (3)$$

The second term vanishes, and the third is the constant opening share. Evaluating the partial derivative in the integrand of the first term, by substituting the exponential form for the attraction, gives

$$\frac{\partial s_{1,m}}{\partial t_{01}} = \beta_1 s_{1,m}(t) - \beta_1 [s_{1,m}(t)]^2 \tag{4}$$

Substituting (4) into (3) and simplifying,

$$\begin{aligned}\frac{\partial S_{1,m}}{\partial t_{01}} &= \beta_1 \int_{t_{01}}^{t_f} [s_{1,m}(t) - (s_{1,m}(t))^2]\, dt - s_{1,m}(t_{01}) \\ &= \beta_1 \left[\frac{1}{\beta_1 (1+A_1)} \right]_{t_{01}}^{t_f} - \frac{A_1(t_{01})}{1+A_1(t_{01})} \\ &= -s_{1,m}(t_f)\end{aligned} \tag{5}$$

QED.

Proof of Proposition 1:

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 first opening movie, 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 the associated cumulative share. We consider separately times before the opening of the second movie and after the opening of the second movie, designated t_B and t_A, i.e., $t = t_B$ if $t < t_{02}$, and t_A otherwise. Referring to Figure 1. 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:

$$s_1(t_B) = s_{1,m}(t_B) = \frac{A_1(t)}{A_1(t) + 1} \quad (6)$$

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

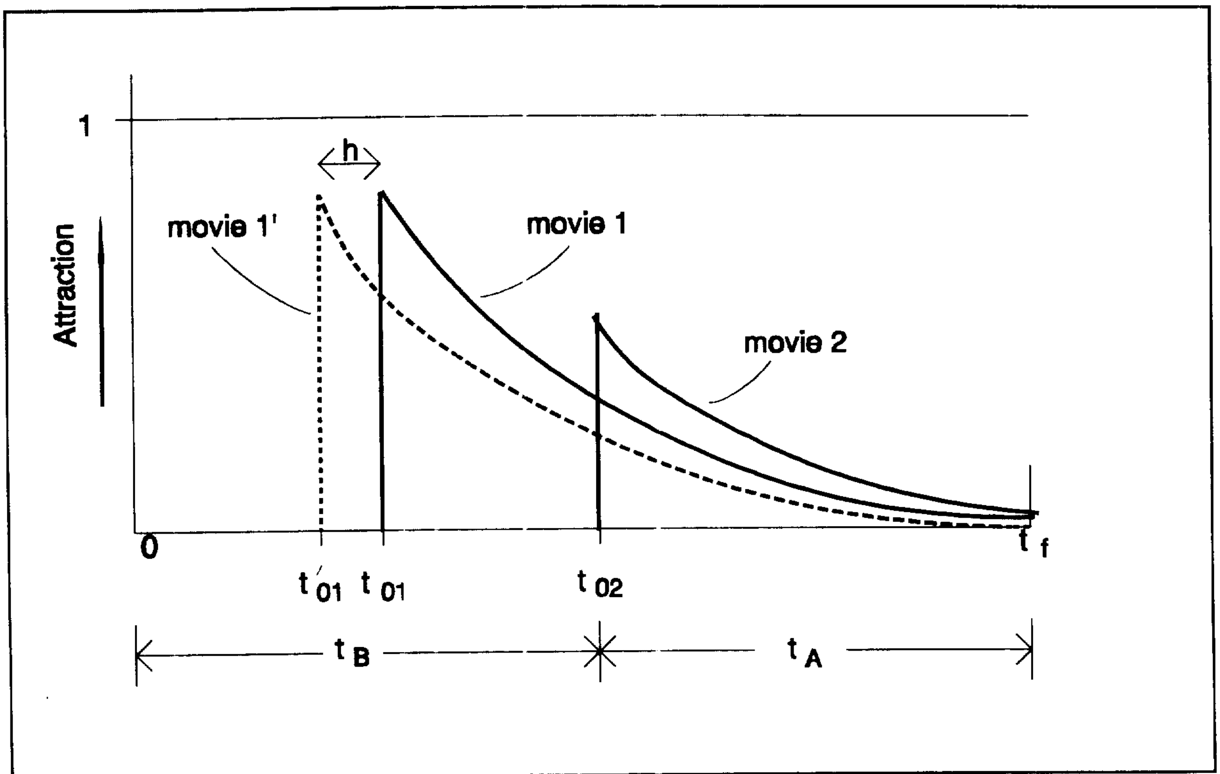

Figure 1: Attraction lifecycles for two competing movies and notation for proof of Proposition 1.

Now examine the changes when movie one 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 may express Lemma 1 as $S_{1,m}' > S_{1,m}$. Splitting this expression at t_{02},

$$S_{1,m,B}' + S_{1,m,A}' > S_{1,m,B} + S_{1,m,A} \quad (7)$$

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:

$$S'_{1,B} + S'_{1,m,A} > S_{1,B} + S_{1,m,A} \tag{8}$$

Also from Lemma 1 (set $t_{02} = t_f$), we have

$$S'_{1,B} > S_{1,B} \tag{9}$$

We know that movie 2 decreases the share of movie 1, relative to the monopoly case, after t_{02}, in both the primed and unprimed cases. Let the decrease be X and X', such that

$$\begin{aligned} X' &= S'_{1,m,A} - S'_{1,A} > 0 \\ X &= S_{1,m,A} - S_{1,A} > 0 \end{aligned} \tag{10}$$

If we replace the monopoly shares ($S_{1,m,A}'$ and $S_{1,m,A}$) with the competitive shares ($S_{1,A}'$ and $S_{1,A}$) in (8), noting (9) and (10), a sufficient condition for the inequality to remain is that X' ≤ X. Referring to Figure A1, this means that adding movie 2 impacts the *unprimed* movie 1 (the solid line) more than the *primed* movie 1 (the dashed line). When this is the case, Lemma 1 can be extended to the two-movie case.

Let x(t) and x'(t) be the instantaneous analogues of X and X'. For x(t),

$$\begin{aligned} x(t) &= s_{1,m,A}(t) - s_{1,A}(t), \\ &\int_{t_{02}}^{t_f} x(t)\,dt = X \end{aligned} \tag{11}$$

If $x'(t) \le x(t)$, $\forall t \in \mathbf{T_A} = \{t: t_{02} \le t < t_f\}$, then $X' \le X$. We next establish conditions under which $x'(t) \le x(t)$. Expanding x(t) and dropping the time argument in the attractions,

$$x(t) = \frac{A_1 A_2}{(A_1+1)(A_1+A_2+1)} \tag{12}$$

and similarly for x'(t). Expressing the inequality in terms of the attractions and manipulating,

$$A_1 A_1^{/} \leq 1 + A_2 \tag{13}$$

In the limit $h \to 0$, $A_1 \to A_1'$, and (13) becomes

$$A_1^2(t) \leq 1 + A_2(t), \quad t \in T_A \tag{14}$$

QED.

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