Time Consistency and Seller Commitment in Inter-temporal Movie Distribution: An Empirical Study of the Video Window

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Abstract

We report an empirical study of determinants of the "video window" (the interval between a movie's theatrical release and its video release), primarily based on a sample of 1429 theatrical feature films released on video in the United States between 1988 and 1997. Results are broadly consistent with an hypothesis that U.S. motion picture distributors resolved a time-consistency problem by successfully committing to maintain longer windows than would result from a competitive industry in which distributors set windows without regard to their effect on consumer expectations.

1. Introduction and Background

It can be difficult for firms to maintain a system of inter-temporal price discrimination because of the well-known time consistency problem (Coase, 1972). Basically, for a seller with monopoly power to effectively price discriminate, that seller must have a way of committing to consumers that there will be some length of time before the price will be reduced. Otherwise, high value consumers will decide to just wait to pay the lower prices. Similarly for the next highest value category of consumers, and so on. In the extreme case, the monopolist is unable to make any sales at prices above what would have been the competitive price level.

These circumstances seem to apply to theatrical movie distribution. Major films are typically released over time, first to theaters, followed some months later by DVD, then pay-per-view (including video-on-demand) exhibitions on cable, DBS, and the Internet, followed later by monthly subscription pay TV networks. Often years down the road, the movie appears on basic cable and/or free broadcasting. This practice appears to be a form of inter-temporal price discrimination, by which high value consumers are attracted to relatively high-priced theatrical exhibitions, etc., while low value consumers wait to consume the product later on lower priced media (Conant, 1960; Owen and Wildman, 1992).

In this paper, we focus on seller commitments involving the "video window," the interval of time between a movie's theatrical release and its video release. To introduce the issue we address, consider the following films exhibited during the period of our study. In 1996, Disney released Father of the Bride 2 to theaters, a relatively successful film that earned $76 million over a relatively long theatrical run of 140 days. This movie was then released on video 46 days later, or a total of 186 days after its theater opening. In the same year, Sony Pictures Corp. released Screamer, a low budget film that remained in theaters for only 21 days, earning $6 million at the box office. This movie was not released on video, however, for another 158 days, or a total of 179 days after its theatrical opening. What induced Sony to wait so much longer to release Screamer to video at roughly the same six month window as Father of the Bride 2? In fact, why do distributors wait at all before releasing theatrical films to video? As we discuss in more detail, the average time lag between close of the theater run and video release for theatrical features is substantial – about 82 days for our data sample of videocassettes in the late 1980s and 90s.

Underlying the inter-temporal price discrimination model in the movie case is the assertion that consumers are drawn to theaters on the expectation that there will be some length of time before the film is available on video. These expectations are evidently formed by consumers' perceptions of some average video window for movies in the past. Under these circumstances, it is apparent that the distributor of a given film might benefit from relying on those expectations to attract the largest possible crowd at the theater, and then when the theater audience falls off – within one to two months for most movies – immediately releasing it to video. As industry executives publicly acknowledge, there are real temptations to follow this strategy.[1] The earlier is the video release, the fresher the impressions of an expensive theatrical advertising campaign in the minds of consumers, and the fresher is the movie itself. There are also financial incentives. Inventory costs for large scale Hollywood films can be in the millions per month, and studios generally receive no revenues from video release prior to their accrual. This logic implies that in the absence of some kind of a commitment device in a competitive environment, there would be a tendency for video windows to collapse over time to a shorter length than distributors as a whole would prefer.

In most European countries at least, industry-wide agreements or statutes have served to regulate a minimum video window (Frank, 1994; Paul Kagan Associates, 1994; Screen Digest, 2002). Table 1 summarizes the mechanisms for 15 European countries that were in place as of the mid-1990s, based on trade literature reports, and indicates the window length – typically 6 or 8 months – upon which these agreements or statutes were reportedly based, and the degree of rigor to which the agreements were adhered.[2]

In the United States, no legislation governs movie windows. There were trade press

[1] J. Kipnis, "Hollywood speeds films to home DVD market," Billboard, May 3, 2003, p. 1; Seth Goldstein, "Home video finds a lower spot on media food chain," Billboard, Oct. 25, 1997, p. 72; "On the Record: Studio Executives and Directors Overwhelmingly Support Preservation of the Theatrical Window, National Association of Theater Owners, December, 2006 (www.natoonline.org; downloaded January, 2007).

[2] Since the mid-1990s, window lengths in Europe have reported been relaxed. See Screen

reports of an attempt by the National Association of Theater Owners (NATO) to coordinate major studio adherence to a minimum video window in the mid-1990s; these reports included reference to an existing "unspoken agreement" among major distributors and theater chains to adhere to a six month interval.[3] When video windows have on occasion come under pressure, such as after some announcements in the early 2000s by independent distributors of forthcoming experiments with simultaneous video and theater release, trade press discussions have been active, with some major studio executives stressing the importance of preserving windows.[4] Further back in history, now-illegal cartel agreements among motion picture distributors and exhibitors in the 1930s specified time lags between first run, second run, and other subsequent run theaters on a theater-by-theater basis (Conant, 1960). As discussed briefly in our conclusion below, these agreements can be interpreted as devices intended to resolve the time-consistency commitment problem by means of overt collusion.

These anecdotes and comparisons suggest the plausibility of some form of coordinated video window setting behavior among U.S. distributors as a means to cope with the time consistency problem. In this paper, we investigate video window setting behavior employing a unique database of 1429 theatrical movies released on video in the United States between 1988 and 1997. Is there evidence, we ask, that distributors have successfully committed to maintain longer windows than would result from a competitive model in which distributors independently set windows without regard to their effect on consumer expectations? We offer a quite incomplete, but, we hope, provocative answer in this paper.

Following a review of relevant literature and some institutional details, we examine

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Digest, 2002, 2005.

[3]A series of articles around this time describes the NATO initiatives. See especially L. Klady, "Valenti to Biz: Get a Grip," Daily Variety, March 6, 1996, and "Kartozian urges exhibs to build with 'prudence,"'Hollywood Reporter, March 5, 1997. Joseph Steuer, "To studios: pause a bit before playing vids," Hollywood Reporter, October 24, 1996.

[4]"On the Record: Studio Executives and Directors Overwhelmingly Support Preservation of the Theatrical Window, National Association of Theater Owners, December, 2006 (www.natoonline.org; downloaded January, 2007); "Longer theatrical, video windows sought," Video Business, November 8, 1996, p. 6.

descriptive data on video windows and related information over the 10 year study period for indications of coordinated window setting behavior. We then develop econometric models that attempt to explain window outcomes based on a variety of economic variables and movie-specific factors. We use those empirical models to make further inferences into the plausibility of coordinated window setting behavior, as well as to better understand the influences of external economic factors on window setting behavior. In conclusion, we discuss implications of the results, historical parallels, and welfare implications.

A. The Time Consistency Problem

The original insight into the time-consistency problem is attributed to Coase (1972). Coase's key idea (now commonly known as the "Coase conjecture") was that if firms with monopoly power selling durable goods are unable to commit to maintain prices above costs, then that monopoly power cannot in fact be exercised in the consumer market. Coase also recognized that firms might employ a variety of devices to avoid time-consistency, such as leasing the product, committing to limit future production, or committing to later repurchase the product at a set price – and thus could exercise at least some of their monopoly power. In the leasing case, for example, consumers obviously do not need to worry that the seller will lower the price immediately after purchase. Bulow (1982) formalized the Coase conjecture to establish conditions under which the time-consistency problem would occur and showed how it could be avoided through leasing and other devices.

A large theoretical literature extending these results and identifying other strategies or market conditions that can serve as commitment devices has since arisen. For example, firms may establish a reputation for not reducing prices (Ausubel and Denekere, 1989) or offer "best price" provisions (Butz, 1990). Takeyama (2002) shows that quality segmentation in a first period may serve as a commitment device by exhausting low value demand that might otherwise tempt a monopolist to lower prices later. Gul (1987) and Ausubel and Denekere (1987) present models of oligopolistic durable good sellers in which the competing firms or potential entrants discipline each other to maintain prices above cost. Among other more relevant theoretical contributions to this literature are Stokey (1981), Kahn (1986), Conlisk, et al (1987), Bond and Samuelson (1984, 1987), Tirole (1988), and Beihl (2001).

A parallel literature on the economics of inter-temporal price discrimination has explored conditions under which that is a profitable strategy in the first place (Stokey, 1979; Landsberger and Meilijson, 1985; and Varian, 1989). Basically, these authors show that inter-temporal discrimination can be profitable if sellers have some monopoly power, if there are sufficient numbers of consumers in different demand groups, if consumers are sufficiently different from each other in terms of their demand preferences and their time discount rates, and if enough consumers have higher time discount rates than do producers.[5]

Rosen and Rosenfield (1997) attempt to explain the ticket pricing and other strategies of live theater operators, with some reference to time consistency issues. Owen and Wildman (1992) hypothesize a number of factors, such as the interest rate, the penetration rates of VCRs and other alternative media, that are likely to affect video window lengths, but they offer only a descriptive discussion and do not consider time-consistency. Prasad, Bronnerberg and Mahajan (2004) develop a theoretical model of product timing in the movie industry that considers consumers' video window expectations. They conclude that an individual movie distributor's optimal date of video release is generally earlier than the expected release, which may result in an equilibrium industry window that is shorter than an industry optimum.

Frank (1994) studied determinants of the movie video window empirically, using German data. He found that German windows became shorter over time as VCRs diffused, and that they were longer for more successful movies, although his sample excluded movies with relatively short theater runs to avoid potential bias from a "gentleman's agreement" between distributors and German cinema associations that the video window should be at least 6 months. Nelson, Reid, and Gilmore (2007) acknowledge the time consistency issue in an empirical investigation of trends in the "out-of-market gap" for DVDs (the interval between theater closing date and DVD release) using a 1998-2005 data sample.

[5]The commitment devices explored in the time-consistency literature are not necessarily conducive to inter-temporal discrimination itself. For example, an artist's public destruction of an original work from which prints can be made preserves high prices of existing prints by guaranteeing that no price reductions at all will be made in the future.

They report a substantial decline in the gap over that period, and among other results, find that the gap decreased with the rate of DVD penetration and the length of a film's theater run, and increased with the film's box office receipts.

Waldman (2003) offers a valuable institutional discussion about time consistency and price discrimination in durable goods markets. A small number of experimental papers (notably Reynolds, 2000) are also concerned with time consistency, but systematic studies of how firms in any industry make commitments in order to cope with time consistency appear absent from the literature.

B. Price Discrimination and Time Consistency in Movie Distribution

In recent years, the six or seven largest film distributors have controlled 80 to 90% of the U.S. movie box office, and generally comparable shares of revenue from theatrical feature exhibition on video and pay television systems (Vogel, 2007).

Figure 1 illustrates the typical pattern of windows followed by these distributors for a major film in the U.S. in the mid-1990s, near the end of the period of our study. The movie began its life in theaters, a market typically exhausted within 1 to 4 months. Except for relatively unimportant airline and hotel pay-per-view showings, the movie was then usually held out of circulation until about the 5th or 6th month, when it reappeared in stores for rental or sale on videocassettes. Release on pay-per-view via DBS or cable systems generally followed 45 to 60 days after home video release. About one year after theatrical release, HBO, Showtime, or other monthly subscription premium cable channels claim exclusive exhibition rights for the next 12 or 18 months. The movie then continued on various alternate routes to basic cable networks (eg, on TNT, or TBS) and/or advertiser-supported broadcast exhibition. Broadcast and cable network syndication contracts usually last for multiple years, and by the time the first complete cycle is ended, a film might be anywhere from six to fifteen years old. More popular movies may also be recycled through this system indefinitely.

This system was little different in the late 1980s, at the beginning of our sample period, except that viable DBS systems did not launch in the U.S. until 1994 and pay-per-view cable systems were in their infancy. By this writing in the mid-2000s, the pecking order of media remains basically the same, with the addition of DBS and the Internet to pay-per-view exhibition (increasingly via video-on-demand (VOD). Beginning in about 1997, DVD rapidly began replacing VHS as the prevailing video format, a transition that was virtually complete by 2008. Window lengths, including the video window, have generally compressed somewhat as well, especially after 2002, but the basic features of the release sequence are little changed from the period of study.

Although other strategy is no doubt involved, such as the building of word-of-mouth, the signaling of average movie quality that an initial theatrical release conveys, and the collection by distributors of demand information from the theater performance,[6] our assumption that inter-temporal separation of theaters and video is motivated by demand substitution between these media seems evident. In general, the movie release sequence appears to segment high from low value consumers by quality of the viewing experience (ie, the wide-screen display in theaters, followed by the smaller TV screen for home video exhibition, followed by the lack of viewer control of scheduling on pay TV channels, and finally a commercial-cluttered showing on broadcast TV), but most fundamentally by the time lags between release to different media. Owen and Wildman (1992) and Waterman (2005) show evidence that per capita realized prices paid by consumers generally decline throughout the sequence, as do per capita distributor gross revenues.

Of course, as Stokey (1979) and Landsberger and Meiljson (1985) point out for the general case, declining prices could simply reflect declining costs of exhibition or a declining value of the movie as it becomes older. In a study of book publishing, a media industry having an analogous distribution practice of releasing books in hardback and later in soft cover, Clerides (2002) uses a detailed industry database to show that price-cost margins do imply price discrimination. Perhaps the most compelling suggestion of inter-temporal discrimination in the movie industry is the persistence of periods during which the film is essentially withdrawn from the market altogether–notably the several week or months-long "out-of-market gaps" between the time that most movies complete their theatrical exhibition and their reappearance at video stores. In general, a longer window is more

[6] De Vany and Eckert (1996) view the release sequence as an information collection device. Chae (2003) challenges the price discrimination interpretation on theoretical grounds. See Waterman (2005) for more detailed discussion.

protective of first run theater exhibition, but in demand terms, there are obviously diminishing returns to window length because the film becomes older and the impact of the initial theatrical campaign and release publicity diminishes.

As copyright holders, movie distributors have the exclusive right to determine the video, as well as other movie windows, in the release sequence. The video window is by far the most important for distributors. Between 1988 and 1997, video accounted for between 38% to 50% of all domestic distributor revenues from the release of theatrical features, generally increasing over the period. Theater rentals accounted for between 25% and 36% of the total, generally declining. Revenues from hotel, airline and other distribution that occurs between the theater and video releases are very minor, and we generally ignore their possible effects on video window decisions. At least through 1997, pay-per-view media also contributed relatively very minor income to movie distributors.

In the case of the video window, the distributor's decision problem is simplified in one sense by the First Sale Doctrine of U.S. copyright law, which effectively prevents the distributor from controlling whether videocassettes (VHS) or DVDs are rented or sold by retailers. Thus, release of video rentals and sales necessarily occurs on the same date.

Of course, theater admission prices and video rental and sales prices are key elements of the inter-temporal release system. Distributor control of these prices, however, is only indirect. Resale price maintenance laws as well as the First Sale Doctrine prevent distributors from directly controlling them. By manipulating wholesale prices, the distributors can obviously influence retail prices, and both theaters and video retailers generally charge the same known prices for all movies regardless of quality. It is evident that average industry window lengths will affect equilibrium retail prices at both theaters and video stores, but individual distributors have little power to affect retail prices. Our focus, therefore, is only on the distributor's video release date decision.

C. Coping with Time Consistency in Movie Distribution

The conceptual basis of our analysis is that an individual movie distributor can potentially benefit from a "surprise" effect by releasing movies to video earlier than consumers expect; benefiting both from the price discrimination advantage of the perceived waiting time and from maximizing the actual value of the video release. That action, however, leads to a slight downward shift in consumers' expected windows for movies in the future, so that if other firms follow, video windows will tend to diminish or disappear.[7]

A key assumption is that consumers do not blame either distributor A or B by identifying that particular distributor as most likely to offer shorter windows in the future. This appears to be a realistic assumption, somewhat peculiar to the movie industry. Perhaps with the exception of Disney, consumers generally do not attach brand names to the movies they see. Instead, they appear to regard the industry as an amorphous whole, called "Hollywood." Thus, moviegoers would be unlikely to identify particular distributors as having shorter windows, thus making it possible for distributors to shorten the window on any one movie, or possibly all of their movies, without substantially risking their own reputation with consumers.

Under these circumstances, what devices might movie distributors otherwise use to effectively commit to consumers that a given movie's video window will (at least probably) be of some minimum length?

A plausible mechanism is the contracts that distributors write with theaters, such as is reportedly done in Austria (See Table 1). To our knowledge, however, theater exhibition contracts in the U.S. never contain such terms. One likely factor working against such provisions is the high pre-release uncertainty of film performance (DeVany and Walls, 1996). As we discuss further, distributors may want to have a shorter window for films that do poorly in theaters. Another factor working against such contracts is that consumers also do not appear to blame individual theaters for showing movies that might then appear on video sooner than they expected. While theaters as a whole lose from shorter video windows, theater ownership in the U.S. is fairly diverse, the largest circuit having only

[7]In general, this logic describes that of the formal model presented in Pasad, et al. (2004). Their model specifies an optimal window for the industry as a whole. Based on a numerical 2 firm solution, they show that without commitment, the optimal video introduction date of an individual firm is below consumers' expected date. They interpret their results to imply that competition in the absence of commitment can result in a shorter than optimal window, shared by all competitors, which may occur before the theater release has ended.

about a 15% share of box office revenues during the study period;[8] video distribution is simultaneous nationally. Thus, theatrical exhibitors would seem to have little incentive to demand minimum video windows in their contracts.

There nevertheless remain certain "natural" forces that tend to assure consumers that the video of a particular movie is unlikely to be available for at least some interval. As Rosen and Rosenfield (1997) point out for the live theater case, it takes time to exhaust demand. Presumably, movie consumers perceive that a distributor would not be rational to release to video at least until that demand is substantially depleted. Especially for very successful movies, this perception presumably encourages theater demand. This factor could not explain, however, the relatively long periods of time that movies are essentially out of the market before their video release.

Another factor is institutional. Distributors generally announce a specific video street date to video retailers six to twelve weeks in advance, and distributors are probably constrained to wait until a theater release is in progress, or even substantially completed, before making the video announcement. At least for relatively short-lived theatrical films, this announcement period could account for some "out-of-market" intervals. We discuss this factor in more detail in the context of our empirical data.

2. Methodology

Our broad objective is to empirically distinguish a "full commitment" model of industry behavior in which movie distributors studios functionally behave as a monopoly to set video windows such that consumers have consistently fulfilled expectations of an industry profit-maximizing video window length, vs. a "no commitment," competitive model in which individual studios independently set video windows for each individual movie without regard to the effect that those decisions have on consumer expectations.

First, following the lead of the literature on bid rigging in auctions, we attempt to identify patterns in the data that may suggest or imply industry coordination of some kind in the setting of video windows (Porter and Zona, 1993, 1999; Baldwin, Marshall and Richard, 1997). In particular, a tendency for video windows to systematically cluster around one

[8] Litman (1998); National Association of Theater Owners, Encyclopedia of Exhibition, various.

particular length, such as 180 days, irrespective of other economic or institutional factors, would be consistent with a full commitment hypothesis of industry coordination. Evidence that there is some minimum window length that is rarely violated would also suggest a full commitment hypothesis.

A second possibility is that if members of an industry trade association are successful in coordinating video windows that are longer than would otherwise result, then firms that are not members of that trade association may behave differently. In European countries, at least, the industry agreements to maintain windows appear to be coordinated through industry trade associations. In the U.S., virtually all significant theaters are members of NATO. On the distributor side, the six or seven major studios that are members of the Motion Picture Association of America (MPAA) have historically accounted for 80% to 90% of total box-office revenues. If studios coordinate window setting through the MPAA, then we might expect non-MPAA members in the U.S. to opportunistically select shorter windows.

After investigating our descriptive data for suggestive patterns, we develop econometric models that attempt to identify evidence of successful industry commitment in window setting.

Database

Our primary data set consists of 1429 theatrical movies released on videocassette between Jan. 1, 1988 and December 31, 1997. Our main data source is the "*A Title List*," maintained by *Video Store Magazine (VSM)*, a leading trade publication. The *A Title List* includes 1833 movies released on video during that period and selling at least 50,000 units at the wholesale level – thus including the great majority of theatrical films of economic significance. The *VSM* data are primarily collected by weekly survey of a large sample of video retailers and are intended to be comprehensive. The *A Title List* includes video distributor identification, video release date ("street date"), wholesale video revenues, and a variety of other information.

We supplemented these data with information from the A.C. Nielsen EDI electronic database. The EDI data cover virtually all movies released in theaters in the United States between 1986 and the current date, and include: theatrical distributor identification, release date, a production investment estimate, week to week box office results for the duration of the movie's theatrical run, the number of theater screens by week, and movie characteristics such as rating, genre, and principal cast. The EDI data are collected through a weekly survey of theatrical film distributors, supplemented by a statistical sample of weekend results from U.S. theaters, and are the primary source of entertainment industry data published in *Variety*.

A total of 205 of the 1833 *A Title List* movies were eliminated due to inconsistent or missing data identifying the theatrical or video distributor, theatrical or video opening dates, or weekly box office information, leaving a total sample of 1628.[9]

For our primary statistical analysis, we excluded 182 movies that earned less than $1 million at the box office, or whose maximum weekly theatrical exposure did not reach at least 24 screens. Our reason for these restrictions was to eliminate films whose theatrical exposure was only nominal (180 films were under $1 million box office) or which were never given a substantial national theatrical release (75 films reached 23 or fewer screens). Although the levels of these restrictions are arbitrary, we made them in a conservative attempt to insure that the video window definition was a meaningful one.

Finally, we eliminated cases in which the video window was in excess of 365 days (17 additional cases with windows of 368 to 2,552 days). Our rationale here is the likelihood that factors irrelevant to the economic process we are interested in will have intervened. Relatively minor films with very long windows, for example, might reflect inadequate financial resources of the distributor, or perceived changes in market conditions that formerly rendered a video release unviable.

All observations in the resulting final database of 1429 movies used for our primary analysis had complete data, except that 272 did not have movie production cost information, leaving a set of 1157 movies for our models that included those data.

Although we have intermittent observations for later years, they are from a different

[9]In the original VSM database, video release dates for some movies were defined as the first day of the month in which they were actually released. For these years, we obtained a set of actual day-specific release dates from Kagan Research, Inc. and substituted that information.

primary database, and we did not attempt to include data after 1997 – when DVD players began to reach significant penetration. That change in video technology resulted in a fairly dramatic shift toward "sell-through" distributor strategies, and according to press reports, video release dates were often delayed in the late 1990s due to greater time intervals required to put together "bonus" materials such as deleted scenes and interviews with the director or other production personnel. We discuss descriptive data for the video window after 1997 in conclusion.

3. Descriptive Analysis of the Video Window

Basic data for the video window (*Window*) over the 1988-1997 time period, based on the 1429 movie sample, are shown in Table 2. (See Table 6 for all variable definitions.) The window remained in relatively close range of a 180 day mean and median, but there were significant differences among the 10 annual *Window* means ($p < 0.001$). A slight downward trend over time is also apparent.

Table 2 also shows that there was considerable variation in window length within each year of release to video. The windows for 568, or approximately 40%, of the sample movies fell within plus or minus 10% (18 days) of the overall median of 180.0 days. The windows for 68.5% (981 cases) of the movies fell within 20% (36 days) of the 180 day median. Those proportions are less than would be expected if the distribution were normal (approximately 30% and 60%, respectively). Similarly, the final column of the table shows the ratios of the inter-quartile ranges (IQRs) of the data to the IQRs of the normal distributions with the same standard deviations. The ratios are generally less than one. With the exception of the one release in 1991 with a window of 14 days, the windows for all movies in the sample were at least 56 days in length. Figure 2 illustrates the frequency distribution of windows for a representative year, 1996.

Inspection of Table 2 further indicates a decline in the variance from 1988 to at least 1995, and thus the possibility of inconsistent window coordination by distributors over time. There were significant overall differences in the annual variance of window lengths (Bartlett's test for equal variance, chi-square (9) = 59.9, $p < .001$). The basic clustering pattern illustrated in Figure 2, however, persists over the study period.

We thus observe a tendency for video windows to systematically cluster around a mean value that declined only moderately over the period, but little evidence of a particular minimum window benchmark. Practical realities of theatrical distribution, however, would likely constrain the precision of setting window lengths to a specific benchmark length. Video distributors typically float potential video street dates to their large retail buyers in advance of committing to a final date. For a given movie, these buyers report back the street dates floated by other distributors, and as a result, distributor adjustments ranging from a week to perhaps a month or more are commonly made to avoid undesired competitive conflicts with other movies. This trial and error process is similar to that by which major distributors finalize theatrical release dates (Einav, 2007). We cannot tell how much of this randomness could be noise from the interactive street date setting process.

The relationship between video windows and theater run lengths is shown in Table 3. In contrast to *Window* itself, there has been a clear upward trend in average theater run lengths (Col. (1)).[10] Especially for more successful movies, however, long and fairly flat theater run tails are accounted for by relatively insignificant "subrun" theater engagements, often at discount prices. This is illustrated by the perhaps more realistic definition of run length as the time by which 95% of the eventual total of box office receipts have been received (Col. (2)). The trend in average run lengths essentially disappears. Thus, the tail of the theater run length distribution increases over the sample period, but there seems to be little trend in how long it takes for a movie to earn the overwhelming bulk of its theater receipts.

Columns (3) and (4) of Table 3 show the average amount of time within the video window that the sample movies are unavailable to consumers (except for airlines and hotels), according to each of these definitions. The overall average of this "out-of-market" gap was about 12 weeks by the full theater run length definition and more than 17 weeks using the 95%-of-receipts definition.

These data thus indicate a relatively long period of time – consistent in length over the sample period in terms of the "95%-of-box office" definition – that movie distributors have

[10]Theater run length is defined to be the total number of days after theater opening for which any revenues are reported by EDI. Data are reported only by one week intervals, and are thus lumpy to that extent.

typically withheld their movies from the marketplace in advance of their video release.

The relationship between the "out-of-market" gap and theater run lengths is detailed in Figure 3. In evidence are the relatively long periods that short-lived theatrical movies are inaccessible to consumers in either theaters or on video, by either definition of the theater run.

To what extent might these "out-of-market" gaps be explained by institutional features of the movie marketplace we introduced above? In partial answer, Figure 4 shows the frequency distribution of announcement periods (public announcement to the trade of the street date to the street date) for a sample of 242 movies released between 1994 and 1996.[11] The mean period was 63 days. Usually about the first half of the announcement interval is open to orders from retailers. After orders close, the distributor directs duplicators to manufacture the video units, and then they are shipped to the retailers. Also during the announcement interval, advertising materials are developed for a video release consumer campaign that usually lasts one to as much as three weeks.

Video retailers need information about a movie's theatrical performance to decide how many video units to order, and at least recently for major films, concerns have been expressed by distributors that video street date announcements to the trade can find their way to the mainstream consumer media and undermine theater demand.[12] If we conservatively assume that distributors cannot make a video street announcement until the movie's theater run is substantially or entirely completed, and the full 63 day mean announcement period is necessary for the decision making, ordering, manufacturing, shipping, campaign development, and other business activities to be conducted, then the "institutionally necessary" "out-of-market" gaps would be shorter by that amount.

The "out-of-market" period after subtracting the mean announcement period, however, is still considerably greater for shorter run movies than could be accounted for by

[11] These data were provided to us by the National Association of Theater Owners.

[12] See, for example, S. Hettrick, "Window to Wonder," Daily Variety, Sept. 19, 2002, p. 12. It seems unlikely that this leakage of information to the consumer press would have been a problem during the period of our study. Extensive business reporting about the movie industry in the popular press is a fairly recent phenomenon, beginning in the mid to late-1990s.

these factors (subtract 63 from the y-axis on figure 3). Also, these assumptions are surely conservative since announcement periods for many movies are less than 63 days, and in many cases were made well before the theatrical release has ended. As Figure 5 and 6 show, about half of the 1994-96 announcements were made before the end of the theater closing date, but only 10% were made at or before the 95%-of-box office-receipts date.

Turning to Table 5, we see that only about 6% (83 of 1429 films) were released by "independent," non-MPAA member distributors. These films do have somewhat shorter mean windows than MPAA member released films, but also have other distinct characteristics, a subject we return to below.

In summary, rigid benchmarks are clearly not evident in the descriptive data, but they do not rule out an industry coordination model and invite further analysis.

4. Econometric Analysis

A. General Model

For the individual distributor of a movie, profit Π is given by,

$$\Pi = (P_T - C_T)A_T + (1+d)^{-W}(P_V - C_V)A_V - K \tag{1}$$

where P_T and P_V are theater and video prices; C_T and C_V are theater and video costs per capita; d is the time discount factor of the distributor; W is the window, defined as actual time from theater opening to video opening; K is production cost of the movie, which is assumed to be fixed; and A_T and A_V are theater and video demand. For simplicity, we have included only revenues from theaters and video, thus ignoring the role of other media in the movie release sequence.

On the consumers' side, the theater and video demands are based on an identical set of independent variables:

$$A_T = A_T(W^e, W, P_T, P_V, V-T, S, Z) \tag{2}$$

$$A_V = A_V(W^e, W, P_T, P_V, V-T, S, Z) \tag{3}$$

In equations (2) and (3), W^e indicates the distribution of consumers' expected window for the movie. Expected and actual windows are assumed to affect both theater and video demand, although the actual window could only affect theater demand if it occurs before the end of the theater release. Theater and video prices (P_T and P_V) affect demand via substitution between theaters and video, as well as with outside goods. That is, P_T affects theater demand negatively and video demand positively, and conversely for P_V.

The term $V - T$ represents the general revenue potential of the video market relative to the theatrical market, at the time of release. That difference is basically determined by the quality and availability of theaters relative to video hardware. A higher $V - T$ is expected to increase video demand for a given movie relative to theater demand.

The season of a movie's release, S, reflects the well-known fact that demand for movies varies substantially and predictably through the year. Holiday periods, for example, tend to have peak demand for both theaters and video (Einav, forthcoming). The date of a movie's theater release can affect the optimal timing of video, for example, as distributors try to meet holiday release periods for video sales.

Finally, Z is a vector of individual movie characteristics affecting absolute and relative demand for a given movie on theater and video. This vector may embody a variety of features, such as production investment (which affects both theater and video demand positively); genre (which may have an uncertain or varying effect); or other signals of movie quality, such as observed box office performance, distributor marketing strategies, or an estimated length of time the movie will be in theaters.

Assume that distributors cannot profitably make specific advance commitments to consumers about when their movies will be released to video. Consumers anticipate the average minimum window of a particular movie based on their experience with windows in the past. At least potentially, the full array of movie-specific and other variables that enter the profit function of distributors also affects the expected window, to the extent that consumers rationally consider those variables to anticipate how distributors will vary the window for a particular film at a particular time.

Thus, for a particular movie at a particular point in time,

$$W^e = W^e(\Omega, P_T - C_T, P_V - C_V, V - T, d, Z, S) \tag{4}$$

where Ω represents the past experience with windows.

An equilibrium is obtained by assuming for simplicity that consumers are identical in their estimates of expected window length, or that they all have the same probability distribution of those estimates. Then, in a steady state equilibrium, $W^e = W$, and the equilibrium window, W^*, is given by,

$$W^* = W^*(P_T - C_T, P_V - C_V, V - T, d, Z, S,) \tag{5}$$

Thus, W^*, depends on market structure and industry behavior, and as discussed above, may be quite different across movies. Profit-maximization will in general, however, result in an equilibrium set of windows that depends on the array of variables in (5).

B. Empirical Models

We operationalize the basic model as follows:

$$\begin{aligned} Window_i = {} & a * VCRPen_i + b * RealInt_i + c * ln(ProdCostD_i) + \\ & d * ln(ProdCostD_i) * RealInt_i + e * ln(BoxTotalD_i) + \\ & f * ln(MaxScreens_i) + g * IndDum_i + h * SellThrough_i + \\ & j * Genre_i + k * Month_i + m * TheaterRun_i + e_i \end{aligned} \tag{6}$$

where i identifies movies. Definitions for these and all other variables included in the models we report in this paper are in Table 6. Alternative variables and model specifications are discussed in the Results section.

$VCRPen$ measures video potential relative to theater potential. We hypothesize that the video window should depend negatively on VCR penetration. Frank (1994) shows theoretically that as video becomes a more important source of movie revenues relative to theatrical release – as it did over our study period – the industry's optimal window becomes shorter. The intuition of his result is that at equilibrium, the marginal tradeoff between increasing theater revenues and reducing video revenues by lengthening the window shifts in favor of video revenues as VCR penetration rises.

The use of data observations over a 10 year period is potentially problematical due to changing exhibition technology and demand conditions. Other than video market development, however, such changes over this period seem to be relatively minor. PPV exhibition, whose window follows video, grew somewhat over this period and its windows were in flux. But even at the end of the period, PPV exhibition accounted for less than 1% of total movie distributor revenues, vs. approximately 47% for video (Paul Kagan Associates).

Relative market potential is also indicated in equation (5) by relative prices and costs of theaters and video, but we did not attempt to include these data due to a lack of cost data.

RealInt represents the distributor's time discount factor. Higher interest rates should induce distributors to have shorter windows because the present value of video revenues falls with rising rates. It is necessary to use a real interest rate (i.e., corrected for inflationary expectations), because that represents to distributors the actual expected cost of postponing the video market receipts for the film. *RealInt* is defined to be the nominal 6-month U.S. Treasury bill rate less the expected inflation rate. We statistically estimated the latter variable based on actual inflation in the past according to a time series estimation procedure used by Davidson and MacKinnon (1985). Rational behavior suggests a negative sign.

Other variables included in equation (6) are movie specific. Among these, higher film production cost, *ProdCostD*, may also induce a film's distributor to use a shorter window if capital market constraints are significant; its log form indicates the expectation of diminishing returns. Production cost is a financial variable subject to inflation and related economic forces, used in a model that estimates a non-financial variable. As Table 4 indicates, there were substantial trends over time in the production cost variable. It is not clear how, if at all, that this variables should be deflated over time. We report models in which production costs are deflated using an index based on the mean value of the variable in each year, in order to eliminate annual trends entirely.

The interaction term, $ln(ProdCostD) * RealInt$, reflects the expectation that if capital markets are imperfect, pressures to shorten windows to recoup costs of relatively expensive movies may be greater in times of high real interest rates. If so, this variable would have a positive sign.

IndDum indicates one of the four possible permutations of MPAA member involvement in the movie's theatrical and video releases, as described in Table 6. To specify this variable, we investigated the corporate affiliations and histories of the approximately 100 theatrical and video distributors having movies in the final database. For cases in which the company changed its status over time (e.g., it was acquired or sold by an MPAA member), the observations from the date of deal were coded as non-independent (MPAA member) or independent distributor. Removal from the database of hybrid cases (e.g., theatrical release by an MPAA member and video release by a non-MPAA member, or vice versa) proved to have virtually no effect on results, so these observations are left in the database as MPAA member-released films. We expect a negative sign on $IndDum$.

$SellThrough$ is a dummy indicating a basic release strategy used by studios for a relatively small number of high budget, high market potential movies during the period of our analysis. Typically, studios followed a "rental pricing" strategy, in which they wholesaled cassettes to retailers at prohibitively high prices for the sale market (eg, $60 to $100), and then "re-priced" about 6 months later down to the $15 or $20 level to pick up the sale market. In the "sell-through" option, studios wholesaled the videos in the latter price range at the initial release date with heavy advertising in expectation of mass market purchases, essentially sacrificing revenue from the rental market. Sell-through movies might tend to have shorter windows, for example, as their distributors attempt to meet gift holiday release dates, implying a negative sign.

With respect to the movie specific variable, $Genre$, different types of films may tend to have different windows. Animation films, for example, might have shorter windows if children tend to be less affected by window expectations. The genre variables are also at best a rough approximation of movie characteristics, but if optimal windows vary substantially by type of movie for some reason, we should observe significant patterns.

$Month$, a set of 11 dummies, represents the seasonal factors. Studios might, for example, shorten or lengthen windows for video release dates to fall at optimal periods. For example, a major film released to theaters in late summer may have a relatively short window if its distributor attempts to take advantage of high demand during the Christmas period. We generally do not have a priori expectations for signage of the $Month$ dummies.

$MaxScreens$ measures the largest number of theater screens that the movie appears on in any part of its theatrical release. A distributor may elect to use many theaters initially and exhaust theater demand quickly, or to use fewer theaters over a longer period of time. In general, we would expect that other things equal, more broadly distributed movies will leave the theater market sooner and have shorter video windows, but that there would diminishing marginal effects. Thus we expect a negative sign.

To represent theater market performance, we employ two variables. One is theater run length ($TheaterRun$). We generally expect video windows to be affected by how long a film stays in theaters. Our basic measure of theater run is the number of days from theater opening until the film is completely withdrawn from theaters. The more popular the movie, that is, the longer it should take to exhaust theater demand, which should in turn generally increase the video window. The other theater market performance measure in (7) is $BoxTotalD$, which we define to be total box office receipts of the movie over the full period of its theatrical run (detrended). Consistent with the explanation for production cost deflation, the actual box office variable tested in the models was adjusted for nominal inflation over the period and used in logarithmic form to indicate an assumption of diminishing returns.

It is difficult to predict how a movie's theater box office revenue performance should affect the window independently of the theater run length. Higher box office performance of a given movie will affect video demand, negatively through substitution effects, but positively through quality signaling effects, with uncertain net results of its effect on windows.

Ideally, we would use a variable representing the actual box office performance of the movie at the time that a window date decision is made or at least announced. As discussed above, however, 90% of street date announcements are made after at least 95% of box office receipts are in – a point from which the distributor is undoubtedly able to make a very accurate estimate of the eventual box office receipt total.

Similarly, $TheaterRun$ may not be fully determined at the time the video release data decision and announcement is made. To compensate for this problem, we also estimate and report models in which the theater run length is defined as the date by which 95% of the total eventual theater box office revenues are earned ($TheaterRun@95\%Rev$). In any case, the latter variable may be a more reasonable measure. Distributors may, for example, simply allow a movie to languish in sub-run theaters, earning marginal revenues, in advance of its announced video release date.

C. Empirical Comparisons

Conceptually, we can pose two extreme cases of distributor behavior in window setting. At one end of the spectrum, a "no commitment" case, a competitive distributor ignores any negative external effects of its window decisions on consumer expectations of the windows of other distributors' releases. In an industry with numerous players, the individual distributor's decisions will have a negligible marginal effect on consumer expectations of the windows of its own movies and the distributor chooses the window by maximizing profit as in equation (1). Variations in the window will thus be affected by the variety of economic variables in (2) and (3).

At the other extreme, a "full commitment" case, distributors as a group are able to commit to consumers optimally. In this case, distributors coordinate video window setting as if they were a monopoly. Windows are set such that consumers' expected future windows maximize expected profits from theaters plus video for all movies combined.

We cannot determine the particular profit-maximizing point at which video release should occur in either a no commitment or a full commitment model. In the competitive case, as Frank (1994) and Prasad et al. (2007) show in their formal models, the window date in the absence of commitment depends positively on theater run length, but the equilibrium point depends on unknown profitability tradeoffs between theater and video revenue streams. In the full commitment case, an optimal array of windows depends on an unknown function by which consumers predict future windows based on past windows, as well as potential institutional constraints.

One plausible model of successful commitment about which our data may provide insight, however, is that distributors choose some benchmark levels for windows that exceed the no commitment level. Coordination among distributors to adhere to the benchmark levels would be suggested if (i) windows systematically exceed institutional constraints and (ii) are unresponsive to the economic variables, notably the movie's theater run, that we would expect to determine windows in the no commitment model.

A meaningful empirical test of a benchmark model requires isolation of a group of relatively shorter theater run movies for which the commitment issue is clearly relevant. For this purpose, we divide the sample into three segments of approximately equal size: movies having theater run lengths of (a) under 11 weeks; (b) 11 to 17 weeks, (b) greater than 17 weeks.[13]

For movies with theater runs under 11 weeks, we expect to draw the clearest possible evidence of a benchmark model. A film that stays in theaters for 10 weeks (70 days), followed immediately by a video announcement period of 63 days, could be released to video no later than 133 days after the theater release – well before the 184 day average window period. At the opposite extreme, for movies in the longest theater run segment of our sample, having a minimum 18 week theater run (126 days), addition of the mean announcement period sums to 189 days, approximately the mean window. For this third of the sample, seller commitments are of questionable relevance – and would seem surely irrelevant for movies with theater runs substantially beyond 18 weeks. For movies in the intermediate 11-17 week interval, the relevance of commitment is uncertain.

Turning to specifics, the benchmark model implies that the $TheaterRun$ coefficient will have no significant effect on $Window$ in the under-11 week theater run segment. For the 11-17 week and 18 week-plus sample segments, that coefficient may or may not be positive and significant. Conversely, the no commitment model implies a positive and significant relationship between $TheaterRun$ and $Window$ for all three sample segments.

5. Results

A. Primary models

Tables 7 and 8 report OLS results for two sets of four alternative models. The four alternatives are for the full sample and then for each of the three theater run length subsamples. The two sets are with (1) $TheaterRun$ and (2) $TheaterRun@95\%Rev$, the run by which 95% of the total eventual theater box office revenues are earned. As noted above, the latter is our preferred measure of the theater run.

Considering first the two full sample models (1 and 5), signage and significance of coefficients are generally as expected. $VCRPen$ is strongly significant and in the expected direction, as found by Frank (1994) in his analysis of German data. Among financial variables, $RealInt$ and $ln(ProdCostD)$ are significant and negative as expected, while the interaction term among these variables is positive. The magnitudes of these financial

[13]As noted above, data for theater run lengths were available only at one week intervals. The intervals chosen miminize the sum of size differences between the three groups.

effects are relatively minor, but they indicate significant influences coming from capital markets, and suggest imperfections in these markets. Distribution patterns as indicated by $ln(MaxScreens)$ show a negative but small and marginally significant effect. Sell-through movies have substantially shorter windows by about 18 to 20 days. The genre and season variables have sporadic, relatively minor effects with the exception of much longer windows in the one case of animated films. $IndDum$ is negative and significant, indicating that non-MPAA member distributed movies had windows that were on average 25 to 27 days shorter than for MPAA movies.

Turning to the box office performance variables, both theater run length measures are strongly significant and positive for the $Window$ models (1 and 5). The box office measures in these models ($ln(BoxTotalD)$), however, are not significant.

Of most interest are the sub-sample estimates. The coefficients on the theater run variables in the under-11 week and 11-17 week segments are close to zero and insignificant in 3 of 4 cases (Models 3, 6, and 7), as predicted by the benchmark model. The coefficient on $TheaterRun$ in the under-11 week segment (Model 2) is negative and marginally significant, but in the opposite direction that would be expected from a competitive model. The positive and strongly significant coefficients on the theater run variables in over-17 week theater run segments in the $Windows$ models (4 and 8) suggest that longer theater run lengths are beyond a meaningful commitment level and at that point simply "push" the video release date out in time. The same then applies to the models on the full sample.

The hypotheses that the coefficients on $TheaterRun/TheaterRun@95\%Rev$ are the same in the under-11 and over-17 week models are rejected (tested at the 5% level).[14]

Significance of other model variables is generally lower in all three of the sub-samples, as might be expected from the smaller sample sizes, but $ln(BoxTotalD)$ has a positive effect on $Window$ for the under 11 week sample. Note that the $IndDum$ variable is consistently negative in the under-11 week sample, but also in the over 17 week sample. Since commitment is apparently unimportant or at least not as important in the longer

[14]The estimates in the two models are based on different sub-samples. Hence the estimates of the coefficients are independent and the variance error of the difference in the estimates is the sum of the variances of the individual estimates.

run sample group, we are left with little suggestion that non-MPAA members behave any differently than MPAA members in any window benchmark coordination efforts. As Table 5 above shows, $IndDum = 1$ cases were a small minority of the 1429 total sample but had relatively extreme characteristics. These independently distributed movies averaged smaller budgets and box office revenues, and were typically released to far fewer theaters, suggesting that missing variables or non-linearities may be responsible for the estimated differences.

Table 9 gives the results from applying three hypothesis tests to the models: (1) the White test for heteroskedasticity based on squared terms but not cross-products, (2) the RESET test, and (3) the F-test for the null hypothesis that the coefficients on the five variables, $RealInt$, $ln(ProdCostD)$, $ln(ProdCostD) * RealInt$, $ln(BoxTotalD)$, $ln(MaxScreens)$, are all zero.

Focusing on Models 2, 3, 6, and 7, we see that the models do not reject the null in the White and RESET tests (tested at the 5% level). In the models with our truncated measure of the theater run (Models 6 and 7), the five variables are jointly insignificant (tested at the 5% level). The model appears to 'break-down' in the case of the movies with longer theater runs, and consequently in the model on the full sample.

Finally, our regression results can be interpreted in terms of the alternative window measure, the "out-of-market" gap,

$$Gap = Window - TheaterRun \tag{7}$$

Substituting equation (6) into equation (7) shows that the implied coefficient on $TheaterRun$ in the model on Gap is $(m-1)$, where m is the coefficient on $TheaterRun$ in equation (6) (and similarly for a 95% of revenue variable, $Gap@95\%Rev$). See Table 10 for the implied coefficients on the theater run variables.[15]

All derived coefficients on the $TheaterRun$ and $TheaterRun@95\%Rev$ variables are

[15] The linear transformation does not affect the standard errors, but the usual t-statistics change. In the $Windows$ models, the t-statistics test the null hypothesis, $H_0 : m = 0$; whereas in the Gap and $Gap@95\%Rev$ models, the t-statistic tests the hypothesis $H_0 : m - 1 = 0$, or $m = 1$.

negative and strongly significant. Mirroring the *Window* model results, these coefficients are very close to -1 for the under 11 week and 11-17 week run length segments for the truncated "95%*Rev*" models – an increase in the theater run in associated with an equal decrease in the out-of-market gap.

B. Alternative specifications

We tested a number of alternative models. When the mostly insignificant *ln*(*BoxTotalD*) and *ln*(*MaxScreens*) variables were excluded from the models, results were mostly unchanged. For the key under-11 week run segment in the *Windows* models, *TheaterRun* was neutral and insignificant (-0.01 / t = 0.1) as was *TheaterRun*@95%*Rev* (0.19 / t = 1.0). Similarly for the 11-17 week segment. The benchmark hypothesis was supported even more straightforwardly, then, in these specifications.

Quadratic or other forms of the box office as well as the production cost and maximum screen variables did not indicate substantive differences. Similarly, estimates in which *ProdCost* and *BoxTotal* were used in current $ form, or deflated by the CPI, showed generally negligible differences.

In place of *VCRPen*, we used a set of nine dummies for each year (less one) of the sample to create fixed effects models. These dummies were mostly negative due to the negative time trend in video windows over the period, but nearly all insignificant, and coefficients for the theater run or out-of-market gap coefficients were not materially different.

To further investigate independent distributor behavior, we interacted the *IndDum* variables with *RealInt*, and *ln*(*ProdCostD*), but did not find significant differences.

We also estimated models without the two variables involving production costs. These estimates made use of the full sample of 1429 observations, but estimates were qualitatively the same.

The basic pattern of results reported in Tables 7-8 is generally robust to alternative configurations of our database. When we dropped the $1 million box office/24 screen minimum restrictions, thus adding 182 movies to the sample, including an additional 55 independently distributed (*IndDum* = 1) movies, only marginal differences in coefficients or levels of significance emerged. We also estimated models that excluded 1988 and 1989, the early years having highest variance in window lengths, to better account for the possibility of structural change over time. These estimates generally produced somewhat weaker results throughout and somewhat smaller differences in windows between MPAA and non-MPAA distributed movies, but the pattern of signage and statistical significance of the main coefficients did not change.

6. Discussion and Conclusions

The results of our empirical analysis are generally consistent with a hypothesis that, for a 10 year period in the late 1980s and 1990s, movie distributors in the U.S. successfully committed through some form of industry coordination to maintain longer video windows than would have resulted from a model in which distributors competitively set windows without regard to the effects of those decisions on consumer expectations. The regression models showed that, for movies having theater run lengths that are sufficiently short so that seller commitment is a plausible issue, the amount of time a film stayed in theaters had little or no statistical effect on the date it was released to video. Rather, windows tended to cluster around a mean in the 180 day range, invariant to the time required to exhaust the theater market. A variety of other economic variables, notably including interest rates and movie production costs, affected video windows in expected directions, but these variables generally had relatively minor influence.

While these results are provocative, they are far from conclusive. Actual video windows for individual movies showed a wide dispersion around the mean in any given year. This variance of actual movie windows around mean levels might partly be explained by random variations induced by the interactive video release date setting process. In any event, however, case-by-case decision making flexibility for individual movies by individual distributors is evident from the data.

In further qualification, individual major distributors release a number of movies in each year, and we cannot dismiss the hypothesis that independent behavior by individual distributors would by itself induce effective commitment only because of the effects that myopic behavior in the release of one movies would have on other movies released by the same distributor. On the other hand, many non-MPAA member distributors release very few movies per year, and we found that these independent distributors had significantly shorter windows on average than did MPAA members. However, these differences persisted for movies having relatively long theater runs, for which seller commitment was not an apparent issue. These results for independent distributors thus do not support the hypothesis that window benchmarks were coordinated by the MPAA to the exclusion of the independent distributors. A possible remaining explanation is that the window benchmark was coordinated by an industry trade organization, such as the National Association of Theater Owners.

We also acknowledge several shortcomings in our statistical analysis. First, representation of the decision making process with the single equation models we have used may be flawed. For example, the effects of variables such as theater run lengths or box office performance on window decisions are surely more complex than represented in our models. More broadly, the true structural model of window decision making is not necessarily one way cause and effect. Theater run lengths are not truly exogenous; and, to some extent at least, distributors probably make theatrical release decisions with a tentative video street date in mind.

We have also stopped short of welfare analysis in this paper. Of course, to the extent that window coordination might somehow serve to exclude other firms from the market, it would have anti-competitive effects. In general, though, coordinated behavior leading to successful inter-temporal price discrimination would appear to be socially beneficial because effective discrimination increases the ability of producers to support "first copy" creation costs of products for which there is sufficient total consumer demand (Spence and Owen, 1975). In a general context, Schmalensee (1981), Varian (1985) and others show that price discrimination is welfare-increasing if total output increases as a result. In this context, even overt collusion by motion picture studios to maintain video windows may be socially beneficial

Looking back in time, our research has implications for understanding the behavior of motion picture distributors and exhibitors prior to the U.S. Supreme Court decision in U.S. v. Paramount Pictures, et al (1948). In this early era of the industry, local cartels of theater owners and the major film distributors in some U.S. cities overtly colluded to control a multi-tiered movie release system involving up to 11 sequential runs at progressively lower and lower priced theaters (Conant, 1960). In this system, individual theaters were assigned to a tier (eg, "A pre-release," B general release," etc,), had a minimum admission price, and had set "temporal clearances," or certain periods of time (generally one to three weeks) for which individual theaters were guaranteed that no later run theater would exhibit a movie after their run had been completed. These precursors of the modern multi-media movie release system were found to have facilitated exclusion of independent distributors and independent exhibitors from the market, resulting in Consent Decrees in which the major distributors agreed to divest their theater holdings and to abide by a number of controls on their transactions with theater operators. Whatever their overall effect on competition, we suggest that one purpose of these cartels may have been the socially beneficial one of resolving the time consistency problem-thus effectively "committing" to consumers that new movies would not be available at lower prices for certain substantial lengths of time following their current exhibitions.

Finally, looking ahead, available descriptive data for years after 1997 indicate that the mean video window remained relatively steady until 2002, falling intermittently from approximately 178 to 171 days.[16] Then in late 2002 and early 2003, there were some radical experiments, led by Columbia Pictures, with video windows of just over 3 months for some major features. Press reports indicate a rather abrupt drop (based on a different sample of larger budget movies), 165 days in 2002 to142 days in 2003, and the average window has reportedly reached about 120 days by the end of 2007.[17] Since 2005 independent producers or distributors have been announcing a series of experiments with simultaneous theater, video, and pay-per view television release. Like similar experiments in the past, these involved marginal films and so far have came to very little in terms of revenue generation. But they motivated the National Association of Theater Owners and spokespersons for

[16]Video Store Magazine/Home Media Retailing (various issues) Note that some of the descriptive data in this paragraph are summary statistics as reported in the trade press and therefore not directly comparable to the trends for 1988-97 reported above. See Waterman (2005).

[17]M. Saccone, "the Incredible Shrinking Theatrical-to-DVD Window," Video Store Magazine, Jan. 2-8, 2005, p. 1, 29; "Vid Digest: DVD titles say; Window pain," Hollywood Reporter, January 24, 2008.

several major studios to declare their renewed confidence in maintaining the video window-which they seem clearly to perceive as one of the key elements of U.S. motion picture distribution strategy.[18]

[18]"On the Record: Studio Executives and Directors Overwhelmingly Support Preservation of the Theatrical Window, National Association of Theater Owners, December, 2006 (www.natoonline.org; downloaded January, 2007); S. Zelder, "Film co Roadside opens new 'window' for films," Reuters News, June 17, 2008.

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Table 1: Video Windows in Europe (1994-96)

Country	Mo.	Window setting method
Austria	6	industry agreement (fixed by contract for each release)
Belgium	6	industry agreement (follows French and Dutch patterns)
Denmark	6	industry agreement
France	12	statute (12 months by law, but 6 months if total box-office admissions are under 100,000; if admissions under 400,000, a derogation may be applied for)
Germany	6	industry agreement ("voluntary," but 6 months is mandatory for state-subsidized films; distributors "nearly always stick" to the 6 months on non-subsidized movies.
Greece	6	industry agreement
Ireland	6	industry agreement
Italy	8	statute/industry agreement (until 1994, one year; set at 8 months by law in 1994, with conditions set for derogations.
Netherlands	6	industry agreement
Norway	6	industry agreement ("strictly adhered to")
Portugal	12	statute
Spain	6	industry agreement (fixed on a case-by-case basis within guidelines: mandatory 6 months on subsidized films until 1996, when shortened from 6 to 4 months
Sweden	6	industry agreement ("fairly relaxed")
Switz	4-6	industry agreement ("not compulsory")
UK	6	industry agreement

Source: Paul Kagan Associates, *Kagan's European Home Video, 1994; Euromedia Regulation*, Feb. 21, 1996.

Table 2: The Video Window: Descriptive Statistics (number of days)

Video year	Obs	Mean	Median.	Variance	Minimum	IQR Ratio
1988	120	185.6	191.0	3163.9	56	1.15
1989	134	198.5	194.0	2578.1	96	0.82
1990	130	187.4	183.5	2082.6	77	0.78
1991	136	185.2	175.5	2095.5	14	0.75
1992	132	189.7	187.0	1778.6	61	0.69
1993	142	186.1	184.5	1813.1	89	0.87
1994	156	180.9	177.0	1233.8	110	0.96
1995	142	180.6	179.0	1145.9	95	0.77
1996	164	179.8	179.0	2030.0	95	0.79
1997	173	174.5	172.0	1488.8	60	0.81
Overall	1429	184.3	180.0	1930	14	0.80

Table 3: Mean and Median of Window-Related Variables (number of days)

Video year	*TheaterRun*		*TheaterRun @95%Rev*		*Gap*		*Gap@95%Rev*	
	mean	median	mean	median	mean	median	mean	median
1988	84.8	70.0	60.8	49.0	100.8	101.5	124.8	123.5
1989	84.9	70.0	58.6	49.0	113.6	117.0	140.0	137.0
1990	93.6	84.0	59.8	49.0	93.8	95.0	127.6	122.0
1991	102.2	84.0	64.3	56.0	83.0	94.0	120.9	123.0
1992	96.8	98.0	63.7	63.0	92.9	94.5	125.9	124.5
1993	100.5	94.5	64.9	56.0	85.6	83.0	121.1	117.0
1994	100.1	94.5	60.6	56.0	80.8	82.0	120.3	117.0
1995	119.4	112.0	64.5	56.0	61.3	67.0	116.1	123.0
1996	114.1	101.5	56.9	49.0	65.8	67.0	122.9	122.5
1997	116.8	112.0	60.5	49.0	57.6	60.0	114.0	116.0
Overall	102.3	91.0	61.4	56.0	82.1	83.0	123.0	123.0

Table 4: Descriptive Statistics for Basic Independent Variables

Variable	Mean	Median	Std. Dev.	Min	Max
VCRPen	69.1	70.3	8.5	45.8	80.4
1988	50.6	45.8	5.2	45.8	56.2
1989	58.9	56.2	3.0	56.2	62.3
1990	63.6	62.3	1.5	62.3	65.4
1991	66.3	65.4	1.0	65.4	67.5
1992	68.7	67.5	1.4	67.5	70.3
1993	70.9	70.3	0.7	70.3	71.7
1994	72.2	71.7	0.6	71.7	72.8
1995	74.2	72.8	1.5	72.8	75.8
1996	77.5	78.8	1.5	75.8	78.8
1997	79.6	78.8	0.8	78.8	80.4
BoxTotal	27.2	15.3	34.7	1.0	312.2
1988	23.0	13.8	28.1	1.2	164.2
1989	24.9	11.8	34.8	1.1	251.2
1990	23.3	12.4	28.3	1.1	138.1
1991	30.6	15.6	43.3	1.0	281.6
1992	27.0	16.4	31.0	1.0	162.8
1993	27.3	14.4	31.6	1.1	172.7
1994	21.6	15.3	21.2	1.2	102.2
1995	28.5	17.5	38.2	1.0	312.2
1996	29.5	17.2	36.3	1.0	241.7
1997	33.8	18.1	43.5	1.0	260.3
MaxScreens	1294	1307	673	25	3565
1988	1042	1117	488	49	2562
1989	1073	1118	543	54	2837
1990	1098	1095	583	31	2332
1991	1191	1230	579	75	2509
1992	1186	1223	619	25	2644
1993	1324	1391	606	25	2491
1994	1315	1406	648	126	2748
1995	1422	1491	697	40	2893
1996	1543	1635	684	34	3012
1997	1567	1745	871	49	3565
RealInt	1.9	2.3	1.8	-1.3	5.5
1988	2.9	2.8	0.4	2.5	4.0
1989	4.6	4.6	0.7	2.5	5.5
1990	4.1	4.1	0.3	3.6	5.5
1991	2.6	2.8	0.9	0.6	4.1
1992	0.2	-0.1	0.7	-1.3	1.5
1993	-1.1	-1.1	0.2	-1.3	-0.4
1994	-0.3	-0.6	0.7	-1.1	1.4
1995	2.3	2.6	0.6	1.0	3.0
1996	2.2	2.2	0.2	1.8	2.6
1997	2.3	2.2	0.1	2.1	2.5
ProdCost	21.8	17.0	18.1	0.0	175
1988	13.5	12.0	9.3	1.7	58
1989	14.1	14.0	7.5	2.0	50
1990	16.0	13.0	11.0	0.5	55
1991	20.3	17.0	14.7	0.3	95
1992	20.1	16.5	14.0	2.5	80
1993	20.7	18.0	12.4	2.5	65
1994	23.2	20.0	15.5	3.0	77
1995	27.2	23.5	19.8	0.0	90
1996	29.8	24.0	24.2	0.0	175
1997	33.6	25.0	28.8	0.3	145

Table 5: Characteristics of MPAA and Non-MPAA distributed Movies

Variable	*IndDum* = *1*		*IndDum* = *0*		*ALL*	
	Obs	Mean	Obs	Mean	Obs	Mean
Window	83	168.0	1346	185.3	1429	184.3
TheaterRun	83	93.8	1346	102.8	1429	102.3
TheaterRun@95%Rev	83	65.1	1346	61.1	1429	61.4
Gap	83	74.2	1346	82.5	1429	82.1
Gap@95% Rev	83	102.9	1346	124.2	1429	123.0
ProdCost	54	8.1	1108	22.5	1162	21.8
BoxTotal	83	6.7	1346	29.6	1429	28.3
MaxScreens	83	669.4	1329	1334.0	1412	1294.9

Table 6: Variable Definitions

Dependent variables	
Window	Time interval in days between a film's theatrical release and its video release
Gap	Time interval in days between the end of a film's theatrical release and its video release
Gap@95%Rev	Time interval in days between the date that a film earns 95% of its total theatrical revenues, and its video release
Independent variables	
VCRPen	% household penetration of VCRs for the year of theatrical release
BoxTotalD	total box-office receipts earned by the movie over the course of its theatrical run ($millions, deflated)
MaxScreens	the maximum number of theater screens reached during the movie's theatrical run
RealInt	nominal 6 month T-bill rate of the FRB less the expected inflation rate (estimated on the basis of past inflation rates from 1960 to 1997 (%))
ProdCostD	estimated production cost of the movie ($millions, deflated)
IndDum	dummy variable = 1 if the movie has a non-MPAA theatrical distributor *and* a non-MPAA video distributor; = 0 otherwise
Month (Feb, etc.)	dummy variables indicating the calendar month of theatrical release.
Genre (Action, etc.)	dummy variables that defines one of eight primary genre categories identified by EDI.
TheaterRun	Interval in days between the film's theater release and the end of its theater run
TheaterRun@95%Rev	Interval in days between the film's theater release and the date that it earns 95% of its total theatrical revenues.

Table 7: Video Window Estimates: Window on theater run length

Dep. Variable = *Window*

VARIABLE	(1) Full Sample			(2) Run length under 11 weeks			(3) Run length 11 to 17 weeks			(4) Run length over 17 weeks		
	Coef.		|t|	Coef.		|t|	Coef.		|t|	Coef.		|t|
Constant	287.44	**	(9.05)	246.97	**	(3.75)	326.99	**	(5.52)	344.20	**	(6.85)
VCRPen	-1.04	**	(6.13)	-0.26		(0.84)	-0.85	**	(2.64)	-1.51	**	(5.46)
IndDum	-27.44	**	(4.69)	-21.55	**	(2.41)	-20.06		(1.54)	-37.87	**	(3.58)
RealInt	-8.90	**	(2.70)	-2.67		(0.39)	-14.98	**	(2.49)	-9.48	*	(1.90)
ln(BoxTotalD)	0.83		(0.37)	13.02	**	(2.80)	6.13		(1.33)	-1.44		(0.35)
ln(MaxScreens)	-4.76	*	(1.74)	-8.55		(1.56)	-11.24	**	(2.14)	-4.67		(1.01)
ln(ProdCostD)	-5.64	**	(2.07)	3.25		(0.50)	-9.23	*	(1.93)	-5.14		(1.35)
ln(ProdCostD) x RealInt	2.57	**	(2.68)	1.07		(0.52)	4.17	**	(2.38)	2.49	*	(1.79)
SellThrough	-19.65	**	(2.80)	-37.29		(0.88)	-6.12		(0.41)	-17.03	**	(2.17)
Action	-12.18		(0.52)	18.87		(0.45)	33.18		(0.81)	-65.58	*	(1.72)
Animated	60.99	**	(2.23)	82.66		(1.58)				-0.94		(0.02)
Comedy	-5.21		(0.23)	25.73		(0.61)	44.43		(1.08)	-62.57	*	(1.66)
Drama	-1.70		(0.07)	22.67		(0.53)	49.09		(1.19)	-54.45		(1.45)
Sci-Fi	-5.17		(0.22)	42.82		(0.98)	33.46		(0.79)	-63.03		(1.63)
Thril	-9.70		(0.42)	21.73		(0.51)	35.91		(0.87)	-68.07	*	(1.78)
Musical	-15.96		(0.63)	6.99		(0.16)	39.08		(0.84)	-35.23		(0.77)
Feb	4.72		(0.69)	-1.94		(0.17)	8.43		(0.67)	8.40		(0.68)
Mar	4.47		(0.67)	2.74		(0.26)	7.61		(0.64)	-4.28		(0.33)
Apr	2.16		(0.32)	-0.22		(0.02)	6.76		(0.56)	10.32		(0.82)
May	3.86		(0.56)	3.72		(0.30)	6.62		(0.53)	3.29		(0.27)
Jun	0.86		(0.12)	-9.75		(0.67)	7.01		(0.53)	5.70		(0.46)
Jul	-0.35		(0.05)	-12.09		(1.02)	8.07		(0.62)	3.61		(0.30)
Aug	2.04		(0.31)	7.20		(0.68)	2.99		(0.25)	0.11		(0.01)
Sep	3.15		(0.47)	8.56		(0.82)	11.93		(0.94)	-13.22		(1.04)
Oct	-0.48		(0.07)	-1.29		(0.12)	15.87		(1.31)	-8.62		(0.74)
Nov	8.49		(1.24)	-3.00		(0.27)	19.01		(1.46)	11.69		(0.96)
Dec	0.16		(0.02)	0.32		(0.03)	10.45		(0.82)	-3.32		(0.29)
TheaterRun	0.25	**	(8.34)	-0.32	*	(1.82)	-0.21		(1.25)	0.43		(9.92)
adj. R^2	0.20			0.04			0.08			0.38		
F	11.78	**		1.67	**		2.27	**		9.72	**	
N	1157			410			363			384		

** significant at 5% level; * significant at 10% level (*Continued*)

Table 8: Video Window Estimates: Window on theater run length @ 95% revenues

Dep. Variable = *Window*

VARIABLE	(5) Full Sample			(6) Run length under 11 weeks			(7) Run length 11 to 17 weeks			(8) Run length over 17 weeks		
	Coef.		|t|	Coef.		|t|	Coef.		|t|	Coef.		|t|
Constant	255.85	**	(7.62)	209.90	**	(2.87)	314.37	**	(4.85)	324.29	**	(5.84)
VCRPen	-0.68	**	(4.24)	-0.44		(1.46)	-0.95	**	(2.99)	-0.80	**	(2.77)
IndDum	-25.35	**	(4.34)	-21.11	**	(2.35)	-21.02		(1.61)	-29.98	**	(2.71)
RealInt	-7.84	**	(2.38)	-2.19		(0.32)	-14.44	**	(2.40)	-4.37		(0.83)
ln(BoxTotalD)	2.20		(1.02)	8.44	*	(1.77)	5.10		(1.03)	1.82		(0.42)
ln(MaxScreens)	-2.67		(0.92)	-4.53		(0.75)	-11.01	*	(1.78)	-2.79		(0.55)
ln(ProdCostD)	-5.09	*	(1.86)	4.11		(0.63)	-8.92	*	(1.86)	-4.27		(1.06)
ln(ProdCostD) x RealInt	2.45	**	(2.55)	0.87		(0.41)	3.99	**	(2.28)	1.58		(1.08)
SellThrough	-18.23	**	(2.60)	-33.95		(0.80)	-6.79		(0.46)	-20.42	**	(2.48)
Action	-20.74		(0.89)	19.40		(0.46)	34.60		(0.83)	-94.68	**	(2.35)
Animated	55.39	**	(2.02)	85.97		(1.64)				-20.30		(0.47)
Comedy	-13.43		(0.58)	25.85		(0.61)	45.62		(1.10)	-94.04	**	(2.37)
Drama	-9.76		(0.42)	22.42		(0.53)	50.33		(1.21)	-84.70	**	(2.14)
Sci-Fi	-13.41		(0.56)	42.35		(0.96)	35.22		(0.83)	-92.83	**	(2.28)
Thril	-17.51		(0.75)	22.39		(0.53)	36.74		(0.88)	-95.25	**	(2.36)
Musical	-24.77		(0.97)	7.21		(0.16)	41.08		(0.87)	-73.42		(1.53)
Feb	4.90		(0.71)	-1.10		(0.10)	9.23		(0.73)	15.88		(1.23)
Mar	4.66		(0.70)	4.13		(0.39)	9.21		(0.78)	6.74		(0.49)
Apr	2.24		(0.33)	-0.80		(0.07)	7.30		(0.60)	15.61		(1.18)
May	5.38		(0.77)	4.38		(0.35)	7.47		(0.59)	13.78		(1.09)
Jun	3.67		(0.49)	-11.95		(0.82)	7.54		(0.57)	19.40		(1.50)
Jul	0.43		(0.06)	-11.55		(0.97)	8.94		(0.68)	12.32		(0.99)
Aug	3.62		(0.55)	6.14		(0.58)	3.61		(0.31)	8.97		(0.71)
Sep	4.33		(0.64)	6.81		(0.65)	12.66		(1.00)	-1.56		(0.12)
Oct	0.16		(0.02)	-2.16		(0.20)	16.19		(1.33)	-2.16		(0.18)
Nov	8.61		(1.25)	-3.49		(0.31)	19.21		(1.46)	20.07		(1.58)
Dec	0.32		(0.05)	0.25		(0.02)	11.22		(0.87)	4.84		(0.40)
TheaterRun @95%Rev	0.39	**	(8.11)	-0.06		(0.25)	-0.09		(0.50)	0.46	**	(7.45)
adj. R2	0.20			0.03			0.08			0.32		
F	11.61	**		1.54	**		2.21	**		7.55	**	
N	1157			410			363.00			384		

** significant at 5% level; * significant at 10% level (*Continued*)

Table 9: Additional Tests

Model	White test	RESET test	Significance test
1	74.6 (0.00)	10.5 (0.00)	2.91 (0.01)
2	36.7 (0.34)	0.05 (0.94)	2.92 (0.01)
3	35.6 (0.34)	2.07 (0.10)	2.49 (0.02)
4	97.0 (0.00)	5.85 (0.00)	2.24 (0.04)
5	66.6 (0.00)	8.28 (0.00)	1.58 (0.15)
6	37.2 (0.32)	0.14 (0.85)	1.99 (0.06)
7	34.5 (0.39)	1.63 (0.17)	2.05 (0.05)
8	56.9 (0.01)	7.97 (0.00)	0.53 (0.71)

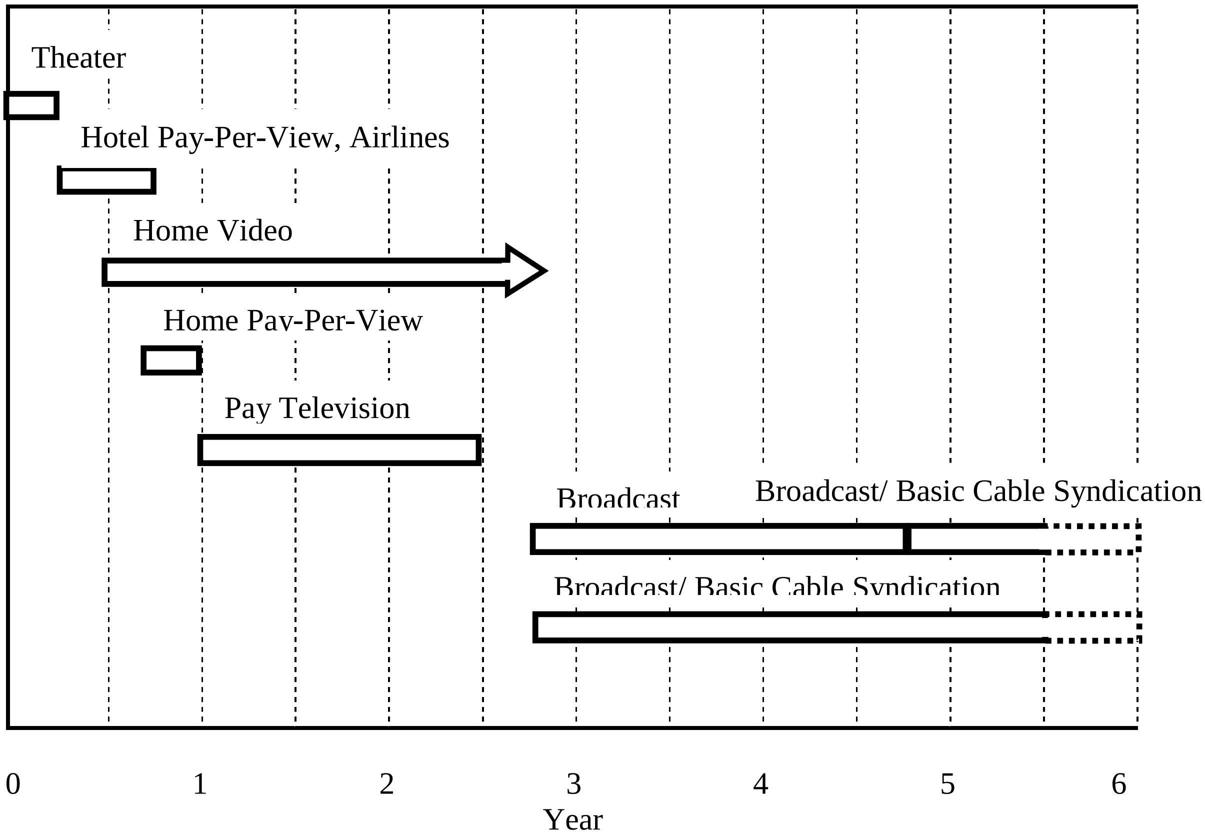
Note: *p*-values are shown in parentheses.

Table 10: Out-of-market Gap Models – Theater run coefficients

VARIABLE	Coef.		|t|	Coef.		|t|	Coef.		|t|	Coef.		|t|
Dep. Variable = *Gap*	**(1) Full Sample**			**(2) Run length under 11 weeks**			**(3) Run length 11 to 17 weeks**			**(4) Run length over 17 weeks**		
TheaterRun	-0.75	**	(24.47)	-1.32	**	(7.56)	-1.21	**	(7.28)	-0.57	**	(13.3)
adj. R^2	0.60			0.15			0.19			0.46		
F	64.74	**		3.70	**		4.33	**		13.13	**	
Dep. Variable = *Gap@ 95% Rev*	**(5) Full Sample**			**(6) Run length under 11 weeks**			**(7) Run length 11 to 17 weeks**			**(8) Run length over 17 weeks**		
TheaterRun @ 95%Rev	-0.61	**	(12.74)	-1.06	**	(4.19)	-1.09	**	(6.02)	-0.54	**	(8.84)
adj. R^2	0.25			0.06			0.11			0.27		
F	15.48	**		1.95	**		2.78	**		6.30	**	

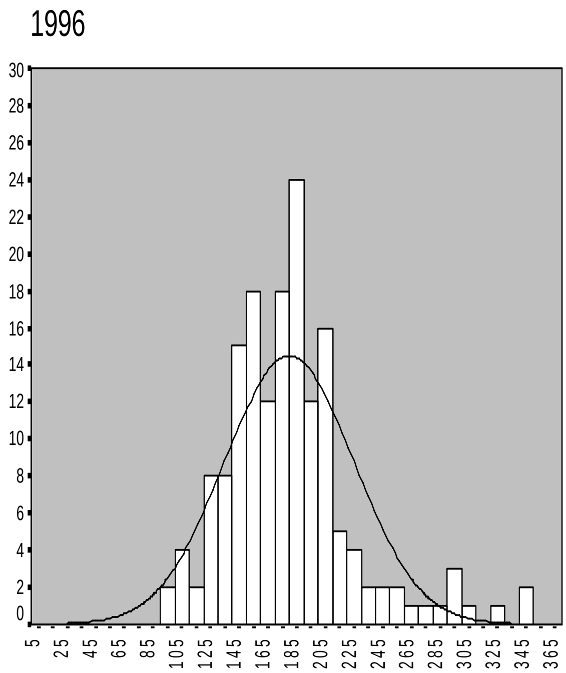
** significant at 5% level; * significant at 10% level

Figure 1: Typical Domestic Theatrical Release Sequence



Source: Compiled by authors from trade literature sources.

Figure 2: Frequency Distribution of Video Window, 1996



Obs.	164.0
Mean	179.8
Median	179.0
Sd. Dev.	45.1

Figure 3: The "Out-of-Market" Gap in Relation to Theater Run Lengths: Averages for 1988 - 1997

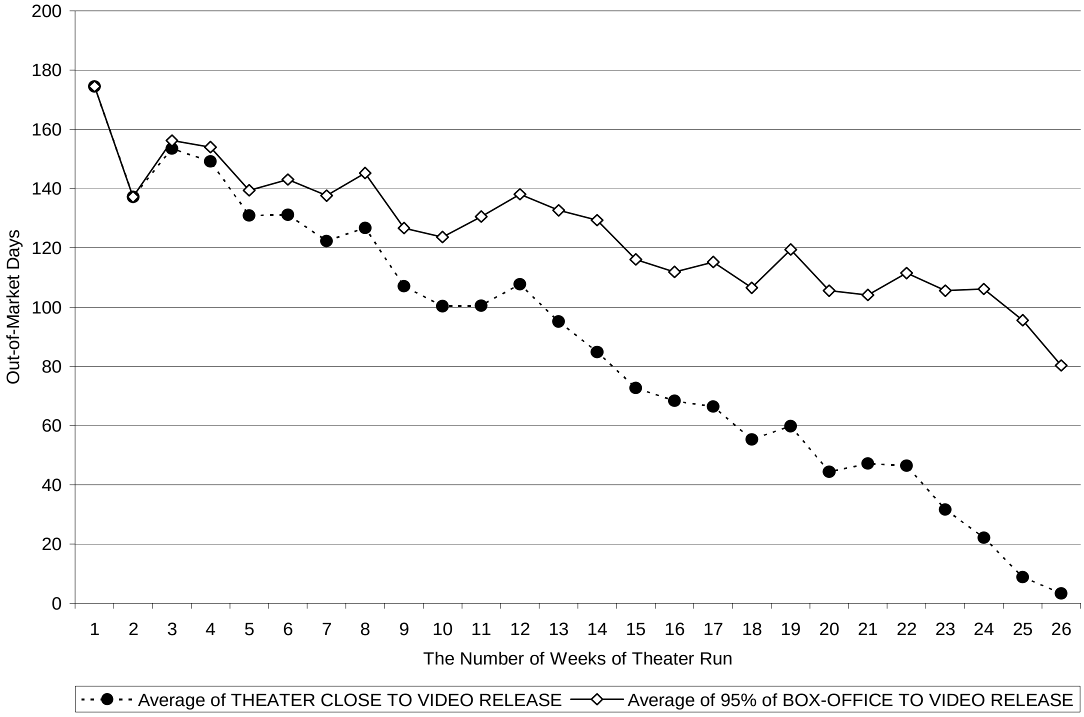


Figure 4: The Video Announcement Period

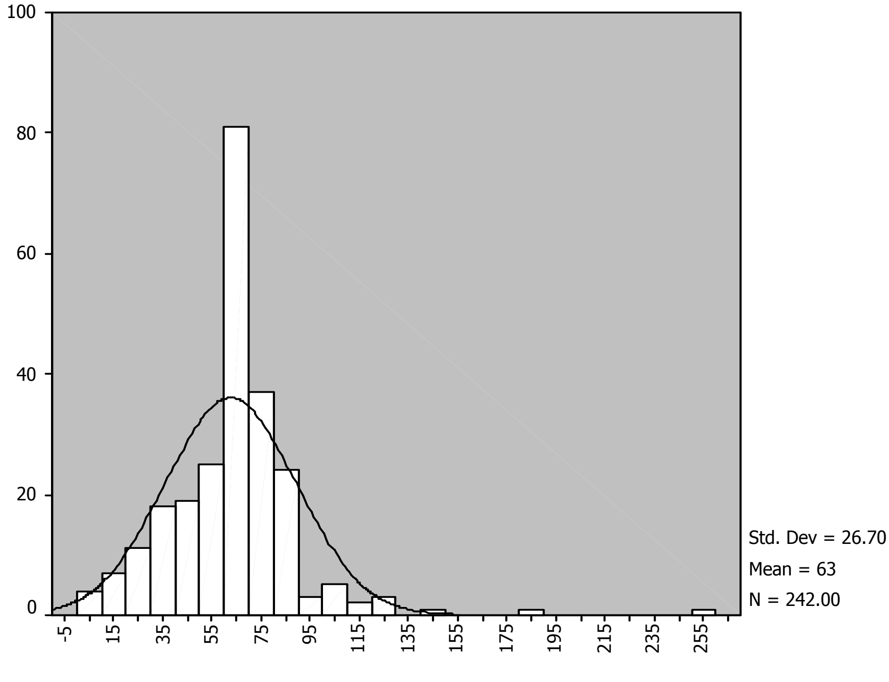


Figure 5: Video Announcement Date Less Theater Close Date

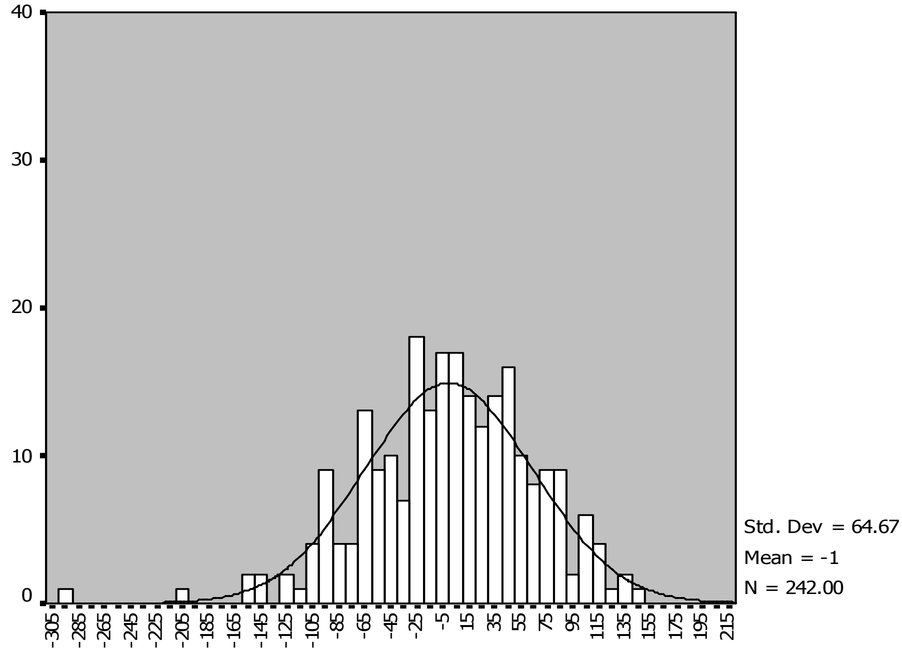


Figure 6: Video Announcement Date Less 95% of Theater Box-office Date