Demand Shifts and Second Degree Price discimination - the Impact of DVDs on the Motion Pictures Industry

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Abstract

This paper applies models of price discrimination to the motion picture industry. Movies are durable goods with no resale market. Therefore, price discrimination using time can be used. The distributors release the movie in two different periods: theaters and video. The first is a high quality product and the second is a low quality product issued in a later point in time. The quality gap between the two versions of the product has shrunk as the DVD technology penetrated the market.

This paper compares two years: 1995 and 2000. Initial results show a difference between the two years. The most evident one is a shrinkage of the time between the theatrical release and the video release.

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1 Introduction

When faced with heterogeneous consumers, a monopoly would like to price discriminate between consumers with high evaluation of the product and those with a low evaluation. By doing so the monopoly is hoping to extract a bigger portion of the consumers surplus. Detecting which are the high valuation consumers and which are the low ones is often either impossible or illegal. The monopoly can sometimes find a mechanism that will help revealing the consumers type in an indirect way. This kind of situation is called second degree price discrimination. The literature on this topic is vast and includes numerous examples of type revealing mechanisms. These examples include discrimination through quality and time.

This paper deals with the motion pictures industry. The type revealing mechanism used in this industry is mainly time. Movies are issued for viewing in two periods. The first is the theatrical release and the second is the video rental release. Apart from the time difference, watching the movie in theaters is more expensive then renting it but the quality of the product in its theatrical screening version is higher than its quality in the home screening version. This situation has changed dramatically with the introduction of DVDs. The quality gap between the two versions of the product has shrunk as the DVD technology penetrated the market.

This paper compares two years: 1995 and 2000. The first is before the DVD technology was introduced to the market (March 1997) and the second is when DVD had already became a part of the market. Initial results show a difference between the two years. The most evident one is a shrinkage of the time between the theatrical release and the video release.

This version of the paper contains the model of price discrimination in Section 2. The data set is described in Section 3 and preliminary results in Section 4. Section 5 concludes.

2 Price Discrimination and Time Inconsistency

This paper applies models of price discrimination and time inconsistency to the motion picture industry. First, the product and the key players in this industry and the decisions they face are described. Then the time inconsistency problem is addressed.

Movies

A movie is a durable good with no resale market. Once consumed by a certain agent, this agent will not want to consume it again. The demand for a movie, therefore, shrinks with time and the

seller faces in each period the residual demand from the last period. Movies are not tangible and therefore there is no second-hand market where a consumer can sell his or her experience of watching the movie. Two different movies can be substitutes but it is reasonable to assume that the cross-elasticity of demand is rather small. Movies are differentiated along many dimensions. Each movie has its own characteristics like the plot and the cast that single it out from the other products in the market.

The Distributors

Undoubtedly, the key players in this industry are the distribution companies. By owning the rights for a movie the distribution company has a monopoly power over this product. It does face a certain amount of competition from other distribution companies who may introduce similar products. The distribution company decides when to introduce the product to the primary market of theatrical screening, it decides when to introduce new movies to this market that will make the current products obsolete, it also decides when to introduce the product to secondary markets of video rental and possibly other markets in the future. The distribution company bears the advertising costs for the movie and it also contracts with movie theaters in the various markets to screen the movie. The distributors decision of when to introduce the movie in the first place is not modeled here. We think of it as their attempt to maximaize the potential demand for their product. Seasonal as well as other considerations influence the timing of movie releases (see Einav (2003)). We take as given the fact that the distributors have decided to release their movies optimally. We focus our interest in their decision when to release the movie to the secondary market - the video renting.

The exhibitors

The second important player in the market are the movie theater owners or the exhibitors. The distributors, as a monopole, negotiates with different movie theaters in each market and contracts with one of them. The contract between the movie theater and the distributor indicates what percentage of the box office revenues will be transferred to the distributor. This percent usually goes down with the weeks of screening. The price of a movie ticket is close to being constant. It does not vary across movies or across time. Very often the contract between the exhibitor and the distributor will include a minimal number of weeks in which the movie must be screened. Once the movie is screened the theater owner can decide for how long will the movie be screened. This decision is, however, limited by the contract with the distributor. Using the competition between various theaters in the same

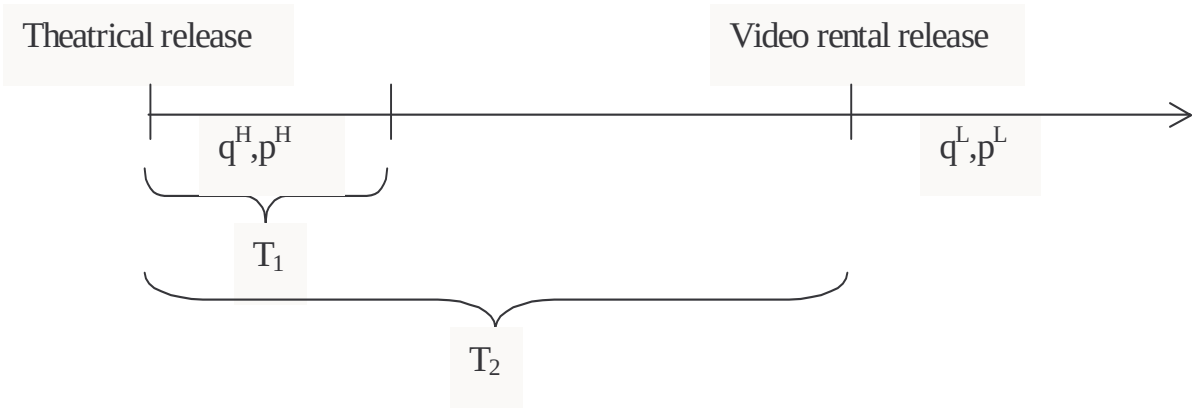

Figure 1: The video window

market, the distributor often demands that the movie will run for a certain minimal time in order to win an exclusive screening permit. This minimal runtime changes from movie to movie and last between 2 to 6 weeks. Beyond this period the movie theater may keep screening the movie or replace it with another movie.

Consumers

Different consumers value each movie differently. The quality of a movie and the utility from consuming it depends on the characteristics of the movie and on the individual preferences of the consumer. A movie j is assumed to have an intrinsic quality Q_j. The utility for consumer i for consuming a movie j depends on the consumer's type θ_j^i which is distributed according to F_j. Consumption of a movie can be done in two periods of time. A consumer may choose to go to the movie in the theater and consume the movie in its high quality version, $q^H Q_j$. After a certain period of time, however, this product may not be available at the theaters. In this case the consumer will have to wait an additional time until the product is introduced in the market of movie rentals. The quality of the product in its video rental version is lower, $q^L Q_j$. The face prices of the product in its two quality versions are known in advanced p^H and p^L respectively. The two unknown elements to the consumers are the length of time the movie will be screened in the theaters, T_1, and the time until the product is issued in its lower quality version, T_2.

Each consumer derives the following utility from consuming a movie

$$V(\theta_j^i, q, t) - p(t) \tag{1}$$

where q is either q^H or q^L, t is the time passed from the theatrical release of the movie and $p(t)$ is the price incurred by the consumer for going to the movie at time t. We assume that $V(\cdot,\cdot,\cdot)$ is increasing in its two first elements and decreasing in the third. The face price of the movie is indeed p^H is the first period and p^L at the second period. If $p(t)$ is taken to be the face value of watching the movie, then it is clear from (1) that if a certain consumer prefers to watch the movie on the big screen he or she will want to do that at $t = 0$ and if they prefer to watch it on video they would like to do it at $t = T_2$. Both the exhibitors and the video rental stores (not modeled in this paper) have capacity constraints - they cannot accommodate all the movie watchers on the day the movie comes to the screens or to the video stores. However, lines at the movie theaters or lack of available copies at the rental store increase the price that the consumer actually faces. After a while when these capacity constraints are non binding anymore the face price is the actual price paid by the consumer. Figure (2) describes the price paid by consumers in the various time periods of the model. A special treatment of availability and pricing in the movie rental market appears in Dana (2001) and Dana & Spier (2001).

To simplify the discussion we make the following assumptions. T_1 is regarded as the effort put by the exhibitors to market the product. Higher T_1 may attract more consumers to watch the movie at the theaters. T_2 is the price discrimination device used by the distributors to distinguish between different types of consumers. Prices are fixed at each period.

For each movie j the distribution of types θ_j^i is F_j and defined over a set Θ of all possible types. Given T_1 and T_2, the consumers are divided into the following three groups.

Group 1: **Theater goers**:

$$\Theta_1 = \left\{ \theta : \begin{array}{c} \exists t' \in [0,T_1] \textit{ such that} \\ V(\theta,q^H,t') - p(t') \geq V(\theta,q^L,t'') - p(t'') \; \forall t'' \geq T_2 \\ \textit{and } V(\theta,q^H,t') - p(t') \geq 0 \end{array} \right\}.$$

Group 2: **Video renters**:

$$\Theta_2 = \left\{ \theta : \begin{array}{c} \exists t'' \geq T_2 \textit{ such that} \\ V(\theta,q^L,t'') - p(t'') \geq V(\theta,q^H,t') - p(t') \; \forall t' \in [0,T_1] \\ \textit{and } V(\theta,q^L,t'') - p(t'') \geq 0 \end{array} \right\}.$$

Group 3: **Outside optioners**:

$$\Theta_o = \Theta \backslash (\Theta_1 \cup \Theta_2).$$

The total demand for the movie in the first period is

$$D^H(q^H,q^L,p^H,p^L,T_1,T_2) = \int_{\Theta_1} dF_j. \tag{2}$$

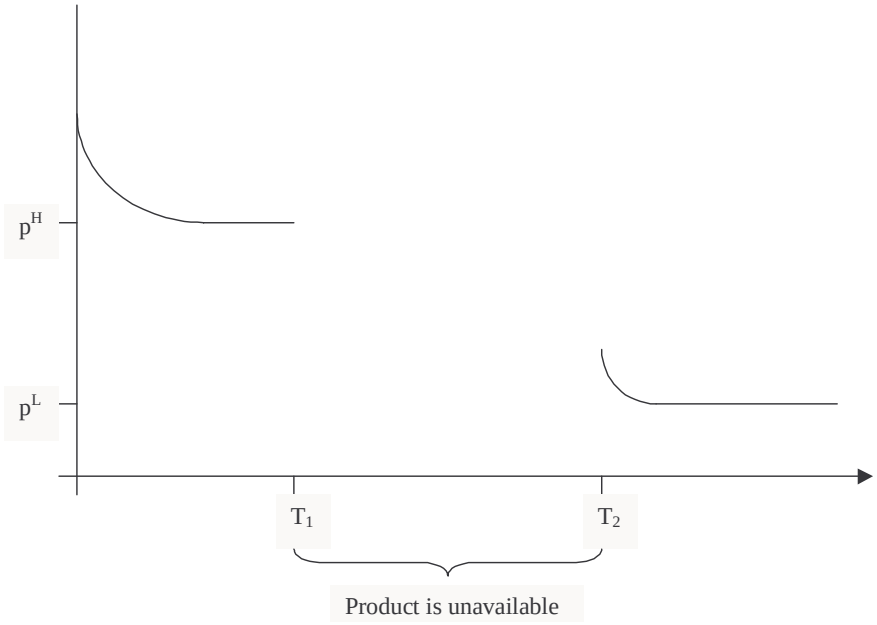

Figure 2: Price of watching a movie as seen by consumers

We assume that $\partial D^H/\partial q^H < 0$, $\partial D^H/\partial q^L > 0$, $\partial D^H/\partial p^H < 0$, $\partial D^H/\partial p^L > 0$, $\partial D^H/\partial T_1 > 0$ and $\partial D^H/\partial T_2 > 0$. It means that as the product stays longer in the market the monopoly is more likely to collect revenues from consumers with high evaluation of the product. In the second period the monopoly offers the same product but in its reduced quality q^L and a reduced price p^L. The monopoly then faces the residual demand

$$D^L(q^H, q^L, p^H, p^L, T_1, T_2) = \int_{\Theta_2} dF_j. \tag{3}$$

Here we assume that $\partial D^L/\partial q^H < 0$, $\partial D^L/\partial q^L > 0$, $\partial D^L/\partial p^H > 0$, $\partial D^L/\partial p^L < 0$, and $\partial D^L/\partial T_2 < 0$. $\partial D^L/\partial T_1$ can be either positive or negative. On one hand the longer the movie stays on screens the less is the residual demand left on the other hand long time in the theaters may serve as a positive signal for the quality of the movie.

2.1 One-shot Game With No Commitment

The problem the monopoly distributor is facing is

$$\max_{T_2:T_2\geq T_1} \alpha p^H D^H(q^H, q^L, p^H, p^L, T_1, T_2) + \beta e^{-rT_2} p^L D^L(q^H, q^L, p^H, p^L, T_1, T_2) \tag{4}$$

where α and β are the portion of the revenues from the theatrical screening and the video rentals respectively and r is the interest rate. The decision about T_1 is done by the theater owners. This decision can depend on a pre-committed T_2 by the movie distributor. We denote this expected variable by T_2^e. Therefore, the theater's problem is

$$\max_{T_1}(1-\alpha)p^H D^H(q^H, q^L, p^H, p^L, T_1, T_2^e) - cT_1 \tag{5}$$

where c is the cost of screening the movie per period. The following time inconsistency problem arises. Given the decision about the length of the theatrical release, the distributor will choose to release the movie to the video-rental market immediately after its theatrical run is over. In other words, the solution for (4) is $T_2 = T_1$. Thus, with no commitment mechanism the theater movies will conclude that $T_2^e = T_1$. The set of consumers that will consume the product in its theatrical release version will be very small. With no commitment mechanism this set can be empty. Solving (5) with this restriction will lead to a very low choice of T_1 or even to $T_1 = 0$.

2.2 One-shot Game With Commitment

The distributor announces T_2 before T_1 is chosen by the the movie theaters and the announced T_2 is implement. The movie theaters have a best response function $T_1^*(T_2)$. This best response function is then substituted into (4) and T_1 is chosen to maximize the distributors profits. The solution to (5) is

$$\frac{\partial D^H}{\partial T_1} = \frac{c}{(1-\alpha)p^H}.$$

The change in T_1^* with respect to T_2 is given by

$$\frac{\partial T_1^*}{\partial T_2} = \frac{\left(\frac{\partial^2 D^H}{\partial T_1 \partial T_2}\right)}{-\left(\frac{\partial^2 D^H}{\partial T_1^2}\right)}$$

wherever these second derivatives exist. When they do, the second derivative in the denominator is negative and thus the sign of $\frac{\partial T_1^*}{\partial T_2}$ depends on the sign of the cross partial derivative of D^H with respect to T_1 and T_2.

The equilibrium with commitment is likely to produce higher profits for both the distributors and the movie theaters.

2.3 The Repeated Game

The with commitment is clearly preferable to the no commitment one but with no enforcement mechanism it is unachievable. Assume now that the game is repeated infinitely many times. Both the

distributors and the movie theaters maximize the discounted sum of the profits from each stage of the game. As it is always the case with repeated games, the equilibrium (and strategies) of the no-commitment game can be repeated infinitely many times and this can be a possible outcome path of the repeated game. We are interested, however, in more interesting possibilities that can arise from the repeated game. More precisely, it is possible to show that for a big enough discount rate we can support the with-commitment outcome as an equilibrium outcome of the repeated game. In order to do that, the movie theaters should use a strategy in which they threat that if the movie distributors deviate from the with-commitment strategy even once they will then resort to a strategy of no theatrical screening at all forever.

3 Data

The data for this paper was gathered from various internet sites. The first is the magazine Variety.[1] It publishes, on a weekly basis, data about all the movies that were screened in the US and provides data about their performance at the box office. The second source is *Hollywood.com* site that provides the exact dates of theatrical release and video release for each movie.[2] Data were collected for two years: 1995 and 2000. The choice of these two years is arbitrary apart from the fact that 1995 is before the appearance of DVDs and 2000 is after. Monthly sales of DVD players were used as an indication for the market penetration of this technology. The data is published by the Consumer Electronics Association.[3] Table 1 describes the variables.

Table 1: The variables in the data set

Variable name	Description
totweek	The total number of weeks where the movie was screened
week100	Number of weeks until the number of screens fell under 100
week10p	Number of weeks until the number of screens fell under 10% of the maximum
totbox	Total revenues at the box office - US only
openbox	Revenues in the first week of screening - US only
openeng	Number of engagements that screened the movie on the opening week
meng	The maximal number of engagements that screened the movie at a certain week
window	The time between theatrical release and video rental release

The market penetration of DVDs is described in Figure 3.

[1] http://www.variety.com.
[2] http://www.hollywood.com. Another source is http://movies.yahoo.com but it is less comprehensive.
[3] http://www.the digitalbits.com/articles/cemadvdsales.html.

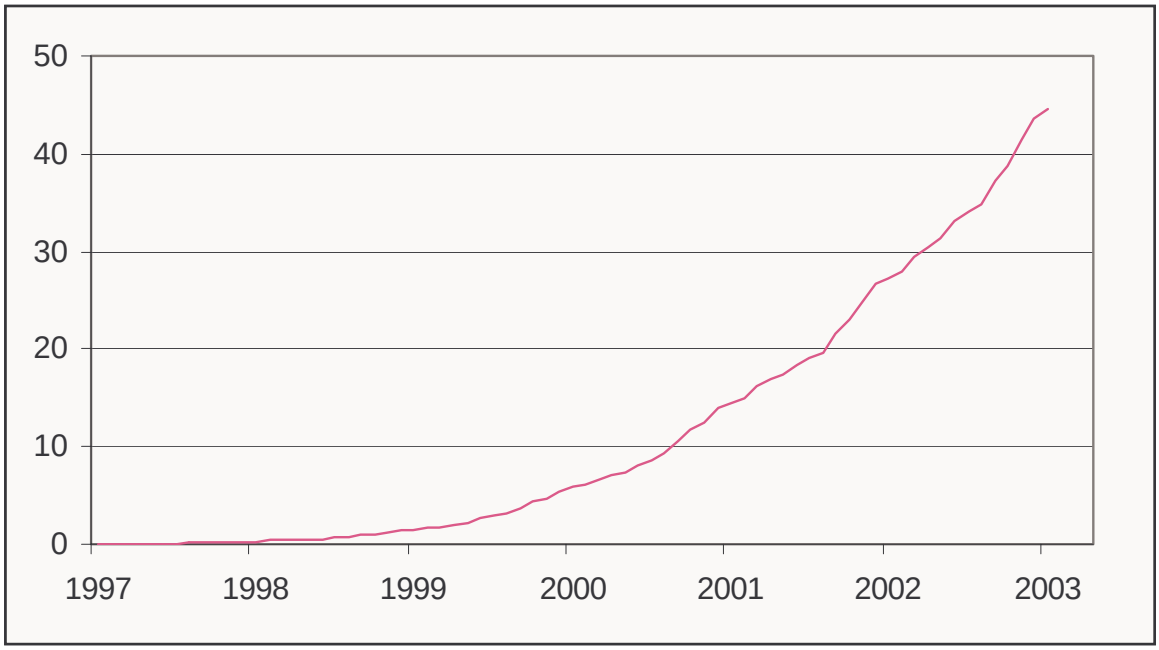

Figure 3: DVD palyers sales in the US from 1997

4 Empirical Results

The first comparison between 1995 and 2000 reflects the differences in the distribution of the time that movies spent in the theaters and the time between the theatrical release and the video release. Figure 4 describes the cumulative distribution of the variable *window* for both 1995 and 2000.

Figure 4 clearly show that there is a shift in the distribution of variable *window* and that the distribution in 1995 stochastically dominates that of 2000. The effect of demand shifts on the distribution of the length of theatrical screening is less obvious. As Figure 5 shows there is a stochastic dominance relation but it is weaker and is probably insignificant.

The next step is to check how the length of the theatrical screening affects the window of time between the theatrical release and the video release. In order to take into account the fact the differences in the quality of the movies the following semiparametric model was estimated.

$$window = f(totweek) + meng\beta + \varepsilon \tag{6}$$

The estimator for f is described in Figure 6.

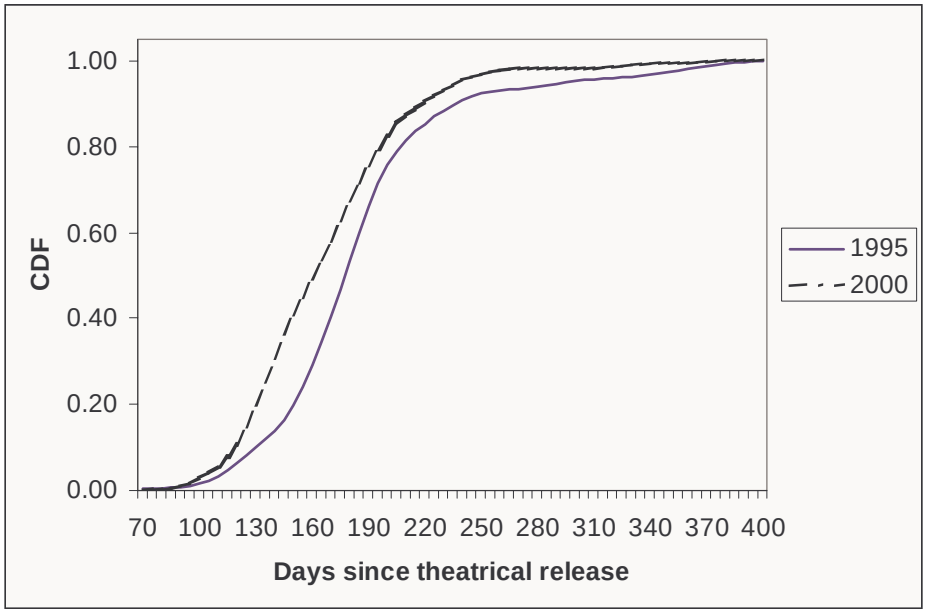

Figure 4: Cumulative distribution function of time since theatrical release to time of video release, 1995 and 2000

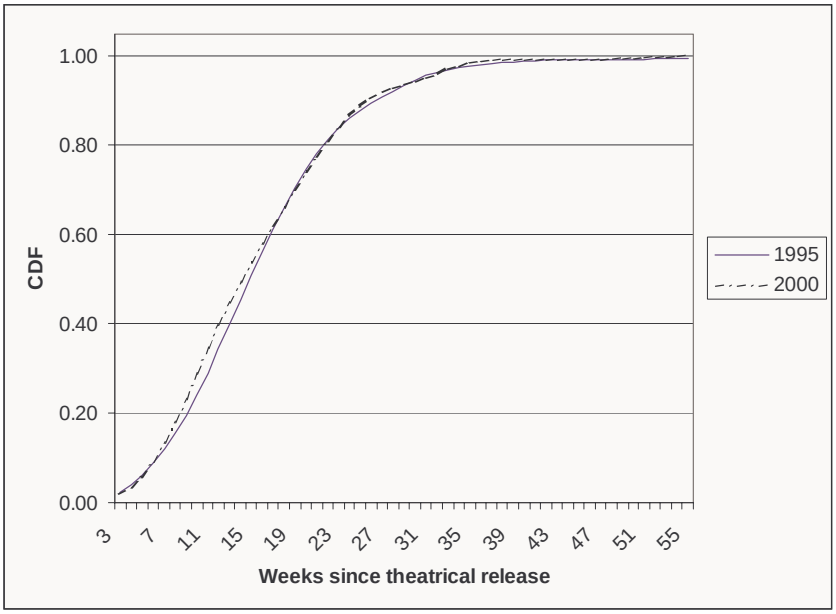

Figure 5: Cumulative distribution function of the time since theatrical release until the number of screens is bellow 10% of the maximum

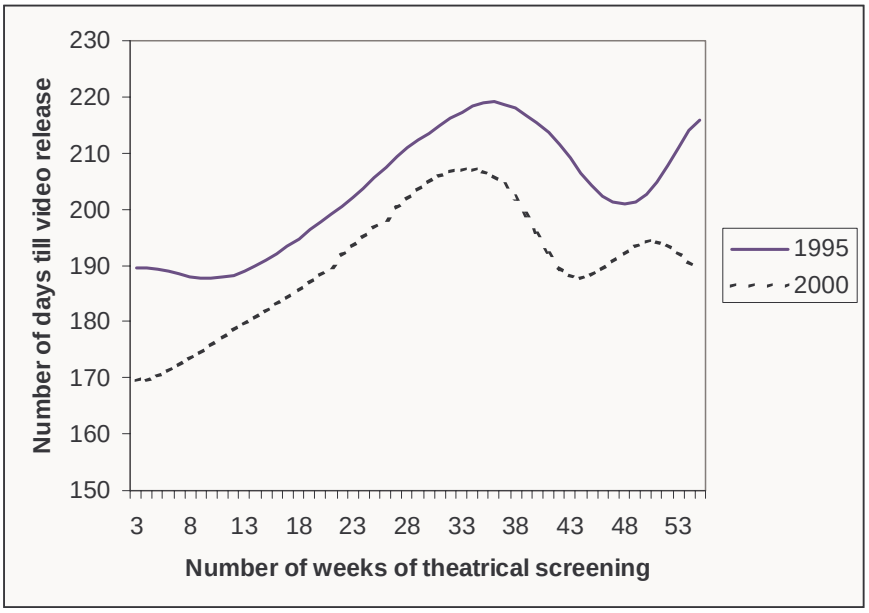

Figure 6: The nonparametric part of model (6).

5 Conclusions and Further Research

The preliminary results show a difference between the pre and the post DVD introduction. The reduction in the quality gap between the movies in their theatrical screening version and their video rental version, as caused a reduction in the time the distributors wait between the theatrical release and the video release. The model in Section 2 was set in a nonparametric way. Therefore at this point most of the comparative static is impossible. Moreover, a welfare analysis can be interesting but requires estimation of the demand functions. Both courses of action are planned.

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