Spaced Out Monopolies: Theory and Empirics of Alternating Product Releases*

Artie Zillante
ICES, George Mason University

May 24^{th}, 2005

Abstract

An oft-neglected pattern of behavior occurs when firms time the release of their products so that they are not released on the same date. The practice is potentially collusive, so there may be legitimate antitrust concerns. This paper presents a model of this behavior, the alternating periods monopoly (APM). A comparison of the APM with other sustainable methods of collusion shows the conditions under which the APM is preferred. I develop an empirical test to detect the APM, and use data from the baseball card industry to investigate the possible use of an APM.

Key words: Noncooperative strategies, alternating periods monopoly, duration analysis
JEL: L12, C72

1 Introduction

Economic analyses of timing problems in production typically center around one of the following: capturing first-mover advantage in the industry, the trade-off between delaying release to produce a higher quality product or releasing early to earn profits sooner, and the obsolescence problem. While these are important issues, all are typically associated with a durable good that consumers no longer need to purchase after the initial purchase, unless they wish to upgrade their current model. A neglected area of timing problems involves industries in which new products appear frequently, such as in the movie, compact disc, video game, baseball card, and other entertainment or hobby type industries. In these industries, manufacturers are constantly releasing new products as consumers amass the old ones and clamor for new ones. Consumers are believed to have preferences for newness, which I define in the manner of Krider and Weinberg (1998). Preferences for newness imply that consumers would like to purchase goods from a certain class each period, but that due to the durable nature of the good consumers do not wish to purchase the same brand each period. By class I mean a fairly general categorization of goods like baseball cards or cereal, whereas brand implies a specific product from that class, like *Fruit Loops* for cereal or *2002 Topps Ten* for baseball cards. In the cereal class, the consumer may purchase the same brand of cereal each market period, as the consumer prefers that brand and his stock is exhausted each period. However, in the case of baseball cards and other entertainment or hobby type products, consumers typically will not purchase the exact same product each market period, since the product they purchased in the previous market period still remains usable.

An important aspect of strategic behavior in these industries is how firms choose to release their products over time. Perhaps firms are capable of releasing a new product each week, and all firms release new, substitutable products on Friday of each week. This may be viewed as competitive behavior in the market, as the firms are competing head-to-head. On the other hand, if firms are capable of producing a new product each week, and only one firm releases a product each week, then the behavior may not be as competitive. Call this strategy where only one firm is active in the market per period and then firms alternate turns being the active firm in the market the alternating periods monopoly (APM). Although such a rotation scheme is

*I would like to thank Mark Isaac, Tim Salmon, Tom Zuehlke, Greg Burge, Donald Bumpass, and participants of Florida State University's Quantitative Methods Seminar for helpful comments. The John and Hallie Quinn Fellowship provided funding for the research. As always, all remaining errors remain my own.

not necessarily evidence of explicit collusion, it could be used by firms as a collusive scheme. The primary incentive for choosing the APM is that it removes intra-period competition among firms. Perhaps the most famous use of a collusive strategy similar to the APM is the "phases of the moon" bid rotation scheme employed in the electrical switchgear industry in the middle of the 20^{th} century. According to Scherer (1970), this scheme involved:

> ...dividing the United States into four quadrants, assigning four sellers to each quadrant, and letting the sellers in a quadrant rotate their bids. A 'phases of the moon' system was used to allocate low-bidding privileges in the high voltage switchgear field, with a new seller assuming low-bidder priority every two weeks. (Scherer, 1970, pgs. 159-161)

To my knowledge, little work has been done on the APM outside of the auction literature. An exception is Herings, Peeters, and Schinkel (2001) (HPS). Using an algorithm developed in Herings and Peeters (2000) that solves stochastic games numerically, they show that the alternating periods monopoly is a symmetric stationary equilibrium for a duopoly market with identical firms. Furthermore, in their example they show that regardless of which firm moves first both firms receive higher profits from the APM than from Cournot competition as long as the discount rate is sufficiently high. Section 2 of the current investigation extends the HPS results by providing general conditions under which the APM is preferred to other forms of industry behavior, including a form of collusion where firms equally share the market (ESM).

There is some anecdotal evidence to suggest that firms may be using the APM when new products are released. On October 11, 2002, The New York Times (pg. C.1.) reported a breakfast meeting between Jeffrey Katzenberg, a Dreamworks studio founder, and Harvey Weinstein, co-chairman of Miramax Films. The two discussed the release dates of two Leonardo DiCaprio films, *Catch Me if You Can* and *Gangs of New York*. Both were scheduled to open on Christmas Day 2002. In the end, Weinstein altered his release date and Miramax "chose" to release *Gangs of New York* just five days earlier, on December 20^{th}. This small change in release date was apparently all that was needed to alter expected profits enough to satisfy both parties, suggesting that what may look like trivial changes in release dates are actually quite important.

There is also experimental evidence that subjects may focus on the APM when given the chance to collude, even if it is not the strategy that generates the highest profits. Both Isaac and Walker (1985) and Davis and Holt (1998) report the usage of the APM in experiments where other strategies would perform better at extracting the monopoly level of profits, the first in a sealed bid auction setting and the latter in a posted offer environment. Kwasnica and Sherstyuk (2002) find a result similar to the APM in their experimental study of collusion in multiple unit auctions with complementarities. They find that experimental subjects are able to collude using bid rotation in two-bidder two-object simultaneous ascending auctions with large complementarities. Bidders would take turns submitting the minimum bid each round in order to avoid competing away the complementarity. The use of an APM is similar to using bid rotation to capture complementarities, where the complementarity in the oligopoly can be defined as the amount each period by which one-firm monopoly profits exceed the sum of monopoly profits when k firms agree to split the market. Zillante (2005a) finds mixed results in an experimental investigation constructed to determine if the APM can arise endogenously using a multi-period binary signaling technique.

Theoretical results regarding the preferability of the APM to other noncooperative and collusive strategies are developed in section 2. The main result is that the per-period industry profit function must be decreasing in the number of firms in order for the APM to be preferred to Cournot behavior. Using this result, it can then be shown that firms prefer the APM to a sustainable form of ESM collusion. Section 3 describes the empirical methodology. Duration models are used to provide evidence as to whether releases are clustered or spaced. Clustered releases imply that industry behavior does not match the APM. Section 4 provides a description of the baseball card industry and the data set. The baseball card industry is used because the primary manufacturers face little competition from smaller manufacturers within the industry. Baseball cards are also a fairly specific class of goods, whereas products in other industries may need to be broken into smaller subcategories, such as genre for movies or music, before assessing the release strategies. Section 5 provides the results of the estimation, and section 6 concludes.

2 Folk Theorem Model

A vast literature exists that provides a theoretical basis for determining the conditions under which collusive behavior may occur. Most of these results rely on the folk theorem established in Fudenberg and Maskin (1986). The folk theorem requires that firms have a discount rate high enough to support the collusive outcome over the noncooperative outcome in repeated market games, and relies on firms using a trigger strategy if other firms deviate from the agreed upon collusive outcome. Once a deviation is observed firms enter a reversionary period where they behave noncooperatively to punish the defector. The reversionary period may be either a finite number of periods or may last forever, depending on the structure of the game.

The seminal paper in the literature on sustainable collusion, Green and Porter (1984), extends standard folk theorem results for repeated games by introducing a model with stochastic demand. Firms produce the collusive output level unless the market price falls below some trigger price $\bar{p}$. There are two reasons that the price may fall below $\bar{p}$. The first is due to the stochastic demand factor. Even if all firms are producing their respective collusive shares, there may be a large enough negative demand shock to cause price to fall below $\bar{p}$. The second occurs when firms cheat on the collusive agreement by producing more than their respective collusive shares in any given period. Regardless of the reason, if price falls below $\bar{p}$, firms behave noncooperatively for a specified period of time, then return to producing the collusive output level. Rotemberg and Saloner (1986) and Staiger and Wolak (1992) are other papers that use the structure of the Green and Porter model. Although the focus of these papers is primarily on how price wars develop in periods of high and low demand, the underlying models apply to how firms can maintain a collusive agreement in the face of unobservable individual production levels by reverting to punishment periods. A more thorough review of the literature on sustaining collusion can be found in Jacquemin and Slade (1989).

2.1 Baseline Results

Suppose an industry consists of k risk-neutral firms facing stochastic market demand in each period. The demand shocks are iid mean zero shocks. Let $E\left[\Pi_{i,t}^{m}\right]$ be the expected monopoly profit to firm i at time t, and let $E\left[\Pi_{i,t}^{c}\right]$ be the expected profit to firm i should all k firms produce at the Cournot level each time period. Both the participation constraint,

$$\delta^{k-1}\sum_{t=0}^{\infty}\left(\delta^{k}\right)^{t}E\left[\Pi_{i,t}^{m}\right]\geq\sum_{t=0}^{\infty}\delta^{t}E\left[\Pi_{i,t}^{c}\right]\;\;\forall i\in(1,2,...,k),\tag{1}$$

and the incentive compatibility constraint,

$$\delta^{k-1}\sum_{t=0}^{\infty}\left(\delta^{k}\right)^{t}E\left[\Pi_{i,t}^{m}\right]\geq E\left[\Pi_{i,0}^{d}\right]+\sum_{t=1}^{\infty}\delta^{t}E\left[\Pi_{i,t}^{c}\right]\forall i\in(1,2,...,k),\tag{2}$$

must be satisfied if the firms are to choose the APM over Cournot behavior. Also, the incentive compatibility constraint insures that firms will not attempt to deviate from the APM. Deviation occurs by producing in another firm's slot, and the deviation profit is denoted $E\left[\Pi_{i,t}^{d}\right]$. It is assumed that deviation from the APM is observable by all firms, and that all firms will produce the Cournot quantity each period after deviation occurs. While the punishment is harsh, it helps to establish an upper bound on the discount rate necessary to support the APM. Thus, the APM strategy is for firms to follow a set order of releasing products, coupled with the active firm producing its monopoly quantity, and if deviation occurs, all firms will produce the Cournot quantity every period.

Both constraints focus on the firm that is scheduled to release in the k^{th} spot in the rotation, as shown by the δ^{k-1} term in front of the LHS of each equation. The intuition behind basing the condition on the firm in the last spot in the rotation is that if firm i is willing to participate when placed in the last spot, it would certainly be willing to participate if it was slotted earlier and received a slightly less discounted payoff stream.

Although equations (1) and (2) differ by the first term on the RHS, both yield the same necessary condition in order for a discount rate to exist that will ensure the APM is an equilibrium strategy. Although the exact form of the deviation payoff is unspecified, the proof of existence of a discount rate to support the APM is unchanged, and only the magnitude of the discount rate necessary to support collusion changes. The condition is

$$E\left[\Pi_{i,t}^{m}\right] > kE\left[\Pi_{i,t}^{c}\right] \forall i \in (1, 2, ..., k). \tag{3}$$

Proposition 1 *If equation (3) is satisfied for all firms, then a discount rate $\delta^* \in [0, 1)$ exists such that for every $\delta \in [\delta^*, 1)$, the APM is an equilibrium strategy.*

Proof. The Limit of Means criterion, established in Aumann and Shapley (1994), is a sufficient condition for such a δ^* to exist. The Limit of Means criterion states that the sequence (v_i^t) of real numbers is preferred to the sequence (w_i^t) if and only if $\liminf \sum_{t=1}^{T} (v_i^t - w_i^t)/T > 0$. Define the sequence (v_i^t) as a sequence of zeros followed by $E\left[\Pi_{i,t}^{m}\right]$ every k^{th} period. Define (w_i^t) as $\left(E\left[\Pi_{i,t}^{c}\right], E\left[\Pi_{i,t}^{c}\right], ...\right)$. Let $\varepsilon = E\left[\Pi_{i,t}^{m}\right] - kE\left[\Pi_{i,t}^{c}\right] > 0$. Every k periods the firm receives ε if (v_i^t) is chosen instead of (w_i^t); on average, the firm receives $\frac{\varepsilon}{k} > 0$ each period. Thus, $\lim_{T\to\infty} \sum_{t=1}^{T} \left(\frac{\varepsilon}{k}\right)/T = \left(\frac{\varepsilon}{k}\right) > 0$. Since the limit of means criterion is not sensitive to a change in a payoff in a single period, the RHS of equations (1) and (2) are evaluated identically by the Limit of Means criterion, proving that such a δ^* exists to support both equations if $E\left[\Pi_{i,t}^{m}\right] > kE\left[\Pi_{i,t}^{c}\right]$.

QED ■

Proposition 1 formally defines the condition necessary to support the repeated game strategy. Intuitively, firms will participate in an APM only if the additional gain is not discounted too much. This proposition implies that for any identical firm duopoly case with linear demand in the form of $a - bQ$, constant marginal costs (c), and a noncooperative payoff that is Cournot, the discount rate must be greater than 0.8 in order for the APM to be preferred to Cournot behavior. This can be verified by noting that for two firms the Cournot profit per firm is $\frac{(a-c)^2}{9b}$. The monopoly profit is $\frac{(a-c)^2}{4b}$. For the second firm to prefer the APM over the Cournot outcome,

$$\delta\frac{(a-c)^2}{4b} \geq \frac{(a-c)^2}{9b} + \delta\frac{(a-c)^2}{9b}. \tag{4}$$

Solving for δ gives $\delta \geq 0.8$. The discount rate necessary to support the APM in a 4-firm industry with linear demand, constant marginal costs, and identical firms is actually lower, at 0.765, and can be found in a similar manner. Given the frequency of releases for the product classes under consideration, the interest rates implied by these discount rates are plausible. Note that while the sufficient condition is derived assuming that $E\left[\Pi_{i,t}^{c}\right]$ is the Cournot profit, the condition holds for any general noncooperative or competitive profit level that may be labeled $E\left[\Pi_{i,t}^{c}\right]$.

2.2 Comparison of Sustainable Collusive Arrangements

Neither the APM nor the ESM is Pareto superior in terms of expected payoffs if collusion holds. This can be verified by realizing that all firms, in expectation, receive the same amount of undiscounted expected profits in either the APM or the ESM, assuming no punishment periods for ESM. However, the first firm to release in the APM receives its share of the profits sooner in the APM than in the ESM, while the last firm to release in the APM receives its share of the profits sooner in the ESM than in the APM. One potential flaw in comparing the APM and the ESM is that the ESM is not sustainable if it is assumed that firms cannot observe each others exact production levels and demand is stochastic, unless there is credible commitment by the firms to revert to noncooperation for a specified amount of time if the price in the market drops too low.

Since neither the APM nor the ESM without reversions is Pareto superior in expected payoffs, I compare the APM with a sustainable version of the ESM. The sustainable ESM is a modified version of the Green and Porter model, where the key element to the sustainability of that model is that firms enter reversionary noncooperative periods with positive probability. The basic outline of models of this type is that k firms in the industry agree to produce $\frac{1}{k}$ of the monopoly quantity each period. However, the market price fluctuates based upon both the amount produced in a period as well as a stochastic factor. Assume the market price has distribution function $F(p(Q))$ and disturbances are iid across time and independent of the market quantity, Q. A trigger price, $\bar{p}$, is determined by the firms, and if the price falls below $\bar{p}$ firms play a noncooperative market game for T periods. Even though production levels are unobservable between firms these models are sustainable versions of the ESM because firms commit to entering the punishment phase regardless of the reason price falls below $\bar{p}$. Thus, the incentive to deviate by producing more than $\frac{1}{k}$ of the monopoly quantity each period is removed.

Let $F(\bar{p})$ be the probability that the price is below the trigger price. I have suppressed the argument to the demand function since all firms will produce $\frac{1}{k}$ of the monopoly quantity in each collusive period in equilibrium in the sustainable ESM. Again, letting $E[\Pi_i^m]$ be the expected monopoly profit per period and $E[\Pi_i^c]$ be the expected k-firm Cournot profit per period, the expected equilibrium lifetime profits of any firm in the sustainable ESM model are

$$\frac{E[\Pi_i^m]}{k} + \sum_{j=1}^{\infty} \delta^j \left[\begin{array}{c} \frac{E[\Pi_i^m]}{k} \left(1 + \sum_{t=1}^{j} (-F(\bar{p}))^t\right) \\ +E[\Pi_i^c] \left(\sum_{t=1}^{j} (-1)^{t-1} \left(F(\bar{p})^t\right)\right) \end{array} \right]. \tag{5}$$

It should be noted that I have set the number of reversionary periods the firms will play, T, equal to one in setting up the lifetime profit function.[1]

Since equation (5) is somewhat cumbersome, I use a simplified version to show that if a discount rate exists that supports the APM as an equilibrium strategy, then all firms prefer the APM to the sustainable ESM model for some subset of those discount rates. Let $x \in (0, 1]$. Since equation (3) must hold for the APM to exist, firms prefer that they spend more time in the collusive state than in the noncollusive state, which implies that firms prefer lifetime profit functions with larger probabilities of being in the collusive state. For equation (5), it can be shown that firms attain their highest probability of being in the collusive state in the third period,[2] with that probability being $1 - F(\bar{p}) + \left(F(\bar{p})^2\right)$. Since $F(p) \in [0, 1)$, there exists some $x \in \left(0, F(\bar{p}) - \left(F(\bar{p})^2\right)\right)$ such that firms will prefer the lifetime profit function where the probability of being in the collusive state is $(1 - x)$ to the lifetime profit function where the probability of being in the collusive state is $1 - F(\bar{p}) + \left(F(\bar{p})^2\right)$. Thus, if the APM can be shown to be preferred to the simplified version of the sustainable ESM,

$$\frac{E[\Pi_i^m]}{k} + \sum_{j=1}^{\infty} \delta^j \left[\left(\frac{E[\Pi_i^m]}{k}\right)(1 - x) + E[\Pi_i^c](x) \right], \tag{6}$$

by transitivity it can be shown to be preferred to the actual sustainable ESM found in equation (5).

It can then be shown that the APM will be preferred by the last firm in the rotation to the ESM when there is stochastic demand if

$$\frac{\delta^{k-1}}{1 - \delta^k} E[\Pi_i^m] \geq \frac{E[\Pi_i^m]}{k} + \frac{\delta}{1 - \delta} \left[\left(\frac{E[\Pi_i^m]}{k}\right)(1 - x) + E[\Pi_i^c](x) \right]. \tag{7}$$

Proposition 2 *If equation (3) is satisfied for all firms, $\forall x \in (0, 1]$ a δ^* exists such that for every $\delta \in [\delta^*, 1)$ the inequality in equation (7) holds, showing the APM is preferred to the sustainable ESM.*

Proof. The Limit of Means criterion is a sufficient condition for such a δ^* to exist and it is defined in the previous proof. Define the sequence (v_i^t) as a sequence of $\left(\frac{E[\Pi_{i,t}^m]}{k}, \frac{E[\Pi_{i,t}^m]}{k}, ...\right)$. Under the Limit of Means criterion, this sequence (v_i^t) is evaluated identically to the sequence of payoffs generated by the APM, which is a sequence of zeros followed by $E\left[\Pi_{i,t}^m\right]$ every k^{th} period. Define (w_i^t) as:

[1] Although the choice of T should be endogenously determined by the discount rate and payoffs, a choice of $T = 1$ assumes that discount rates are high, which they must be for the APM to be an equilibrium strategy.

[2] Technically firms prefer the Green and Porter case where there is no chance of reversion to noncooperation to the cases where there is some positive chance of reversion to competition, but since the case with no reversion is not sustainable it is omitted.

$\left(\left(\frac{E\left[\Pi_{i,t}^m\right]}{k}\right)(1-x)+E\left[\Pi_{i,t}^c\right](x),\left(\frac{E\left[\Pi_{i,t}^m\right]}{k}\right)(1-x)+E\left[\Pi_{i,t}^c\right](x),...\right)$.

Let $\varepsilon = E\left[\Pi_{i,t}^m\right] - kE\left[\Pi_{i,t}^c\right] > 0$ so that $E\left[\Pi_{i,t}^c\right] = \frac{E\left[\Pi_{i,t}^m\right]}{k} - \frac{\varepsilon}{k}$. Using substitution, (w_i^t) becomes $\left(\frac{E\left[\Pi_{i,t}^m\right]}{k} - x\frac{\varepsilon}{k}, \frac{E\left[\Pi_{i,t}^m\right]}{k} - x\frac{\varepsilon}{k}, ...\right)$. Every period the firm receives $x\frac{\varepsilon}{k}$ if (v_i^t) is chosen instead of (w_i^t). Thus, $\lim_{T\to\infty}\sum_{t=1}^{T}\left(x\frac{\varepsilon}{k}\right)/T = \left(x\frac{\varepsilon}{k}\right) > 0, \forall x \in (0,1]$.

QED ■

Given that neither the ESM without a reversionary period nor the APM are Pareto superior methods of collusion, proposition 2 provides a powerful result. If demand is stochastic and firms are risk-neutral, then the APM is preferred to the sustainable ESM by even the last firm to produce in the APM rotation. Note that this proposition still requires a discount rate high enough to support the APM. Intuitively, because there is positive probability of receiving the Cournot payoff with certainty in some periods, the undiscounted profits for all firms are lower in the sustainable ESM than they are in the APM. Assuming a discount rate of one and a four-firm industry, the fourth firm in the APM would receive a profit vector of $(0,0,0,E\left[\Pi_i^m\right])$. In the sustainable ESM there is no guarantee that the firm receives a sum of undiscounted profits over four periods equal to $E\left[\Pi_i^m\right]$ due to the probability of a reversionary period.

Two final notes about the model need to be made. First, there are additional equilibria which can be viewed as APM strategies but in which the firms do not follow a set rotation. In fact, alternating the rotation from a strict 1,2,3,4,1,2,34, etc. pattern to something like 1,2,3,4,4,3,2,1,1,2, etc. can actually lower the discount rate necessary to support the strategy. Thus, it is possible for firms to play an APM strategy without actually following a set rotation. Second, the model assumes each firm releases in its own "market period". While a "market period" is a somewhat nebulous concept once the real-world consideration of continuous time is considered, the typical assumption is that market periods are of the same length. Thus, it is assumed in the discrete time APM model that the product releases are equally spaced. Zillante (2004) discusses how consumer preferences can cause the equal spacing of products to be an equilibrium response.

2.3 Additional considerations

The baseline results established above apply under very general circumstances. I briefly present two specific industry conditions that may affect the decision of the firms as to whether or not they should form an APM. The first is innovation costs, which are related to the concept of preferences for newness. If the firm is constantly developing new brands, a logical next step is to assume the firm is constantly incurring innovation costs.[3] Let Π^m be the monopoly profit, I be the innovation cost, k be the number of firms and N be the number of periods the market will meet. If firms collude using an ESM strategy then each firm will have to pay the innovation cost each period, and an individual firm's undiscounted monopoly profits would be given by $(\frac{\Pi^m}{k} - I)N$. If firms use an APM strategy, then each firm receives $(\frac{\Pi^m}{k} - \frac{I}{k})N$. Although this simple example neglects discounting, it is trivial to show that firms prefer the APM in this environment since they only have to pay the innovation cost $\frac{N}{k}$ times as opposed to N times in the ESM. In fact, HPS shows numerically that the introduction of an entry cost each period will only make the APM a more attractive strategy. In addition, they show that if per period entry costs are too high, Cournot competition involves losses for both firms and a collapse of the industry, while the APM allows both firms and the industry to remain active.

Production technologies are a second factor that could affect the viability of the APM. With baseball cards it is not difficult for a manufacturer to stop the printing presses and restart them when it is his turn to produce or to produce continuously and warehouse the cards. Alternatively, consider the market for milk. Although producers may want to use an APM monopoly, it seems unlikely that each manufacturer could shut down his cows until it was his turn to produce again. This makes it unlikely that an APM would be used because the production technology and the fact that the products are perishable would not allow it. Also, consider the railroad industry, which is the basis for Green and Porter. It seems unlikely that an APM would work well due to the networking needed between rail lines to serve consumers. If a consumer needs

[3] This analysis also applies to industries where firms are not developing new products. In these cases it is more useful to consider the innovation cost as a recurring entry cost or fixed cost incurred if the firm produces.

to transport himself or his product and the rail company "in" that period does not have access to lines to complete the trip, the consumer may find alternative methods to using the railroad, defeating the purpose of the APM.

3 Empirical Methodology

Papers that attempt to detect whether or not observed industry behavior is consistent with collusion tend to fall into two categories. Papers such as Baker and Bresnahan (1985) and Nevo (2001) constitute a first category. These papers analyze residual demand within the beer and cereal markets respectively. These residual demand techniques rely on cross-sectional price and quantity data to determine the substitutability of goods within the product category when prices change. While useful in industries where the same goods are consumed over time, these techniques are not as useful in industries with preferences for newness because they rely on estimating cross-price elasticities between brands. One of the keys to the residual demand analysis is that all or most brands be available during the same time periods, allowing for the consistent estimation of these elasticities when prices change. In the baseball card industry, and, more generally, industries with preferences for newness, there may not be much available data on simultaneous sales of products released even a few time periods apart.

Papers such as Porter and Zona (1993) and Bajari and Ye (2002), which attempt to determine whether collusive bidding has occurred in procurement auctions, constitute the second category. The collusion detection methods in these papers rely on participation in each auction by cartel and non-cartel members. Using the bids submitted by all firms and controlling for other factors, it is possible, under conditions of conditional independence of bids and exchangeability, to determine which bids placed in the auction could be collusive. While the bid rotation schemes used in auctions closely parallel the APM, the techniques used to determine if behavior in procurement auctions is consistent with collusion relies upon observing both the winner of the auction (i.e. the sole producer in the APM) and the bids of other participants. In addition, each procurement contract is granted to only one winner, whereas it is possible for two or more firms to produce in the same market period. Given the lack of data and the potential to have multiple producers in one period, the methods developed for detecting collusive behavior in auctions are unsuitable for detecting the APM in the baseball card industry.

Due to the limitations of these methods, particularly in regards to goods with preferences for newness characteristics, an alternative approach is used in an attempt to detect potentially collusive behavior. Duration models are used to determine if the product releases in the baseball card industry are spaced out over time or clustered. While the results found using duration analysis are not as powerful as those made with the techniques described above, there is little room for manipulation of the data by firms who wish to avoid detection. The only method capable of avoiding detection is clustering releases, which defeats the purpose of the APM.

3.1 Duration Analysis

In order to determine whether brands are randomly introduced into the market, I estimate a set of duration models to test for duration dependence. Duration dependence can be defined as the impact the length of a spell has on the timing of the end of the spell. If data exhibits positive duration dependence it means that as more time passes it is more likely the spell will end, while negative duration dependence means that as more time passes it is less likely the spell will end. A third type of duration dependence, constant, means that the length of the duration has no impact on the probability it will end. In the baseball card industry, as well as others, positive duration dependence implies that the probability that a new release occurs is increasing since the time of the last release, while negative duration dependence implies that the probability is decreasing. Thus positive duration dependence is consistent with the notion that firms are waiting to release products, while negative duration dependence implies clustering of products.

A more intuitive method to determine whether positive or negative duration dependence is occurring is to look at the hazard function. For a distribution function, $F(t)$, and its associated density function, $f(t)$, the hazard function is defined as

$$h(t) = \frac{f(t)}{1 - F(t)}. \tag{8}$$

The hazard function evaluated at t tells the probability of an event occurring given that we have observed a duration of length t. An increasing hazard function reflects positive duration dependence while a decreasing hazard function reflects negative duration dependence. It is also possible to have constant duration dependence, which is shown by a hazard rate independent of t. Constant duration dependence would imply that product releases occur randomly, and that the length of the duration has neither an increasing nor decreasing effect on when a new release will occur. The exponential distribution function, $1-\exp(-\lambda t)$, is an example of a distribution function with a constant hazard rate, which in this case is λ.

The Weibull distribution function is used to determine which type of duration dependence exists in the data. The Weibull function is chosen because the hazard function can display increasing, decreasing, or constant duration dependence depending on the shape parameter. The Weibull distribution function is

$$P(t) = 1 - \exp(-\lambda t^{\alpha}), \tag{9}$$

and its hazard function is

$$h(t) = \lambda \alpha t^{\alpha-1}. \tag{10}$$

The variable λ is the scale parameter, and α is the shape parameter. A test of α equal to 1 vs. α not equal to 1 is equivalent to testing whether the Weibull can be statistically distinguished from the exponential model, which provides a test as to whether the hazard rate is constant. Additionally, the Weibull distribution can establish positive duration dependence if α is statistically greater than 1, or negative duration dependence if α is less than 1.

While the duration models are not directly linked to the theoretical model in section 2, it can be shown that increasing hazards are consistent with equalization of product spacing, while decreasing hazards are consistent with clustering. Consider an industry which produces N products over a fixed time period of length T days. The N releases determine $N-1$ durations. If the firms are following the APM where releases are equally spaced, then one release occurs every $\frac{T}{N-1}$ days, which is also the average duration length regardless of how the releases are spaced. If the products are equally spaced, then the standard deviation of the durations is zero, as every duration is equal to the average duration. Now, consider the standard deviation of the durations if all the releases occur on either the first or last day of T, with at least one release occurring on each of those two days. This release pattern, which clusters all the product releases on two days and is more consistent with competitive behavior than cooperative behavior when goods are substitutes, results in the standard deviation being maximized for given N and T.

For a given N and T, calculate the coefficient of variation (CV). Note that the mean of the durations will be constant for given N and T, which causes the standard deviation to determine the CV. When the standard deviation is 0, releases are equally spaced, and the CV is also 0. As the standard deviation increases, the CV increases. When the standard deviation and mean are equal, the CV equals 1. Linhart (1965) establishes that the shape parameter of the Weibull distribution (α) and the CV are inversely related.[4] As the CV increases from 0 to 1, α decreases from infinity to 1. The CV and α are equal at 1, and as the CV approaches infinity, α approaches 0. When the data are underdispersed, the hazard of the Weibull will be increasing, and when the data are overdispersed, the hazard of the Weibull will be decreasing. Underdispersion is consistent with the APM, and overdispersion with releases being clustered. Thus, it is possible to use duration analysis to determine if the releases are consistent with the APM.

4 Baseball Card Industry and Data

I use data from the baseball card industry to determine if the manufacturers of baseball cards are using a form of the APM. The baseball card industry is characterized by fairly stable participation, as entry into the baseball card market is controlled by Major League Baseball (MLB) and the Major League Baseball Player's Association (MLBPA). Firms must obtain licenses from both entities to produce products that appeal to collectors. The licenses require a fixed annual payment, and percentage payments on any revenues above a certain level. During the time period of interest, 1999-2003, the baseball card industry was a 4-firm industry, although the fourth firm has changed from Pacific (1998-2000) to Playoff (2001-2003). The other three manufacturers, Topps, Fleer, and Upper Deck, have retained their licenses since 1989. For more information on the baseball card industry, see Zillante (2005b).

[4] While the discussion focuses on the Weibull, this is also true for the Gamma distribution, from which the Weibull is derived.

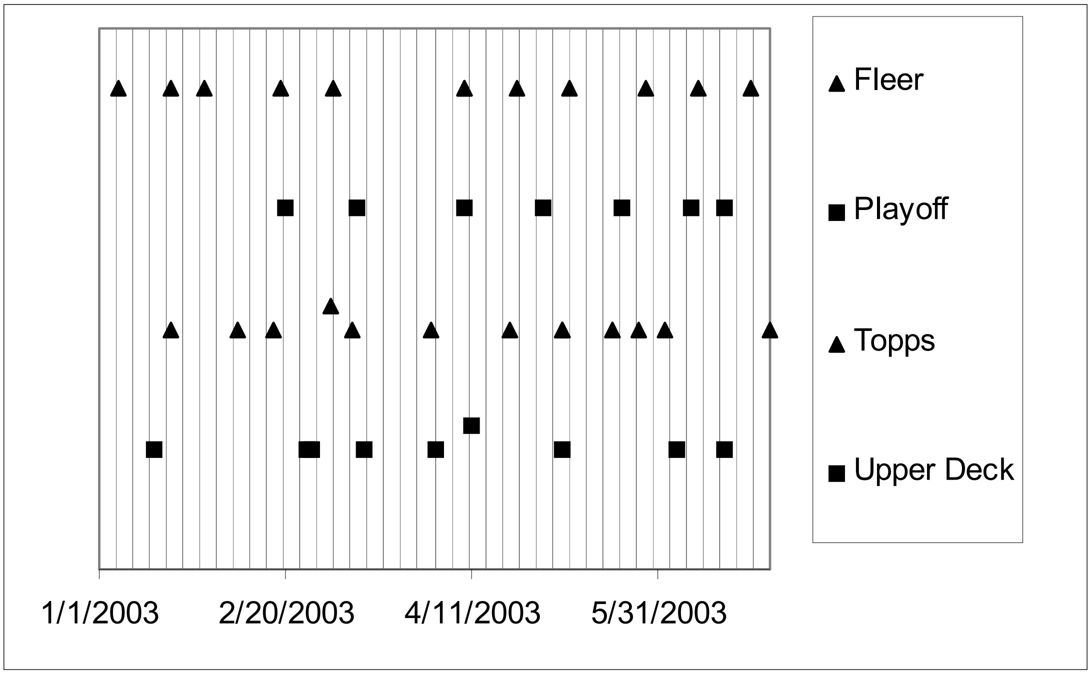

Figure 1: Timeline of product releases by each manufacturer for 1/1/2003 – 6/30/2003

4.1 Data

The data consist of the release dates and descriptive statistics of 349 of the 356 baseball card releases that occurred between January 1^{st}, 1999 and December 31^{st}, 2003. Only products which focused primarily on MLB, were released in pack form, and were released nationally are included. This excludes 4 products. Release dates for 319 of the products were taken from weekly issues of Sports Collector's Digest (SCD), a well-established hobby publication. In a typical issue, SCD provides price guides, checklists, or press releases for products which were recently released or which will be released shortly after the print date of the magazine. SCD also lists descriptive information about the product, such as suggested retail price per pack of cards, the number of cards in a pack, and the release date of the product. SCD reports release dates using either "ships" or "shipped". Whenever possible, the release dates were taken when SCD described the product as "shipped", since this implies an actual ship date. There are 30 release dates that were not obtained from SCD. These release dates were obtained either from the baseball card manufacturers' websites; a second baseball card publication, Beckett Baseball Collector; or from Beckett Publications' website, www.beckett.com. Although there are 7 products for which I could not obtain release dates, there are no more than 4 missing from any one year. The few missing dates have little impact on the empirical results.

For the 349 releases, there were 297 distinct release dates. The most releases occurring on any day was 3, which occurred 11 times, and 2 releases on the same day occurred 30 times. All of the dates on which 3 products were released occurred after 2001, and 6 of the 11 dates had at least one release that was a "high-end" release, with a SRP greater than \$9.98. There seems to be no manufacturer that was targeted by the others, as all manufacturers participated in 5 to 7 of these 11 dates, with 7 to 10 products for each manufacturer.

Figures 1 and 2 show the actual date of each release by manufacturer for the calendar year 2003. The vertical gridlines are placed every 4.5 days, which is approximately the average length of time between release dates. Brands with suggested retail prices greater than \$9.98 are set slightly above the lower priced brands for each manufacturer. Note that some releases may blend together if one manufacturer released multiple products on the same day or a short time span apart. While the spacing is not perfectly equal, the figures

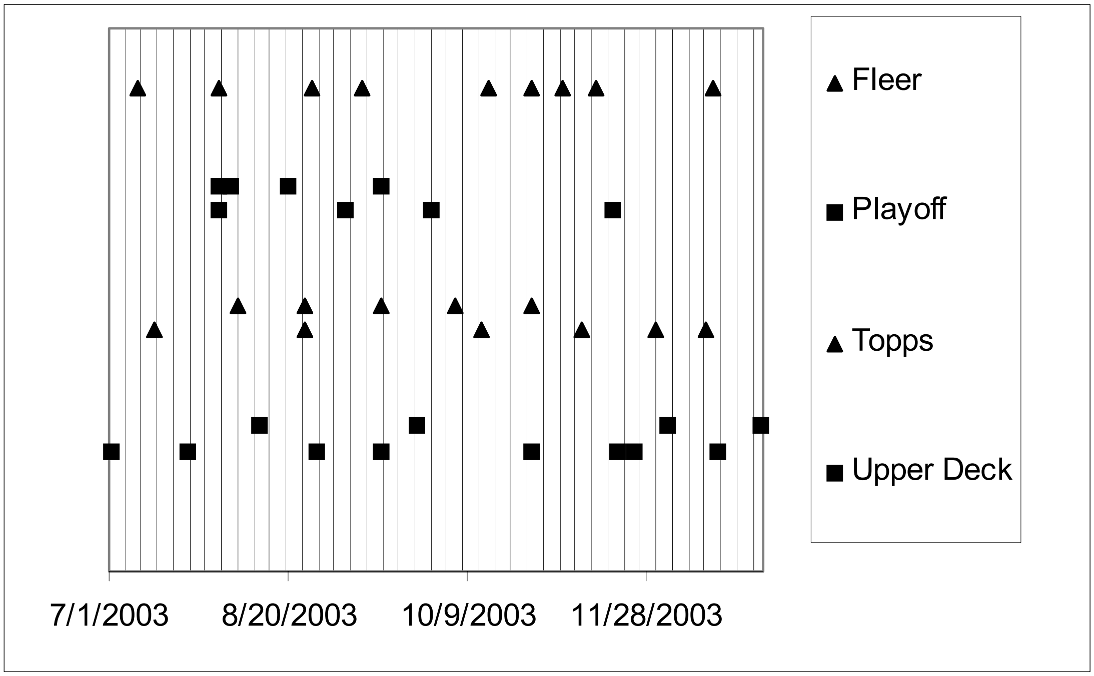

Figure 2: Timeline of product releases by each manufacturer for 7/1/2003 – 12/31/2003

provide some evidence for the spacing of product releases, particularly by individual manufacturers. The one manufacturer which does not appear to space its releases over the course of the calendar year is Playoff, as most of Playoff's releases in figure 2 are clustered from July to September. There are a few long lags by individual manufacturers, most occurring between August and November. There are likely two reasons for these long lags. One is that baseball's regular season is ending, and manufacturers are waiting until the baseball postseason is completed to release their newest products. The other is that the professional football and basketball seasons begin during this time period, and the manufacturers may be focusing on releasing products related to these two sports as their seasons begin.

5 Results

The results are presented in the following manner. First, I present the results of the estimation for the entire time period for all releases and for releases with a SRP less than \$9.99. Low-priced releases are separated because high-priced releases may represent a different market. Next, I focus on the estimation for individual firms. This is done to see if firms are spacing their own releases, or if individual firms cluster their releases. Finally, I present results for 2 and 3 firm combinations. These results are presented to determine if there are any combinations of firms within the industry which seem to be playing an APM, even if the industry as a whole is not. Durations for 2 and 3 firm combinations are calculated by removing the release dates of manufacturers not included in the combination, and then recalculating the durations based upon the releases that remain.

There has been one small adjustment to the data. In cases where multiple releases occur on the same day, the duration in days from one release to the next is 0. However, the likelihood function for the Weibull distribution is undefined if an observation equals zero. In order to circumvent this problem, on days where 2 releases occurred, the duration with a value of 0 is adjusted upward to 0.1, while the following duration is adjusted downward by 0.1. When 3 releases occur on the same day, the two durations with a value of 0 are each adjusted upward to 0.1, while the following duration is adjusted downward by 0.2. These changes are small, preserve the length of the time period, and do not affect the qualitative results of the estimation.

Combination	λ (Scale)	α (Shape)	# durations	# days
All	0.2370***	0.8956***	348	1821
1999	0.1894***	0.9227	55	345
2000	0.1859***	0.9574	59	349
2001	0.3079***	0.8932	69	338
2002	0.2760***	0.8895*	81	362
2003	0.2413***	0.9593	80	358
Low prices	0.2215***	0.8916***	317	1809

The asterisks refer to significance levels for a 2-tailed test of λ=0 and a 1-tailed test for $\alpha \gtrless 1$.
*** is significant at 1%, ** is significant at 5%, and * is significant at 10%

Table 1: Duration results for models incorporating all manufacturers

Combination	λ (Scale)	α (Shape)	# durations	# days
Fleer (F)	0.0288***	1.1098*	76	1792
Pacific	0.0063	1.3994*	20	679
Playoff	0.0715***	0.8627*	41	940
Topps (T)	0.0368***	1.1635***	109	1777
Upper Deck (UD)	0.0154***	1.3955***	99	1821

The asterisks refer to significance levels for a 2-tailed test of λ=0 and a 1-tailed test for $\alpha \gtrless 1$.
*** is significant at 1%, ** is significant at 5%, and * is significant at 10%

Table 2: Duration results for individual firms

5.1 All Releases

Table 1 provides the estimation results for the duration model when all the releases are used, only low-priced releases are used, and for each individual year from 1999 to 2003. The estimated coefficient for α when all the data is used is 0.8956, and this result is significantly less than 1 at the 1% level. Using only the low price data yields a similar coefficient for α, and it is also significantly less than 1 at the 1% level. While the results do not suggest that the manufacturers are using the APM, they are consistent with comments in trade publications made by both hobby store owners and consumers. Both parties suggest that manufacturers are clustering their releases too much.

There are two reasons to estimate model for individual calendar years. The first is to determine if releases are becoming more spaced out or more clustered over time. The second reason is more subtle. Due to the fact that the number of releases differs from year to year, it is possible that looking at the entire 5-year span combines data with different equally spaced durations. For example, in 1999 the average duration length was 6.3, while in 2003 the average duration length was 4.48. Combining these data may obscure results for individual years. As table 1 shows, the estimated α coefficients for each year are slightly higher than those for the entire time period.

Although none of the estimated α coefficients are significantly less than 1, they are increasing as time passes. There is a drop in 2001, although this is likely due to Playoff replacing Pacific as the fourth manufacturer. Due to the lag time between Playoff receiving its license and actual production, all of Playoff's releases for 2001 occurred after February. Also of significance is that the manufacturers become better at spacing their releases even as the number of releases increases.

5.2 Individual Firm Releases

Although the results of the estimation for all releases by all firms show that the firms are not following the APM, it is possible to use the estimation technique to determine if firms are individually attempting to use an APM technique. To calculate the durations used in this section, simply remove all the releases by firms other than the one in question, and calculate the durations based on the remaining releases.

The results of the estimation suggest that firms are following the APM at the individual level. Table 2 shows the results of the estimation for each of the individual manufacturers. The hazards for Topps and

Combination	λ (Scale)	α (Shape)	# durations	# days
F, P	0.0934***	0.9372	139	1792
F, T	0.1036***	1.0012	186	1792
F, UD	0.0934***	1.0133	176	1821
P, T	0.1112***	0.9489	172	1777
P, UD	0.0897***	0.9970	162	1821
T, UD (all)	0.0991***	1.0654	209	1821
T, UD (99-00)	0.0699***	1.1188	64	668
T, UD (01-03)	0.1025***	1.0938*	137	1070
F, P, T	0.1711***	0.9119**	249	1792
F, P, UD	0.1615***	0.9146**	239	1821
F, T, UD	0.1754***	0.9513	286	1821
P, T, UD	0.1698***	0.9443	272	1821

The asterisks refer to significance levels for a 2-tailed test of λ=0 and a 1-tailed test for $\alpha \gtrless 1$.
$***$ is significant at 1%, $**$ is significant at 5%, and $*$ is significant at 10%

Table 3: Duration results for selected firm combinations

Upper Deck are increasing, and the estimated coefficients for α are significantly greater than 1 at the 1% level. The estimates of α for Fleer and Pacific are also greater than 1, and these estimates are significant at the 10% level. Note that these estimates are significantly greater than 1 despite the fact that the number of releases, and thus the average duration length, are changing over time. The only manufacturer with an α less than 1 is Playoff, the newest entrant. Recall from figures 1 and 2 that Playoff appears to have the most clustered releases, and that the other manufacturers have more consistently spaced releases. While figures 1 and 2 only show the release dates for 2003, figures for other years show similar patterns for individual manufacturers.

Taken as a whole, these results suggest that manufacturers believe that their own products may compete with each other, and they tend to space the releases of their own products. Another possibility is that production lags cause each individual manufacturer to space its product, although if production lags were the cause it would be possible to increase capacity to offset any production lags. The results also show that it is possible for the technique to yield estimates of α that suggest the APM is occurring, and that these results are consistent with conjectures that are consistent with conjectures that could be made about behavior by looking at the data directly.

5.3 Multiple Firm Releases

Table 3 shows the results of the remaining firm combinations. Note that Playoff and Pacific are treated as one firm in an effort to utilize all of the data. Because their licenses do not overlap, no releases by the firms overlap, so they were never in competition with one another. Results for 1999-2000 using only Pacific releases and for 2001-2003 using only Playoff releases are not reported to conserve space, but are discussed below. The abbreviations for table 3 are as defined in table 2.

In most of these combinations, the hazard function is decreasing or constant, suggesting that most firms are clustering their releases. However, most of these coefficients are not significantly less than 1. The combination of Topps and Upper Deck is interesting because it has an increasing hazard, suggesting that the two major manufacturers attempt to avoid releasing products on the same day. Also, α is significantly greater than 1 near the 12% level. For this combination, I chose to examine the data at a finer level, breaking the Topps and Upper Deck combination into 2 sections, 1999-2000 and 2001-2003. For each of these sections, the hazard is increasing, and the result for the years 2001-2003 is significantly greater than 1 at the 10% level. Again, the finer data supports the hypothesis that the two major manufacturers are attempting to space their releases.

The results using only Playoff data are qualitatively similar to the results in table 3 that combine Playoff and Pacific. The results using only the Pacific data are slightly different. When Pacific and Fleer are combined for 1999-2000, the estimation reveals a decreasing hazard, consistent with the results in table 3. However, when Pacific, Topps, and Upper Deck are combined, the hazard rates are increasing, although not significantly greater than 1. This suggests a few possibilities. One is that Pacific, being the smallest manufacturer, may not have had a large enough collector base to draw customers into the store by itself. Thus, Pacific released its products closer to the weakest of the 3 remaining manufacturers, perhaps hoping that Fleer would draw customers to the store, but not customers who were predetermined to buy Fleer products. Another possibility is that Fleer attempted to drive Pacific from the market by releasing around the same time as Pacific. This clustering of Fleer and Pacific releases, coupled with the fact that Playoff tends to cluster its own releases, is the reason that combinations with Fleer and Pacific tend to have lower estimates for α than other combinations.

6 Conclusion

This investigation began by noting that firms could potentially use a form of strategic release called the alternating periods monopoly to hinder competition. Theoretical results using a repeated market game structure are provided, and it is shown that when market demand is stochastic, risk-neutral firms prefer the alternating periods monopoly to models of collusion where the market is shared by all firms each period and adherence to the collusive agreement is enforced by reversion to punishment phases if the market price drops below a specified level.

Duration analysis is the empirical technique used to determine whether or not the manufacturers in the baseball card industry are employing the APM strategy. When the entire range of data is considered, it appears as if the baseball card manufacturers are not releasing products in a manner that is consistent with the APM. This is consistent with anecdotal evidence within the industry. However, when looked at over time and by manufacturer, the results are not as clear. Manufacturers certainly realize that spacing their own releases is a valuable strategy, and when only the releases of the two largest manufacturers are considered, it is apparent that they have been acting in a manner consistent with the APM.

Unfortunately, the econometric technique used in this investigation is not powerful enough to distinguish between collusive and noncollusive behavior among firms. It should be noted that this is not solely a failure of this technique, but of most econometric techniques that attempt to detect collusion. Both Bajari and Ye (2002) and Porter and Zona (1993) state that when some assumptions of their models are violated, collusion and competition are observationally equivalent. Since the duration analysis technique merely provides evidence that behavior matches a potentially collusive strategy, it should not be seen as a definitive statement as to whether firms are actively participating in a cartel, but as a starting point for a more exhaustive investigation. Also, it is hoped that this technique will be the starting point for a more powerful econometric test that will perform better at differentiating collusion from competition.

One potential extension that could be made to this study would look at how firms could use an APM in multiple markets. The four baseball card manufacturers also compete in other trading card markets, primarily football and basketball. The theory in this study considers only producers who compete in one market, with products that are close substitutes. It may be the case that firms that compete in multiple markets are able to rotate products in such a manner that none of them faces a period where they are inactive, or that firms are able to reap greater profits by controlling multiple monopolies each period.

Overall welfare effects should be determined before a final judgment is made on the legality of the APM. It is quite possible that the APM is a particularly devastating form of collusion in that it raises per-period prices and, in industries with preferences for newness, reduces the variety of goods available to consumers. However, it is also possible that consumers benefit from the APM by being able to enjoy a continual stream of new goods rather than being bombarded with a glut of new products all at once. Suppose consumers have preferences for newness. Consumers may prefer a situation where one firm releases a new product each period rather than one where all the firms release their new products at the same time followed by a few periods of no new product releases. While both scenarios may see the exact same amount and type of products released, consumers may prefer the stream of releases to the alternative scenario because the products will seem to have a “newness” feature to them. Thus, the APM may not be harmful to welfare, especially if firms have high innovation costs in the development of new products.

References

Aumann, R. and L. Shapley (1994). Long-Term Competition – A Game Theoretic Analysis. In *Essay in Game Theory*, pp. 1–15. Springer-Verlag.

Bajari, P. and L. Ye (2002). Deciding between Competition and Collusion. Forthcoming, Review of Economics and Statistics.

Baker, J. and T. Bresnahan (1985). The Gains from Merger or Collusion in Product-Differentiated Industries. *Journal of Industrial Economics 33:4*, 427–444.

Davis, D. and C. Holt (1998). Conspiracies and Secret Discounts: Initial Laboratory Results. *Economic Journal 108*, 1–21.

Fudenberg, D. and E. Maskin (1986). The Folk Theorem in Repeated Games with Discounting or with Incomplete Information. *Econometrica 54:3*, 533–554.

Green, E. and R. Porter (1984). Noncooperative Collusion Under Imperfect Price Information. *Econometrica 52:1*, 87–100.

Herings, P. J.-J. and R. Peeters (2000). Stationary Equilibria in Stochastic Games: Structure, Selection, and Computation. Meteor Research Memorandum 00/031, University of Maastricht.

Herings, P. J.-J., R. Peeters, and M. P. Schinkel (2001). Intertemporal Market Division: A Case of Alternating Monopoly. Working Paper.

Isaac, R. M. and J. Walker (1985). Information and Conspiracy in Sealed Bid Auctions. *Journal of Economic Behavior and Organization 6:2*, 139–159.

Jacquemin, A. and M. Slade (1989). Cartels, Collusion, and Horizontal Merger. In *Handbook in Industrial Organization*, Volume I, pp. 415–473. Elsevier Science Publishers.

Krider, R. and C. Weinberg (1998). Competitive Dynamics and the Introduction of New Products: The Motion Picture Timing Game. *Journal of Marketing Research 25*, 1–15.

Kwasnica, A. and K. Sherstyuk (2002). Collusion via Signaling in Multiple Object Auctions with Copmlementarities: An Experimental Test. Working Paper.

Linhart, H. (1965). Approximate Confidence Limits for the Coefficient of Variation of Gamma Distributions. *Biometrics 21:3*, 733–738.

Nevo, A. (2001). Measuring Market Power in the Ready-to-Eat Cereal Industry. *Econometrica 69:2*, 307–342.

Porter, R. and D. Zona (1993). Detection of Bid Rigging in Procurement Auctions. *The Journal of Political Economy 101:3*, 518–538.

Rotemberg, J. and G. Saloner (1986). A Supergame-Theoretic Model of Price Wars During Booms. *American Economic Review 76*, 390–407.

Scherer, F. (1970). *Industrial Market Structure and Economic Performance*. Chicago: Rand McNally.

Staiger, R. and F. Wolak (1992). Collusive Pricing with Capacity Constraints in the Presence of Demand Uncertainty. *RAND Journal of Economics 23:2*, 203–220.

Zillante, A. (2004). Demand Driven Temporal Spacing Patterns. Working Paper.

Zillante, A. (2005a). Intertemporal Collusion with Multi-period Signaling. Working Paper.

Zillante, A. (2005b). Survival in a Declining Industry: The Case of Baseball Cards. Working Paper, Under Review.