AN ABSTRACT OF THE DISSERTATION OF

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Title: The Behavior of Economic Agents and Market Performance

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This dissertation addresses issues concerning the behavior of firms, which has significant effects on performance. In the first study, we empirically investigate the effect of the reduction in number of firms on price competition in the U.S. macro-brewing industry. The number of macro brewing firms decreased from 766 in 1935 to about 20 today. Major national brewers such as Anheuser Busch, Miller and Coors have continually gained market share. In spite of the reduction in number of competitors, market power remains low. There is evidence in the literature that changes in marketing and production technology have favored large brewers. However, an intense war of attrition has historically kept prices low. As this war wound down in the late 1980s, the number of firms diminished unabated. Many theoretical models of oligopoly behavior suggest that a decrease in number of firms reduces competition and increases price. We use two different techniques and find that price competition remains high even though the number of rivals has fallen.

In the second study, we estimate the life cycle of movies in theaters. In this market there is no price competition. The primary form of competition is through product differentiation in the form of product quality, advertising and genre. We find evidence that the longer the duration of movies in theaters, the greater is the probability of death. Secondly, we also observe that a movie with either higher advertising expenditures or better product quality has a better probability of survival. Thirdly, we find that a movie which faces stiffer competition from substitutes is more likely to have a greater decay of sales.

In the third study, we investigate the effect of product recalls due to an unintended acceleration problem on the market value of Toyota. We investigate four cases related to unintended acceleration problems. We find evidence of a significant negative effect on the market value of Toyota in the major recall in January 2010. Following this recall, there were Congressional hearings and testimony of the CEO of Toyota. Congress requested the National Highway Traffic Safety Administration (NHTSA) to investigate whether or not the fix recommended by Toyota was sufficient to solve the problem. When the NHTSA study concluded that Toyota had correctly solved the problem, the market value of Toyota substantially increased.

The Behavior of Economic Agents and Market Performance

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I understand that my dissertation will become part of the permanent collection of Oregon State University libraries. My signature below authorizes release of my dissertation to any reader upon request.

Jayendra Gokhale, Author

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CONTRIBUTION OF AUTHORS

Dr. Victor J. Tremblay provided ideas and assistance in all aspects of this dissertation. Dr. Wesley W. Wilson helped in modeling for Chapter 3.

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Chapter 1

The Behavior of Economic Agents and Market Performance

Introduction

This dissertation analyzes three cases where firm behavior can have potentially dramatic effect on performance. In Chapter 2, we estimate the effect of the changing nature of the macro-brewing industry. The behavior of the macro or mass-producing segment of the U.S. brewing industry appears to be paradoxical. Since Prohibition, the number of independent brewers has continuously declined while the major national brewers such as Anheuser-Busch, Miller, and Coors gained market share. In spite of this decline in numbers, profits and market power remained low in brewing. Iwasaki et al. (2008) explain this result by providing evidence that changes in marketing and production technologies favored larger brewers and forced the industry into a war of attrition where only a handful of firms were destined to survive. This led to fierce competition, especially from the 1960s through the early 1990s. In the last 16 years, the war appears to have subsided. Thus, the purpose of this study is to determine whether price competition has diminished since the mid 1990s.

In Chapter 3, we study the life cycle of motion pictures as movie theaters compete for consumers. New movies appear and replace existing movies. We develop and estimate a model of the product cycle for movies and the decay rate of sales over time to examine the effect of product quality, advertising and the introduction of substitutes. New movies tend to have a strong substitution effect on existing movies. The main goal of this chapter is to determine if these effects differ by movie genre.

In Chapter 4, we study the financial effect of unintended acceleration problems with several models of Toyota automobiles. We analyze the effect of Toyota's faulty accelerator pedal design on stockholder wealth. Using the event study methodology, we show that a major recall in January 2010 caused the company's cumulative abnormal returns to fall by 19 percent. Continued concerns that Toyota was unable to identify and adequately fix the problem induced the National Highway Traffic Safety Administration to conduct its own investigation in March 2010. The results of this government investigation exonerated the company. Thus, the Toyota case provides an excellent opportunity to study the effect of both company error and government action which lifted the cloud of suspicion that Toyota automobiles are unsafe.

Chapter 2

Competition and Price Wars in the U.S. Brewing Industry[1]

2.1 Introduction

There are two paradoxical features of the macro or mass-producing segment of the U.S. brewing industry. First, industry concentration has risen steadily since the end of Prohibition. The number of independent macro brewers reached a peak in 1935 at 766 firms and has continuously declined since then to about 20 firms today. This is reflected in the rise in the four-firm concentration ratio (CR_4) and the Herfindahl-Hirschman index (HHI), two common measures of industry concentration.[2] Figure 2.1 documents this increase for the period 1947-2009.[3] Second, in spite of rising concentration, profits have remained low, and previous studies have failed to detect the presence of market power.[4]

This appears to be a paradox because many static models of oligopoly suggest that profits and market power will rise with a fall in the number of competitors, which is inconsistent with brewing. Nevertheless, not all models

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[1] Part of this chapter is published in *Journal of Wine Economics*: 7(2), 2012, 226-240

[2] CR_4 is defined as the market share of the largest four firms in the industry. HHI is defined as the sum of the squared market shares of all firms in the industry and ranges from 0 to 10,000. To make HHI compatible with CR_4, we divide HHI by 100 so that it ranges from 0 to 100.

[3] We ignore the craft and import segments of the market. The main reason for this is that most import and craft brands of beer are poor substitutes for regular domestic lager, such as Budweiser, Coors Banquet, and Miller High Life. In addition, when Iwasaki et al. (2008) include this segment as a demand determinant, its effect is never significant. Thus, we focus only on the macro segment of the beer market. See Tremblay and Tremblay (2005, 2011) for more complete descriptions of the import and micro segment of the U.S. beer industry.

[4] For a review of the evidence, see Tremblay and Tremblay (2005).

predict this outcome. For example, price equals marginal cost in the Bertrand model when products are homogeneous goods and there are two or more competitors. Furthermore, Tremblay and Tremblay (2011) and Tremblay et al. (forthcoming) demonstrate that price can equal marginal cost even in a monopoly setting when the incumbent firm competes in output and there exists one or more potential entrants that compete in price.

In the brewing industry, Tremblay and Tremblay (2005) speculate that the reason why firm profits remained low is that firms were forced into a generalized war of attrition (Bulow and Klemperer, 1999). In such a war, $N = N^* + K$ firms compete in a market that will profitably support only N^* firms in the long run. Thus, if $K > 0$, K firms must exit from the market for it to reach long-run equilibrium. As documented in Tremblay and Tremblay (2005), two events caused N^* to fall in brewing. In the 1950s and 1960s, the advent of television gave a marketing advantage to large national producers who were the only firms large enough to profitably advertise on television.[5] In addition, increased mechanization beginning in the 1970s reduced the cost of large scale production. These changes gave a marketing and production advantage to larger beer producers.

[5] At that time, all television ads were national in scope. No spot or local television advertising was available. This made it too costly for local or regional brewers to advertise on television.

Table 2.1 shows how the market share of the national beer producers[6] grew over time and how changes in marketing and production economies affected optimal firm size. It lists estimates of the minimum efficient scale (MES) needed to take advantage of all scale economies in marketing and production for various years. MES-Output measures annual minimum efficient scale in millions of (31 gallon) barrels. MES-MS measures the market share needed to reach MES-Output. N^* measures the number of firms needed to produce industry output if each firm produces at MES. This is called the efficient or cost-minimizing industry structure (Baumol et al., 1982). As the table shows, MES grew and N^* fell over time.

[6] For most of the post-World War II era, the major national producers included the Anheuser-Busch, Schlitz, Pabst, Miller, and Coors brewing companies. In the early 1980s, Schlitz went out of business and Pabst played less of a dominant role. Coors became a national brewer in 1991. For further discussion of the evolution of the major brewers, see Tremblay and Tremblay (2005).

The intensity of the war is reflected in the number of firms that must exit the industry for the efficient structure to be reached in the long run. It is defined as $K = N - N^*$ when $(N - N^*) > 0$ and equals 0 otherwise. The value of K was largest in 1960s and 1970s, a period known as the “beer wars”. This is aptly described in *Newsweek* (September 4, 1978, 60):

> After generations of stuffy, family-dominated management, when brewers competed against each other with camaraderie and forbearance, they are now frankly at war. Marketing and advertising, not the art of brewing, are the weapons. Brewers both large and small are racing to locate new consumers and invent new products to suit their taste. Two giants of the industry, Anheuser-Busch of St. Louis and Miller Brewing Company of Milwaukee, are the main contenders.

This description is remarkably accurate, as the facts show that the war was fought with advertising, the introduction of new brands, and tough price competition. Figure 2.2 plots the advertising intensity of the major brewers, measured as advertising spending per barrel. It shows that advertising was quite high from the mid 1950s through the late 1960s, a period in which television advertising became a prominent tool of the national brewers. In 1950, only 9 percent of households had a television set, a number that increased to 87 percent by 1960 and 95 percent by 1970.[7] Advertising spending rose once again in the 1980s, a period when the Coors Brewing Company made large investments in

[7] Today, about 98 percent of households have one or more television sets.

advertising in order to expand into new regions of the country and become a national brewer.[8]

Brewers also fought for market share by introducing new brands. Table 2.2 lists the number of brands offered by the leading brewing. In 1950, most brewers offered a single flagship brand. The Anheuser-Busch Brewing Company is the lone exception, as it had continuously produced a flagship brand, Budweiser, and a super-premium brand, Michelob, since Prohibition. Brand proliferation became apparent by the late 1970s, and by 1990 the major brewers each offered 9 or more different brands of beer.

Iwasaki et al. (2008) formally tested for the effect of the war on concentration and price competition. They found that advertising and rising MES contributed to increases in industry concentration. In spite of rising concentration, they found that the war reduced price-cost margins during the 1960s through the early 1990s. Unfortunately, their work does not shed light on the extent to which market power has changed since the war has begun to subside.

There are several reasons why one might expect the intensity of the war to have diminished by the 2000s. First, there is little room left for consolidation. In 2002, Miller was purchased by South African Breweries to form SABMiller. In 2008, Anheuser–Busch was purchased by Belgium's InBev to form Anheuser–Busch InBev, and Coors and SABMiller established a joint venture called

[8] Coors reached national status in 1991.

MillerCoors. Second, Pabst gave up the production of beer in 2001, contracting with Miller to produce all of its beer. Finally, the remaining macro brewers have retreated to niche markets, competing more with the micro than the macro brewers.

The purpose of this paper is to determine whether the degree of competition has fallen in the final stages of industry consolidation. Two methods are used. The first is the new empirical industrial organization technique, which uses regression analysis to estimate the markup of price over marginal cost. The second is a new technique that was developed by Boone (2008), which compares the variable profits of efficient with less efficient firms over different regimes of competition. The main advantage of Boone's technique is that it avoids measurement problems associated with accounting data. Our paper finds evidence that competition has decreased since the late 1990s but not enough to substantially increase market power.

2.2 Estimation of the Degree of Competition

In this section, we review the two methods that are used to estimate the degree of competition in brewing. The first is called the new empirical industrial organization technique.[9] The empirical model derives from a general first-order

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[9] For a review of this technique, see Bresnahan (1989). For a discussion of its strengths and weaknesses, see Slade (1995), Genesove and Mullin (1998), Corts (1999), Perloff et al. (2007), and Tremblay and Tremblay (forthcoming).

condition of profit maximization. To illustrate, assume a market with N firms, where firm i's inverse demand is $p_i(q_1, q_2, q_3, \ldots, q_N)$, p_i is firm i's price, and q_i is firm i's output. The firm's long-run total cost function is $C(q_i, \underline{w})$, where $\underline{w}$ is a vector of input prices; marginal cost is $MC = \partial C/\partial q_i$. Solving the firm's first-order condition for price produces an equation called an optimal price equation (supply relation or markup equation):

(2.1) $$p_i = \frac{\partial C}{\partial q_i} - \theta \frac{\partial p_i}{\partial q_i} q_i,$$

where θ is a behavioral parameter of market power. We will see subsequently that choosing different values of θ will produce different oligopoly equilibria.

This specification is related to the Lerner (1934) index of market power ($\mathcal{L}$). To illustrate, assume that firms produce homogeneous goods, such that $p_i = p$ and $\partial p_i/\partial q_i = \partial p/\partial Q$. Under these conditions, Equation (2.1) can be rearranged as

(2.2) $$\mathcal{L} \equiv \frac{p - MC}{p} = -\,\theta \frac{\partial p}{\partial Q} \frac{Q}{p} \frac{q_i}{Q} = \frac{ms_i \theta}{\eta} = \frac{\theta}{N \cdot \eta},$$

where ms_i is the market share of firm i, which equals 1/N when the market is in equilibrium because of symmetry. When price equals marginal cost, market power is nonexistent and $\mathcal{L} = 0$; $\mathcal{L}$ increases with market power. This specification describes a variety of possible cooperative and non-cooperative equilibria.

- In a competitive or Bertrand equilibrium with homogeneous goods, $p = MC$ which implies that $\theta = 0$ and $\mathcal{L} = 0$.

- For a monopolist, $\theta = N = 1$ and $\mathcal{L} = 1/\eta$.
- In the Cournot equilibrium, $\theta = 1$ and $\mathcal{L} = ms_i/\eta = 1/(N\cdot\eta)$. Notice that when N = 1, $\mathcal{L} = 1/\eta$ which is the simple monopoly outcome.
- In a perfect cartel, $\theta = N$ and $\mathcal{L} = 1/\eta$.

If the market outcome ranges from competitive to cartel, then $0 \leq \theta \leq N$ and $0 \leq \mathcal{L} \leq 1/\eta$. One can think of θ as an indicator of the "toughness of competition," as described by Sutton (1991).

In its empirical form, Equation (2.1) is transformed into the following equation.

(2.3) $$p = < MC > + \lambda q_i,$$

where <MC> is an empirical specification of the marginal cost function and $\lambda = \theta(\partial p/\partial Q)$ is a market power parameter to be estimated. With appropriate data, Equation (2.3) is either estimated with firm demand as a system of equations or as a single equation using an instrumental variables technique given that firm output is an endogenous variable. The Lerner index is calculated from parameter estimates and mean values of the data.

The second method that we use to estimate the degree of competition in brewing was developed by Boone (2008). The main advantages of his method are that it requires relatively little data and it avoids the use of accounting cost and profit data, which are poor proxies for their economic counterparts.[10] In order to

[10] For further discussion of this issue, see Fisher and McGowan (1983) and Fisher (1987).

use Boone's method, firms must not be equally efficient. This is a reasonable assumption in brewing where some firms have rather antiquated equipment, are unable to advertise nationally, and may not be scale efficient. With dissimilar levels of efficiency, Boone shows that an increase in competition punishes inefficient firms more harshly than efficient firms. In other words, increasingly tougher competition causes the least efficient firms to exit first.

To test for a change in industry competitiveness, one must derive what Boone calls an index of relative profit differences (RPD). RPD compares the variable profits of different firms within an industry. Let $\pi_i^v(E_i, \theta)$ equal firm i's variable profit, which is a function of its efficiency level (E_i) and the behavioral parameter (θ). Variable profit equals total revenue minus total variable cost. To illustrate this idea, consider a market with three firms where firm 1 is most efficient and firm 3 is least efficient ($E_1 > E_2 > E_3$). Recall that θ ranges from 0 (competitive) to N (cartel), where the degree of competition increases as θ falls. With this notation,

$$RPD \equiv \frac{\pi_1^v - \pi_3^v}{\pi_2^v - \pi_3^v}. \tag{2.4}$$

Under the conditions of the model, an increase in competition will lead to an increase in RPD, $\partial RPD/\partial\theta < 0$. In other words, an increase in competition harms the least efficient firms the most, such that $(\pi_1^v - \pi_3^v)$ increases relative to $(\pi_2^v - \pi_3^v)$. Thus, if RPD rises (falls) over time, we can conclude that competition has increased (decreased) and market power has fallen (risen).

Boone's index has several desirable qualities. First, by using variable profits, it circumvents the measurement problems associated with accounting profits.[11] Second, data are needed for no more than 3 firms in the industry. The only difficulty is that firms must be ranked in terms of their relative efficiency. One approach is to use data envelopment analysis to characterize a firm's technology and relative inefficiency, as suggested in Färe et al. (1985, 2008). Boone suggests a simple alternative in which the firm with lowest average variable costs is most efficient.

In brewing, previous studies can be used to rank the relative efficiency of firms. In terms of scale efficiency, Tremblay and Tremblay (2005) found that only the industry leader, Anheuser-Busch, has been consistently scale efficient. Since then, Miller has been scale efficient for much of the period, followed by Coors. None of the smaller regional brewers were scale efficient. In terms of marketing efficiency, the advent of television gave an advantage to the large national brewers. This is confirmed by Färe et al. (2004), who found that Anheuser-Busch was the most efficient, while the smallest regional brewers and failing firms were the least efficient. Taken as a whole, this implies that the rank order from most to least efficient firms is: Anheuser-Busch, Miller, Coors, and other local brewers.

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[11] That is, one does not need to estimate the appropriate depreciation rate of durable assets that are needed to convert accounting profits to economic profits.

2.3 Data and Empirical Results

The data set used in our regression analysis consists of annual observations from 1977 to 2008 for eleven U.S. brewing companies. These include all macro brewers that were publicly owned: Anheuser-Busch, Coors, Falstaff, Genesee, Heileman, Miller, Olympia, Pabst, Pittsburg, Schlitz, and Stroh. Firm variables include price, marginal cost, output, total revenue, and variable profit (total profit minus total variable cost). All firm data derive from the annual trade publication, *Beer Industry Update*.

The industry data that are used in the study include the measures of industry concentration (HHI and CR_4) and a measure of the intensity of the beer wars (WAR). The concentration indices are updated from Tremblay and Tremblay (2005). WAR is defined as N^*/N. With this definition, the intensity of the war of attrition increases as WAR decreases.[12] The number of firms (N) is updated from Tremblay and Tremblay (2005). The efficient number of firms (N^*) equals Q/MES, where industry production (Q) is obtained from *Beer Industry Update*. An estimate of minimum efficient scale (MES) derives from Tremblay and Tremblay (2005).

Given that output is an endogenous variable, we also use two market demand variables that serve as instruments in the optimal price equation. These are per-capita disposable income (1982 dollars) and a demographics variable, the

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[12] This definition makes it easier to interpret the effect of the war on market power in the optimal pricing regression.

proportion of the population that ranges in age from 18 to 44.[13] Demand studies show that this is the primary beer drinking age group (see Tremblay and Tremblay, 2005). Table 2.3 displays the descriptive statistics of the firm, industry, and demand variables.

We first investigate the relative profit differences (RPD). The data allow us to investigate RPD for only two trios of macro producers: for Anheuser-Busch, Miller, and Genesee (A-M-G) and for Anheuser-Busch, Coors, and Genesee (A-C-G).[14] Unfortunately, this provides estimates from 1978 to 1999. To obtain estimates through 2006, we also include a hybrid brewer, the Boston Beer Company.[15] Given its relatively small size, we rank Boston less efficient than Anheuser-Busch, and given its rapid growth rate, we rank Boston as more efficient than Miller and Coors.[16] This provides two additional trios of firms that are used to calculate RPD: Anheuser-Busch, Boston, and Miller (A-BB-M) and Anheuser-Busch, Boston, and Coors (A-BB-C). Recall that an increase in RPD implies an increase in competition. Mean estimates of RPD for four sets of firms are plotted in Figure 2.3, where the values were normalized to equal 100 in 1991 (the first year that Boston data are available). Consistent with the findings of

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[13] Income data were obtained from the Bureau of Economic Analysis at www.bea.gov. Population data were obtained from the U.S. Bureau of the Census at www.census.gov.

[14] We do not make a comparison of Anheuser-Busch, Miller, and Coors because the relative efficiency of Miller and Coors is frequently too close to call.

[15] Like a major macro brewer, Boston produces traditional lager beer and markets its Samuel Adams brands nationally. However, it also produces European ales like a micro brewer.

[16] From 1991 to 2006, Miller's market share of domestic beer production fell by 10.2 percent, Coors' market share rose by 22.7 percent, and Boston's market share grew by 700 percent.

Iwasaki et al. (2008), the results show that the beer industry became more competitive during the beer wars that extended through the mid 1980s, and the degree of competition remained relatively constant during the 1990s. Although RPD fell in the early 2000s, it rose again by the mid 2000s. This suggests that competition has not diminished substantially from the late 1990s through 2006.

Next, we use regression analysis to estimate the optimal price equation (Equation 2.1). Data limitations require that we use average cost as a proxy for marginal cost. This is a reasonable assumption for the national producers, because they are large and able to reach MES. To control for cost and other possible differences between national and regional brewers, we include a dummy variable, D_N, which equals 1 for national producers and 0 otherwise.

Given our uncertainty concerning whether or not market power has remained constant over our sample period, we consider several specifications. As a starting point, we consider the simple model where market power is constant. This model is given by

(2.5) $$p_i = MC_i + \beta_0 D_N + \lambda q_i,$$

where β_0 and λ are parameters to be estimated. Notice that the parameter on MC_i equals 1. In this specification, firms have market power when $\lambda > 0$.

This model is unlikely to be valid in brewing, however, given previous evidence that there has been a war of attrition in brewing. One hypothesis is that market power has changed over time and is a function of WAR: $\lambda = \beta_1 + \beta_2 WAR$. In this case, the model becomes

(2.6) $$p_i = MC_i + \beta_0 D_N + \beta_1 q_i + \beta_2 WAR \cdot q_i.$$

As we have defined WAR, a reduction in the intensity of the war implies that $\partial p_i/\partial WAR = \beta_2 q_i > 0$. That is, market power increases with the WAR variable.

Sutton (1991) and Tremblay and Tremblay (2005) argue that there were three periods or regimes in brewing that relate to market power. In the first period, 1977-1986, the war was so intense that market power was zero.[17] Market power then rose progressively into the second period (1987-1996) and the third period (1997-2008). If this is true, the following model is appropriate.

(2.7) $$p_i = MC_i + \beta_0 D_N + \beta_3 q_{87-96} + \beta_4 q_{97-08}.$$

In this specification, $q_{87-96} \equiv D_{87-96} \cdot q_i$, $q_{97-08} \equiv D_{97-08} \cdot q_i$, D_{87-96}, = 1 from 1987 through 1996 (0 otherwise), and $D_{97-08} = 1$ from 1997 through 2008 (0 otherwise). If market power rose from period to period, then $\beta_4 > \beta_3 > 0$.

In the final specification, we modify Equation (2.7) to control for the effect of the war on market power during these later regimes. In this case,

(2.8) $$p_i = MC_i + \beta_0 D_N + \beta_3 q_{87-96} + \beta_4 q_{97-08} + \beta_5 WAR \cdot q_{87-96} + \beta_6 WAR \cdot q_{97-08}.$$

[17] This implies that λ or β_1 and β_2 equal 0 before 1987.

This model allows us to determine how market power changed over time and was affected by the WAR variable. If market power has risen over time, then $\beta_4 > \beta_3 > 0$ and $\beta_6 > \beta_5 > 0$.

Each specification is estimated, with and without D_N, using an instrumental variables estimation technique. As discussed above, the instruments are per-capita disposable income and the proportion of the population aged 18 to 44. Given our use of pooled data, we use a clustering method that allows the standard error of the regression to vary by clusters (i.e., firms). Following Cameron et al. (2008), standard errors are obtained using bootstrapping with repeated resampling and replacement within each cluster for 1,000 trials. The specifications that were estimated are labeled models 1 through 8 (M1- M8) in Table 2.4. In each model, the Wald χ^2 statistic is sufficiently high, implying that the parameters of the model are jointly significant. The MC parameter is close to 1, and in most specifications, the national dummy variable is positive and significant, which is consistent with the fact that most national brands sell for higher prices than regional brands.

Regarding the issue of market power, we are particularly interested in two hypotheses. The first is the hypothesis that a decrease in WAR (i.e., an increase in the intensity of the war) reduces market power. This hypothesis is confirmed in models M3 and M4, as the parameter on the interaction variable between output and WAR is positive and significant.

Second, we are interested in determining whether or not market power has increased progressively from 1987-1996 to 1996-2008. In the absence of the WAR variable, Models M5 and M6 are consistent with this hypothesis. In both models, the parameter estimate on $q_{97\text{-}08}$ is greater than the parameter estimate on $q_{87\text{-}96}$, although the difference between parameters is insignificant. We obtain a similar result when we include the WAR variable in models M7 and M8. The parameter estimates on $q_{97\text{-}08}$ exceeds that of $q_{87\text{-}96}$, and parameter estimates on $q_{97\text{-}08}\cdot$War exceed that of $q_{87\text{-}96}\cdot$War. Furthermore, we fail to reject the joint hypothesis that the parameters differ between $q_{97\text{-}08}$ and $q_{87\text{-}96}$ and differ between $q_{97\text{-}08}\cdot$War and $q_{87\text{-}96}\cdot$War (at the 99 percent confidence level for each model).

To further investigate how market power has changed over time, we estimate the Lerner index for the periods 1987-1996 and 1997-2008 from models M5 through M8 (see Table 2.5). Consistent with Tremblay and Tremblay (2005), the results show that the Lerner index is relatively low. The results also show that there has been a small increase in the Lerner index from the 1987-1996 to the 1997-2008 time periods. The increase is never significantly different from zero, however, with p-values equaling 46 percent for M5, 64 percent for M6, 36 percent for M7, and 39 percent for M8. In total, the results suggest that even though the war of attrition is drawing to a close, there is no evidence of a substantial or significant increase in market power in the U.S. brewing industry.

2.4. Concluding Remarks

Industry concentration has risen dramatically in the post-World War II era in the macro segment of the U.S. brewing industry. Previous studies show that profits and market power have remained low during the 1970s and 1980s, because firms were forced to compete in a war of attrition. Today, macro beer production is dominated by just two companies, Anheuser-Busch and Miller-Coors. This raises concerns that market power may rise. The purpose of this paper is to estimate market power and determine if it has risen in the last decade.

Two methods are used to estimate the degree of competition in brewing. The first is the traditional NEIO technique, which we modify to allow market power to vary over time. The second is a technique developed by Boone (2008), which uses data on variable profits to determine whether or not competition has decreased over time. The results confirm that the war was intense through the mid 1980s. Regression results using the NEIO approach indicate that although market power rose in the 1997-2008 period, it remains low. This suggests that the degree of competition in brewing remains high even though the war of attrition is drawing to a close.

Table 2.1 The Market Share of the National Brewers, Minimum Efficient Scale (MES), the Number of Brewers (N), and the Cost-Minimizing Number of Competitors (N*) in the U.S. Brewing Industry

Year	Market Share of National Brewers (Percent)	MES-Output (Million Barrels)	MES-MS (Percent)	N	N^*	K
1950	16	0.1	0.1	350	840	0
1960	21	1.0	1.5	175	87	88
1970	45	8.0	6.4	82	16	66
1980	59	16.0	9.0	40	11	29
1990	79	16.0	8.4	29	12	17
2000	89	23.0	14.0	24	7	17
2009	93	23.0	14.0	19	7	12

Notes: MES-Output measures minimum efficient scale measured in millions of (31 gallon) barrels. MES-MS represents the market share needed to reach minimum efficient scale. N^* represents the cost-minimizing industry structure (i.e., the number of firms that the industry can support if all firms produce at minimum efficient scale). N is the number of macro brewers. MES-MS ≡ (Industry Output)/MES. N^* ≡ 100/MES-MS; rounding errors explain the discrepancy in calculations. $K = N - N^*$ when $(N - N^*) > 0$ and equals 0 otherwise.

Sources: Steinberg (1980), the *Statistical Abstract of the United States*, Tremblay et al. (2005), and Tremblay and Tremblay (2005).

Table 2.2 Major Domestic Beer Brands of the Anheuser-Busch, Coors, Miller, and Pabst Brewing Companies

Year	Anheuser-Busch	Coors	Miller	Pabst
1950	2	1	1	1
1960	4	1	1	9
1970	3	1	4	5
1980	5	2	3	10
1990	10	10	9	17
2000	29	14	21	54
2010	55	-	61*	33

* This reflects the brands for both Miller and Coors, as the companies formed a joint venture in 2008 to form MillerCoors.
Sources: Tremblay and Tremblay (2005) for 1950-2000 and company web pages for 2010.

Table 2.3 Descriptive Statistics of Firm and Industry Data, U.S. Brewing Industry, 1977-2008

Variable Name	Definition	Min	Mean (Std. Dev.)	Max
Firm Variables				
Q	Firm output (measured in 10 millions of barrels)	0.053	2.66 (2.83)	10.3
TR	Total revenue (thousands of 1982 dollars)	24595	1561874 (1679509)	5798582
P	Price (total revenue divided by output; 1982 dollars per barrel)	25.86	55.891 (9.20)	74.092
MC	Marginal cost (total cost divided by output; 1982 dollars per barrel)	26.318	51.165 (8.574)	68.237
π^v	Variable profit (total revenue minus total variable cost; thousands of 1982 dollars)	1396	483732 (647211)	2598093
D_N	National Firm Dummy Variable (= 1 for national producer and 0 otherwise)	0	0.431 (0.497)	1
Industry Variables				
HHI	Hirfindahl-Hirschman Index	11.93	23.314 (7.563)	43.291
CR4	Four-Firm Concentration Ratio	17.05	60.207 (28.02)	94.39
WAR	Efficient number of firms divided by the total number of firms (N^*/N)	0.224	0.325 (0.055)	0.418
Demand Variables				
DEM	Demographic Variable – Proportion of the U.S. population aged 18-44.	0.372	0.414 (0.016)	0.433
INC	Per-capita real disposable income (1982 dollars)	10299	11940 (1553)	16210

Summary statistics are for the minimum (Min), mean, maximum (Max), and standard deviation (Std. Dev.).

Table 2.4 Parameter Estimates and Standard Errors of the Optimal Price Equation

Variable	M1	M2	M3	M4	M5	M6	M7	M8
MC	1.030[a] (0.009)	1.029[a] (0.010)	1.036[a] (0.009)	1.037[a] (0.009)	1.067[a] (0.007)	1.049[a] (0.008)	1.069[a] (0.008)	1.062[a] (0.009)
q	1.198[a] (0.140)	0.575[a] (0.175)	-0.067 (0.147)	-0.014 (0.151)	-	-	-	-
q·War	-	-	3.287[a] (0.152)	3.629[a] (0.198)	-	-	-	-
q_{87-96}	-	-	-	-	0.447 (0.337)	0.098 (0.321)	-0.639[c] (0.379)	-0.635[c] (0.368)
q_{97-08}	-	-	-	-	1.024[a] (0.112)	0.475[a] (0.175)	-0.347[b] (0.143)	-0.482[a] (0.160)
q_{87-96}·War	-	-	-	-	-	-	2.586[a] (0.227)	2.215[a] (0.291)
q_{97-08}·War	-	-	-	-	-	-	3.815[a] (0.220)	3.569[a] (0.234)
D_N	-	3.809[a] (0.559)	-	-1.130[b] (0.522)	-	3.789[a] (0.584)	-	1.545[b] (0.608)
$\bar{R}^2$	0.995	0.996	0.998	0.998	0.995	0.996	0.998	0.998
Wald χ^2	94749[a]	54108[a]	91077[a]	110320[a]	58514[a]	46619[a]	56958[a]	54865[a]

Standard errors are in parentheses. The sample size is 174.
[a]Significant at 1 percent.
[b]Significant at 5 percent.
[c]Significant at 10 percent.

Table 2.5 Lerner Index Estimates

Time Period	Model M5	M6	M7	M8
1987-1996	0.0696	0.0761	0.0700	0.0726
1997-2008	0.0771	0.0812	0.0795	0.0811

Figure 2.1 Beer Industry Concentration (Four-Firm Concentration Ratio and Herfindahl-Hirschman Index), 1947-2009

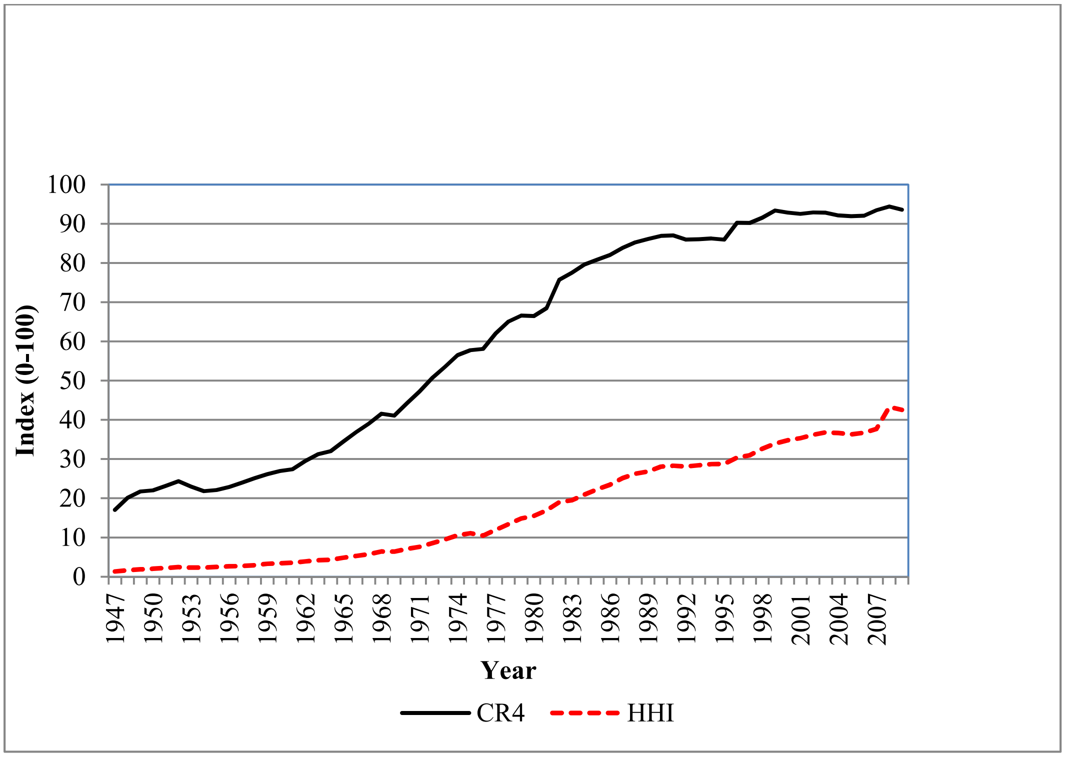


Figure 2.2 Advertising Per Barrel of Leading U.S. Brewers, 1950-2009

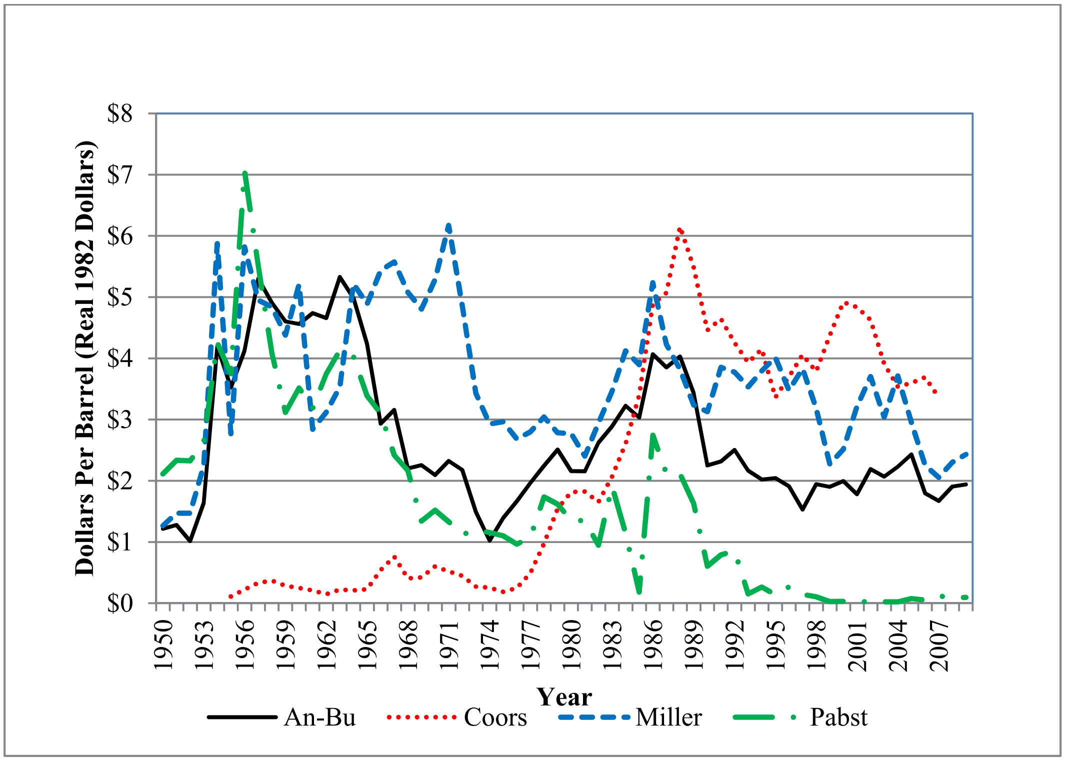
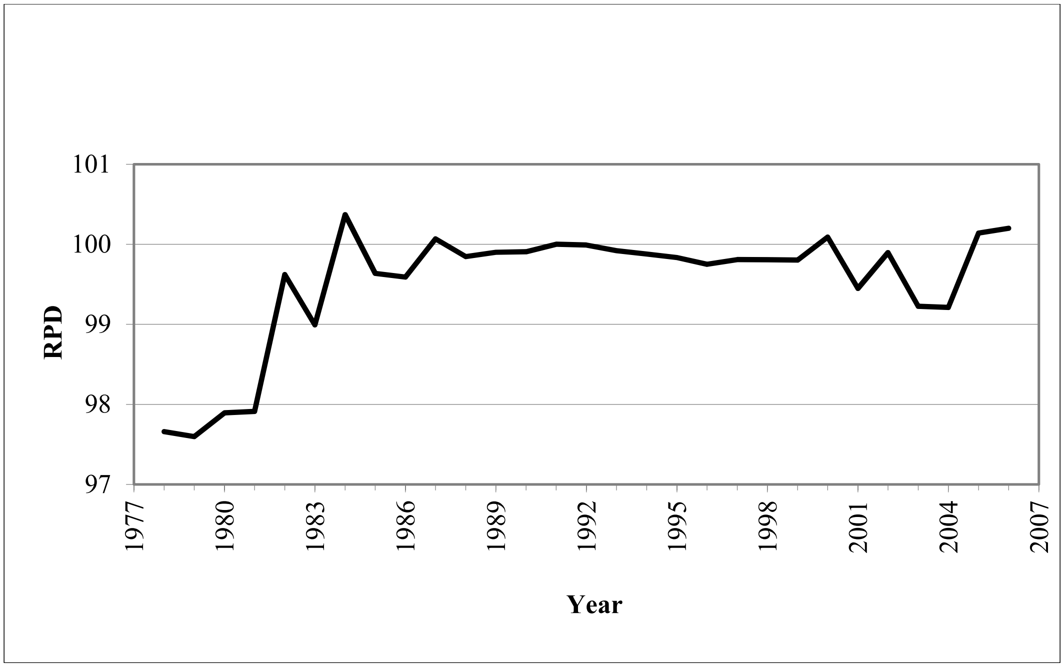


Figure 2.3 Mean Relative Profit Difference (RPD)



Note: This plots the mean RPD for the following triad of firms: Anheuser Busch, Miller, and Genesee; Anheuser Busch, Coors, and Genesee; Anheuser Busch, Boston Beer, and Miller; Anheuser Busch, Boston Beer, and Coors.

Chapter 3

Product Life Cycles: New Products, Quality and Advertising in the Movie Market

3.1 Introduction

In most markets, there is an evolving set of products. New products and changes in existing products are regularly introduced, while series of older products decay and the products eventually exit the market. There are numerous examples. In the automobile, computer, and cell phone markets, new products and/or improvements to existing products are routinely and regularly introduced. The sales of existing products typically decay after introduction of new products, but the effects may differ depending on the similarity of the products introduced, the quality of the existing products and the level of marketing support. The other factor that must be considered is the level of addiction customers develop for the product. In certain products such as addictive products for instance, the level of addiction may offset the decay effect due to time and substitutes.[18]

In this study, we examine effects on decay of sales using data for the motion picture industry. We assume that addictive effects are more than offset by the decay effects.[19] The movie market offers an excellent opportunity to examine these effects because of rapid decay in movie sales from theaters. New movies

[18] Addictive products such as cigarettes may be offered at an initial low price to attract customers, often find sales grow. See Tremblay and Tremblay (2012), Chapter 14

[19] This assumption seems reasonable since it is unusual for viewers to watch the same movie in theater more than once (watching the same movie more than twice is rare).

are routinely introduced, each movie has a different quality rating and there are many different types (genres) of movies such as drama, comedy, action etc. Sales of existing movies decay with time i.e., a heavily advertised and touted movie often experiences greatest attendance at the time of introduction and then sales decay with time, but the introduction of substitutes can increase the decay rate. The quality of a movie is derived from either good performance of actors or a good story. Superior quality generates greater interest and positive word of mouth. Generation of greater interest can slow the decay rate. Persuasive advertising can also slow the decay of movie sales. Advertising support sends a signal to viewers that the movie studio believes that a movie is of superior quality. Some movies involve bigger budgets and producers could try to signal better movie quality. Greater advertising expenditures also reaches wider audience base and creates higher interest in the movie.

The existing literature on product cycles predominantly covers products that last a few years. Levitt (1965) and Vernon (1966) discuss various stages of the product life cycle. These stages are: market development and growth; maturity and decline. For products with a short life cycle such as movies, most of the market development process occurs before a movie is released. This happens in the form of advertising and distribution. In addition, Einav and Ravid (2009) point to signaling of release dates typically occurring around holidays such as the 4^{th} of July or Christmas. Some movies, especially those perceived as good quality experience some appreciation in sales in weeks after release but most movies mature relatively quickly in the first few weeks. Every week, the box office revenues of a new movie decrease as compared to the previous week. The first week of screening accounts for almost 30% of box office revenues.[20] In 2010, 560 new movies were introduced which grossed $ 10.6 billion.[21]

Good movie quality leads to positive word of mouth and slower decay in box office sales. Beck (2007) and Moul (2007) discuss the positive effects of word of mouth on product sales. However, sales of a new movie rapidly decay after reaching maturity until the movie is taken out of the theaters. New products play a vital role in increasing the utility of consumers. However, their role in the context of movies is relatively unknown. Nevo (2003) estimates utility function for individuals who consume products with changing product quality. Petrin (2002) estimates the effect of new product introduction on consumer welfare. New products in the automobile market that successfully differentiate from the existing ones can yield large profits for the innovator and significantly increase consumer surplus. Klepper (1996) discusses the evolution of market structure in industries where there is innovation and technological progress in product development. Product quality and innovation seem to be of paramount

[20] With non-existent price competition, box office revenues represent the number of consumers watching movies in theaters. We examined ticket prices since 1980. In real terms, they are practically unchanged.

[21] According to the National Association of Theater Owners and the Motion Picture Association of America.

importance in the context of movies. Entry and exit strategies also play a vital role in determining product life cycle. Dunne et al. (2009) use a dynamic model to estimate the determinants of entry and exit in markets with imperfect competition. While these studies and the many models of industrial organization point to the negative influence of new products on existing products, the number of studies is scant in the context of movies.

In this paper, we present three empirical findings. First, there is a significant impact of the introduction of new movies on the decay of sales of existing movies. But, if broken down by genre this effect is relatively less significant. That is, there is evidence that the introduction of a substitute movie from any genre causes a decay in sales of a children's movie. However we do not find a similar effect of a substitute movie of the same genre. The level of significance of decay due to an introduction of a substitute movie of the same genre varies by the type of genre. Second, advertising expenditure and better movie quality help lower this decay especially in the dying stages of the life cycle. Third, we find that with increasing time, the decay factor becomes more prominent, that is the greater is the time elapsed since introduction, the greater is the probability of exit.

Existing literature on movies involves a number of studies. Elberse and Eliashberg, 2003; Elliott and Simmons, 2008 focus on modeling movie sales. Einav, 2007 studies the effect of season in which a movie is introduced on movie sales. Zuckerman and Kim, 2003; Basuroy et al., 2003; Reinstein and Snyder, 2005; Eliashberg and Shugan 1997 and Boatwright et al. 2007 study the role of critics. Moul, 2001 and Moul, 2007; Liu, 2006 and Duan et al., 2008 study the effect of word of mouth on box office sales. Sawhney and Eliashberg, 1996 and Ainsle et al., 2005 focus on mathematical modeling of movie sales. Basuroy et al., 2006; Zufryden, 1996; Elberse and Anand, 2007 study the effect of advertising and promotion on movie sales. Ravid, 1999; De Vany and Walls, 1996 and Elberse, 2007 study the role of stars in box office sales. Dellarocas et al., 2007 and Liu, 2006 determine the effect of online reviews and web based promotions on movie sales. The only study on the effect of substitutes in a related field appears to be by Davis, 2002, who finds that entry of a new movie theater leads to cannibalization of sales by incumbents and could cause exit of existing theaters. None of these studies have focused simultaneously on advertising, production cost and quality with the effect of introduction of new movies on movie life cycle.

In the next section, we present a model of movie demand that leads to the empirical framework in Section 3.3. Section 3.4 describes the sources of all data used. Section 3.5 contains the results, while Section 3.6 concludes.

3.2 Model

In our model of movies, we assume that consumers make a decision to go to movies and then choose a specific movie from a set of available movies playing in theaters at that time. Further, consumers react to signals from the market. Prices are an obvious factor but there is a surprising uniformity in prices for first run movies across theaters, and as such, are not useful modeling movie choices.[22] Instead, we assume that choices are made on the basis of market signals such as quality and advertising as well as how long the movie has been in the theaters. At a point in time, there is a set of movies C, and an individual chooses movie 'c' if the utility from that movie exceeds that of alternatives. The utility is higher if movie quality is better or if the movie is relatively 'new' or if the movie is heavily publicized through relatively high advertising expenditures. From this framework, the demand model is as follows:

$$Q_c = f(A_c, R_c, w) \tag{3.1}$$

where Q_c is the box office sales for movie 'c' during week 'w'; R_c is the measure of quality of the movie; A_c is the advertising expenditure on movie c; and w is the week since the release of the movie. Major factors that lead to qualitative shift in demand is the number of substitutes released during a given week and season of the year in which the movie is released.

The idea here is that as advertising and quality of movie c changes, there is greater attendance. In most cases, advertising and quality are determined prior

[22] When we use models described later, we do not find evidence of a relationship between change in box office sales and ticket price.

to release. Naturally, as the length of time a movie has been in the movies increases, the probability of attending diminishes (decays).

There are a number of additional factors considered. First, agents may choose the genre i.e., the type of movie to attend and then the specific movie. Second, over time, the set of movies changes as some existing movies are taken off theaters and some new movies are released. With it changes the choice set 'C'. Third, the week of the year in which a movie is released creates a difference in box office sales. It is well known that movie sales skyrocket during Independence Day (July 4) and Christmas (December 25) weeks (see Einav, 2007). Hence, blockbuster movies compete to receive greater audience eyeballs during these weeks through signaling much in advance of release (see Einav and Ravid, 2009).

The data set contains total sales by movie and week for all first run movies in the U.S., which forms the dependent variable in our empirical work. Control variables include advertising, quality, weeks in the theater, a variable (KILLER) that captures the introduction of a movie. Conventional life cycle studies are based on the Bass (1969) model which considers the probability of an individual adoption at time 't' given no previous purchases. As discussed previously, diffusion models have been applied for movies by Ainsle et al. (2005) and by Sawhney and Eliashberg (1996).

To examine and identify lifecycle effects, we consider a small change in demand for a representative movie ‘j’ during time ‘dt’

(3.2) $$\frac{\partial(Q_{jt})}{Q_{jt}} = f_1(A_j, R_j, \xi_j)\ dt$$

where: Q_{jt} is the demand and is represented by box office sales for movie j at week t; R_j is the measure of quality of the movie; A_j is the advertising expenditure on movie j; and ξ_j are the movie specific shifters such as substitutes released during week ‘t’ and production cost for movie ‘j’.

Every movie becomes less attractive as more and more time elapses since its release. This causes degradation in movie sales. We can associate this with a decay parameter λ, and using equation 3.1 yields:

(3.3) $$\frac{\partial Q_{jt}}{Q_{jt}} = f(A_j, R_j, \xi_j, \lambda)dt$$

If f(.) is a linear function, rewrite (3.3) as:

(3.4) $$\ln\left(\frac{Q_{jt}}{Q_{jt-1}}\right) = \left(a\xi_j + \alpha A_j + \rho R_j\right)\left(w_t - w_{(t-1)}\right) + \lambda_{t,t-1}\left(w_t - w_{(t-1)}\right)$$

where w_t is the number of weeks 't' since the introduction of the movie; and $Q_{j,t-1}$ is the box office revenue for a movie j in week 't-1' from which the change is measured.

The model developed in (3.4) is the log linear form similar to those used in Bass (1969) diffusion models. We can consolidate this equation across the 10 weeks of study for each movie 'j' as follows:

$$(3.5) \qquad \ln\left(\frac{Q_{jt}}{Q_{jt-1}}\right) = \alpha_{t,t-1} A_j D_{t,t-1} + \rho_{t,t-1} R_j D_{t,t-1} + a_{t,t-1} \xi_j D_{t,t-1} + \lambda_{t,t-1} D_{t,t-1}$$

$$\forall t = 2 \ldots 10$$

If advertising expenditures and other shifters do not vary significantly across the weeks in theaters, then we can simplify equation (3.5) as[23]

$$(3.6) \qquad \ln\left(\frac{Q_{jt}}{Q_{jt-1}}\right) = \left(a_j \xi_j + \alpha_j A_j + \rho_j R_j\right) + \sum_{t=2}^{10} \lambda_{t,t-1} D_{t,t-1} + \varepsilon_j$$

In our model, the dependent variable is constructed from weekly box office sales classified per movie, advertising expenditures of a movie, average customer rating for the movie, production cost of the movie and the number of substitutes.

[23] We also consider a model in which the shifters are allowed to interact with a dummy for each week to see the effect of each shifter on a given weekly decay in movie sales. See Appendix 1 for details.

More specifically, we use the following regression model:

(3.7)
$$\ln\left(\frac{Q_{jt}}{Q_{jt-1}}\right) = \alpha A_j + \rho R_j + a_1 PC_j + a_2 Killer_{t,j} + \lambda_1 D_{2-1} + \lambda_2 D_{3-2} + \lambda_3 D_{4-3} + \lambda_4 D_{5-4} + \lambda_5 D_{6-5} + \lambda_6 D_{7-6} + \lambda_7 D_{8-7} + \lambda_8 D_{9-8} + \lambda_9 D_{10-9} + \varepsilon_j$$

where Q_{jt} and Q_{jt-1} are respectively box office sales of movie j in week t and t'; A_j is advertisement expenditure for movie j; R_j is the mean of consumer ratings for movie j; PC_j is the production cost incurred for movie j; $D_{t\text{-}t\text{-}1}$ is the dummy for the week t over t-1, t going from 2 to 10; and $Killer_{t,j}$ is the number of new wide-release movies released in week t for movie j.

In the analysis, there are five central hypotheses examined. These are: higher production cost leads to smaller decay in box office revenues (H_1: $a_1 > 0$); Higher advertising expenses lead to better slower decay in sales ($H_2 : \alpha > 0$); Better quality of movies reduces the decay of box office sales ($H_3 : \rho > 0$); Each dummy captures the killer effect of every week on the decay of sales ($H_4 : D_{t,t-1} < 0$); and more the substitutes, faster is the decay in product life. (H_5: $a_2 < 0$)

Negative and significant value of killer variable suggests that the introduction of a substitute movie has a deleterious effect on the movie analyzed, and speeds its decline. We allow the effects to vary between movies of the same genre as well as from all genres. We estimate 10 regression models to examine the effect of substitutes on decay in box office sales. Model 1 is based upon the specification in equation 3.7 and does not distinguish a movie based on its genre.

However, Model 2 includes the "killer" variable in Model 1 and considers the effect of release of all movies (irrespective of their genre) as substitutes. Models 3 – 6 take into account the genre of a movie. The genres considered are Action (Model 3), comedy (Model 4), drama (Model 5) and children (Model 6). Models 3 – 6 estimate equation 3.7 with "killer" variable where "killer" is defined to be movies belonging to all genres. We also compare the effect of all movies as substitutes with movies from the same genre as substitutes. Hence, in Models 7 – 10, the "killer" variable denotes the number of movies released during a given week that belong to the same genre. These effects are considered for action (Model 7), comedy (Model 8), drama (Model 9) and children's (Model 10) genre.

3.4 Data and Descriptive Statistics

The movie data include 1535 wide release movies selected from a dataset of 2271 movies released between January 1, 1985 and December 31, 1999 taken from Einav's (2007) research which was obtained from Neilson EDI and AD $ Summary published by Competitive Media Reporting.[24] The original dataset covers 13,358 weekly observations. Any movie that reached 600 screens during a week in box office is defined as a wide release movie.[25] The average cumulative box office revenue for non-wide release movies is $3.75 million, and the average

[24] First nine weeks of 1985 have not been considered because data on movies released in 1984 is not possible. Moreover the original data does not go beyond movies released in 1999.

[25] Any movie that reached 600 screens has been included in the data. Einav (2007) makes a similar judgment based on the fact that the peak of screens across movies follows a bimodal distribution with 600 screens falling between two modes.

production cost is $ 5.57 million. It is noted that production costs are determined prior to the movie release, and as such can be thought of as pre-determined sunk costs. Average cumulative box office revenue for wide release movies is $ 43.61 million and average production cost is $ 26.23 million. Wide release movies account for 96% of total box office sales in the original sample. Hence, we consider wide release movies to be a better representation of a typical movie. The average number of weeks in theaters is 8.7, and most of the revenues, 90 percent, are realized in the first ten weeks. Almost 71% of wide-release movies did not finish 10 weeks in theaters. That is, they were taken out of the movie theaters.

Most movies, 85%, are released on Fridays. To account for movies not released on Friday, box office sales until the same Friday were considered to belong to week 0. This could be a potential source of measurement error. To this data, average of viewer ratings for each movie were matched up with data obtained from Netflix (www.netflixprize.com, accessed November 17, 2009). In 2009, Netflix had organized an open competition in which it made its user ratings public for a limited time. Average of Netflix ratings was 3.32 on a scale of 5, where a score of "1" indicates that a viewer "hated a movie" and "5" indicates that a viewer "loved it". Summary statistics for the data are as in table 1.

For non-wide release movies, the average peak number of screens is 150. Weekly revenues of wide and limited release movies are as in figures 1 and 2. For simplicity, we do not consider limited release movies. Limited release movies are usually launched as test cases in few places and few of them end up getting a wide release later in their life cycle. For these reasons, the revenue pattern is not the same as wide release movies.[26]

3.5 Results

Table 2 presents results from regression Models 1 - 10. In Model 1, we consider the empirical specification of equation 3.7, without the "killer" variable. The coefficient of production cost (a_1) is not significantly different from zero at 10 percent, suggesting that production cost does not matter in determining decay in movie sales.[27] This is not unexpected since production cost is a sunk cost, and does relatively little other than sending a signal about the movie. Thus, the hypothesis H_1 cannot be accepted. The coefficient of advertising expenditure, α, is

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[26] The decay of sales for limited release movies could be negative (representing growth in movie sales), this growth may be purely due to expansion in extent of release on account of relaunch as wide release movies. We therefore limit our discussion to wide-release movies, to avoid the difference in pattern of box office revenues for this study.

[27] The coefficient of production cost is not significantly different from zero. This could be due to the fact that production cost is a sunk cost and does not affect the decay in sales. But there is a chance that advertising and movie quality are endogenous. These may be a function of production cost. When the total cost of movies is being allocated, there are instances that the advertising budget may also be determined when production cost for a movie is fixed. Similarly, viewers may construe superior production cost as a signal for higher quality. We test for the endogeneity of movie quality and advertising cost. We use production cost as an instrument for advertising cost and movie quality. We perform 2-stage least squares regressions using production cost as instrument in all models (1 - 10). While, we find no evidence of endogeneity in our base model (Model 1), we do find evidence in the model when the killer variable is introduced. We also perform Hausman's Test for finding evidence of specification bias. The statistic is not significant at 10 percent in the base model, but does show significance when killer variable is introduced. Hence there is some evidence that IV is the appropriate estimator. However, the numerical estimates of OLS and IV are very similar and in no case, are the primary findings of the paper affected by the choice of estimator. Moreover, significance of Hausman's statistic is not evident in all models. Only the models of children's movie (Models 6 and 10) reject the hypothesis that parameters in name consistent (IV) and name efficient (OLS) models are significantly different from each other at 1 percent significance.

positive and significant at 1 percent. Strongly advertised movies are likely to attract greater audiences and face slower decay in sales. Thus, the hypothesis H_2 cannot be accepted. We find that ρ, the coefficient of quality is positive and significant at 1%. This is consistent with H_3. Superior quality prevents the decay of product revenues. As expected, the coefficients of dummy variables ($\lambda_1 - \lambda_9$) which account for decay effect of time are all negative and significant at 1 percent, thus demonstrating the killer effect of time on product life. Moreover, there is evidence of increasing decay effect of time on change in box office sales, as evidenced by the coefficients λ_1, λ_2, λ_3, λ_5, λ_7 and λ_8. This supports hypothesis H_4. As expected, the coefficient for killer variable is negative and significant at 1 percent and points towards the negative effect of substitutes on product life-cycle.

In Model 2, the "killer" variable represents number of substitute movies released during a given week. The key finding obtained by comparing Models 1 and 2 is that every new substitute movie launched during a given week will lead to faster decay in movie sales. "a_2" is negative and significant at 1 percent.

We examine the effects of the introduction of another movie in the same genre as well as in different genres (Models 3 – 10). In general, the results indicate that strong substitution effects for movies of certain genres due to introduction of movies from all other genres. Results also indicate weak substitution effects for movies of specific genres due to introduction of movies in the same genre. For example, the introduction of a new movie from any genre leads to faster decay in life of Action and Comedy movies (Models 3 and 4). However results are not so conclusive for introduction of new movies from the same genre (i.e. Action and Comedy movies in Models 7 and 8). For drama and children's genre, the introduction of new movies does not have statistically significant effects.

To measure the effect of each control variable during different weeks, we run the same regression as specified in model 1, but we interact each control variable with weekly dummies. This empirical specification is seen in equation 3.5. These results are shown in Appendix A. We find that higher advertising expenditures and better movie quality play an important role in slowing the decay of movie sales across all weeks. Coefficients ρ_2-ρ_9 are all positive. Similarly α_1-α_9 are all positive. Similarly $a_{2,1} - a_{2,9}$, the coefficients of the "killer" dummy are all negative, with the exception of $a_{2,2}$. However, as seen from $a_{2,7}$, $a_{2,8}$ and $a_{2,9}$ the release of substitutes has a pronounced effect on decay of movies during the final weeks of life. The magnitudes of these three coefficients are relatively larger and significant at 1 percent. We can conclude that exit of a product is exacerbated by introduction of substitutes. A plot of coefficients of "killer" is shown in figure 3, which demonstrates the increase in magnitude of "killer" variable during the last three weeks of movies in theaters.

3.6 Concluding Remarks

The life of movies in theaters typically ranges from 8-10 weeks. This provides a unique opportunity to study product life cycle. We observe that agents understand and respond to differences in movie quality. Similarly, agents also observe increased advertising expenditures and respond by decreasing the decay of sales (show greater interest in purchasing the product in mature stages of life cycle). Both quality and advertising are important tools at the disposal of the producers. Better movie quality and higher advertising expenditures lead to slower decay in movie sales. However, production cost does not seem to affect the product life cycle. Substitutes tend to shorten the product life cycle. However, the effect of substitutes on product life cycle of in case of movies depends on genre. The effect of substitutes is more dramatic the in case of action and comedy movies but the evidence of such an effect does not exist in the case of children's movies.

This paper has three main conclusions. First, introduction of substitutes is an important reason for sales of a product to decay. Second, good quality products survive significantly longer than average quality products. Demand persists longer for superior quality movies. Third, as with any differentiated product, the effect of substitutes is different for products of different types. There is evidence that a substitute movie causes significant decay of sales, while such evidence does not exist for substitutes of the same genre.

Table 3.1 Descriptive Statistics of Wide release Movies

Variable	Description	N	Mean	Std. Dev.	Min	Max
R	Average of Ratings obtained from Netflix	1535	3.32	0.36	2.10	4.46
pc	Production cost ($ million)	1535	31.41	23.28	1.01	208.68
Q_{21}	log of ratio of revenue in current week to revenue in the previous week	1535	-37.65	189.95	-1000	2.40
A	Advertising expenditures ($ million)	1535	8.79	6.01	0.01	42.48
Killer	Number of substitutes released during a given week	13815	1.83	1.55	0.00	9.00

Summary statistics are for the minimum (Min), mean, maximum (Max), and standard deviation (Std. Dev.).

Table 3.2 Regression Results for Models 1 – 6

Dependent variable: Q_{21}

Genre	**Model 1** All	**Model 2** All	**Model 3** Action	**Model 4** Comedy	**Model 5** Drama	**Model 6** Children
ρ	27.894[a]	28.088[a]	27.226[a]	29.527[a]	38.034[a]	15.895
	(4.769)	(4.766)	(9.424)	(8.186)	(9.695)	(14.631)
a_1	-0.057	-0.061	0.159	0.061	-0.238	-0.182
	(0.089)	(0.089)	(0.149)	(0.234)	(0.178)	(0.249)
α	3.292[a]	3.496[a]	3.463[a]	3.260[a]	3.490[a]	2.883[a]
	(0.342)	(0.347)	(0.681)	(0.659)	(0.684)	(0.816)
λ_1	-123.700[a]	-118.237[a]	-119.666[a]	-117.491[a]	-155.246[a]	-82.579
	(16.349)	(16.409)	(31.800)	(27.613)	(34.576)	(53.354)
λ_2	-133.117[a]	-127.396[a]	-132.691[a]	-123.108[a]	-159.528[a]	-99.302[c]
	(16.349)	(16.415)	(31.858)	(27.656)	(34.520)	(53.191)
λ_3	-154.210[a]	-148.563[a]	-154.453[a]	-152.984[a]	-178.583[a]	-90.322[c]
	(16.349)	(16.413)	(31.848)	(27.645)	(34.539)	(53.154)
λ_4	-153.419[a]	-148.073[a]	-168.938[a]	-133.627[a]	-182.200[a]	-99.737[c]
	(16.349)	(16.406)	(31.841)	(27.609)	(34.521)	(53.261)
λ_5	-165.083[a]	-159.416[a]	-157.005[a]	-160.137[a]	-191.784[a]	-144.467[a]
	(16.349)	(16.414)	(31.838)	(27.631)	(34.525)	(53.434)
λ_6	-162.733[a]	-157.761[a]	-162.599[a]	-154.653[a]	-198.224[a]	-108.577[b]
	(16.349)	(16.397)	(31.804)	(27.590)	(34.524)	(53.274)
λ_7	-172.060[a]	-167.482[a]	-179.020[a]	-159.961[a]	-201.914[a]	-125.177[b]
	(16.349)	(16.388)	(31.815)	(27.569)	(34.501)	(53.135)
λ_8	-174.383[a]	-170.078[a]	-201.614[a]	-163.857[a]	-173.159[a]	-133.735[b]
	(16.349)	(16.383)	(31.775)	(27.586)	(34.489)	(53.110)
λ_9	-168.110[a]	-163.999[a]	-165.925[a]	-157.800[a]	-205.231[a]	-133.876[b]
	(16.349)	(16.379)	(31.768)	(27.565)	(34.495)	(53.128)
a_2		-4.068[a]	-4.620[b]	-5.831[a]	-3.520	2.280
		(1.117)	(2.127)	(1.866)	(2.145)	(3.506)
N	11538	11538	3762	3960	2790	1026

Standard error in parenthesis

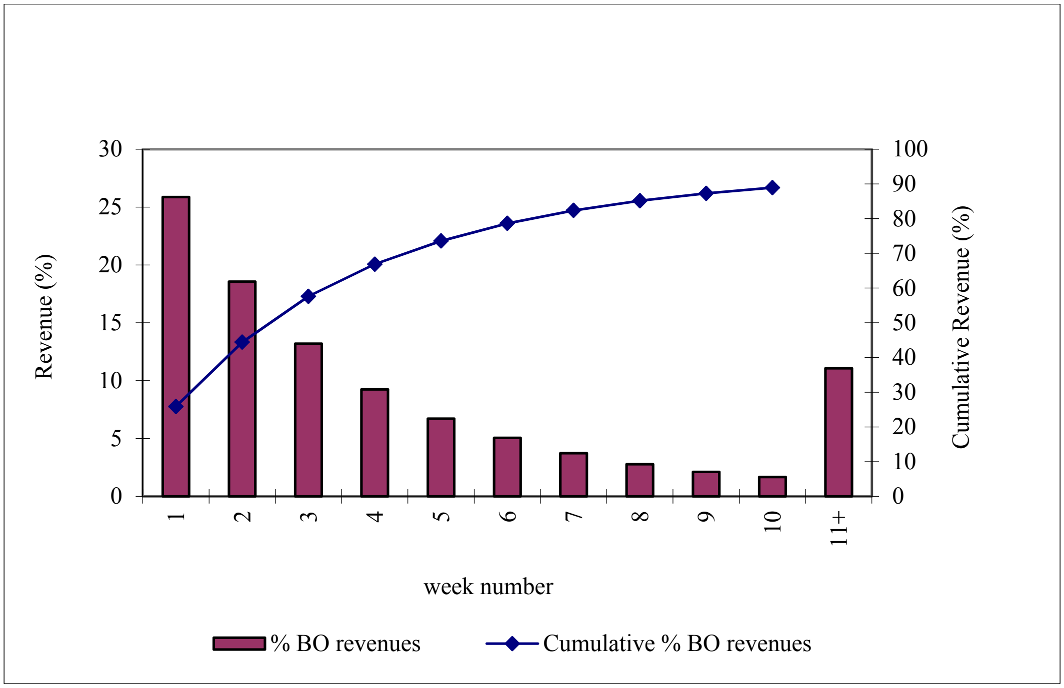
[a] $p<0.01$, [b] $p<0.05$, [c] $p<0.10$

Table 3.3 Regression Results for Substitute Movies Released in the Same Genre (Models 7 – 9)

Genre	**Model 7** Action	**Model 8** Comedy	**Model 9** Drama	**Model 10** Children
ρ	27.486[a]	29.317[a]	37.794[a]	15.902
	(9.434)	(8.201)	(9.698)	(14.632)
a_1	0.153	0.075	-0.218	-0.187
	(0.149)	(0.234)	(0.177)	(0.249)
α	3.189[a]	2.963[a]	3.288[a]	3.001[a]
	(0.675)	(0.653)	(0.675)	(0.811)
λ_1	-127.012[a]	-124.202[a]	-162.609[a]	-76.954
	(31.793)	(27.646)	(34.529)	(52.989)
λ_2	-142.191[a]	-130.724[a]	-165.493[a]	-94.873[c]
	(31.887)	(27.709)	(34.491)	(52.975)
λ_3	-163.845[a]	-160.362[a]	-185.116[a]	-86.507
	(31.904)	(27.694)	(34.509)	(52.958)
λ_4	-178.249[a]	-139.915[a]	-188.245[a]	-94.926[c]
	(31.915)	(27.690)	(34.497)	(52.971)
λ_5	-166.152[a]	-167.174[a]	-197.966[a]	-138.618[a]
	(31.900)	(27.684)	(34.502)	(52.978)
λ_6	-170.836[a]	-160.427[a]	-204.385[a]	-103.568[c]
	(31.888)	(27.671)	(34.501)	(52.978)
λ_7	-187.663[a]	-165.001[a]	-207.595[a]	-121.148[b]
	(31.907)	(27.663)	(34.503)	(52.975)
λ_8	-209.174[a]	-169.339[a]	-178.641[a]	-129.847[b]
	(31.907)	(27.697)	(34.513)	(52.978)
λ_9	-173.188[a]	-162.515[a]	-210.764[a]	-130.025[b]
	(31.898)	(27.692)	(34.503)	(52.968)
a_2	3.405	-2.075	2.980	-6.730
	(4.629)	(3.334)	(4.345)	(11.120)
N	3762	3960	2790	1026

Standard error in parenthesis
[a] p<0.01, [b] p<0.05, [c] p<0.10

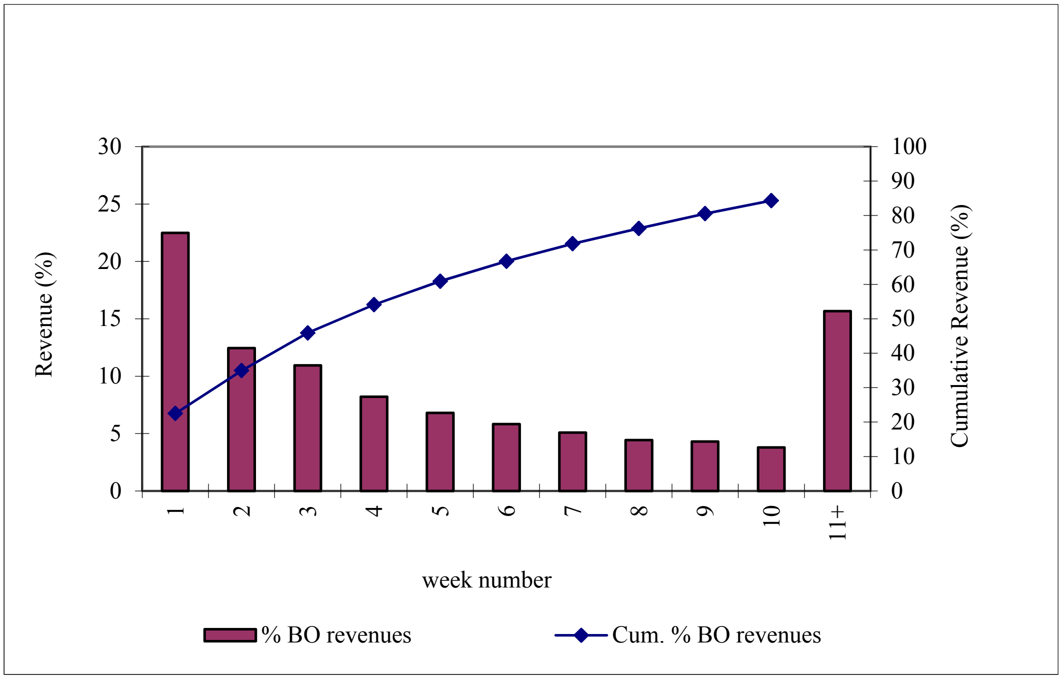
Figure 3.1 Box Office Revenues and Cumulative Box Office Revenues for Wide Release Movies



Note: Revenues are a Percent of Total Revenues.

BO: Box Office

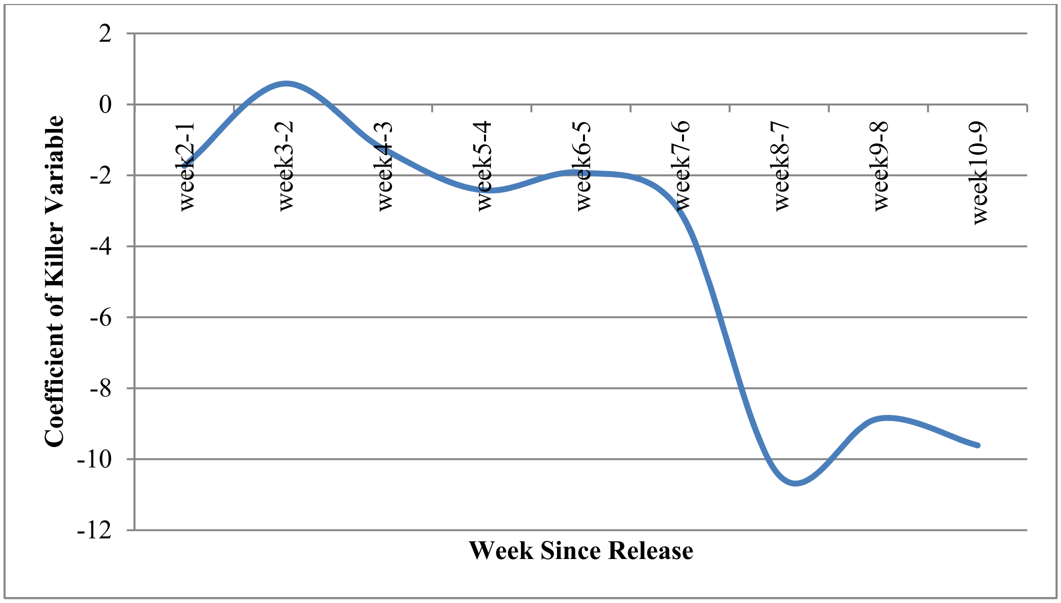
Figure 3.2 Box Office Revenues and Cumulative Box Office Revenues for Non Wide Release Movies



Note: Revenues are a Percent of Total Revenues.

BO: Box Office

Figure 3.3 Effect of Substitutes During Weeks after Release



Chapter 4

The Effect on Stockholder Wealth of Product Recalls and Government Action: The Case of Toyota's Accelerator Pedal Recall

4.1 Introduction

There is a saying in business that if a company loses its resources but retains its reputation, it can always rebuild; however, money cannot bring back a company that loses its reputation. To build a reputation, a company must offer reliable products at a competitive price. The process of building a reputation for quality and value can take decades, and one misstep can tarnish a company's reputation for many years.

One might expect a major product failure to have a dramatic effect on firm value, but the evidence shows that this need not always be the case. A classic example is Johnson and Johnson's recall of its non-aspirin pain reliever, Tylenol.[28] During a three day period beginning on September 29, 1982, seven Chicago area residents died from taking Extra-Strength Tylenol capsules that had been laced with cyanide. This caused the market share of Tylenol to immediately fall to 7 from 37 percent. What is interesting is that this event had little long-term effect on Tylenol's reputation and on stockholder wealth. One reason for this is that cyanide was added to the capsules at retail outlets, not at Tylenol production facilities. Thus, the poisoning was an exogenous event that was not the fault of

[28] See Mitchell (1989) for a review of the Tylenol recall.

Johnson and Johnson. Another reason is that the company's response to the poisonings quickly renewed consumer confidence in the Tylenol brand. Once the source of the poison became apparent, Johnson and Johnson immediately withdrew all Tylenol capsules from the market. In addition, the company repackaged Tylenol capsules with a triple safety seal, a first in the industry. As a result, Tylenol's market share reached 30 percent within six months, and the brand returned to its dominant position by August of 1983.

Product failures that are caused by management error can have a much more detrimental effect on company success. One of the most dramatic examples in business history involves the Schlitz Brewing Company.[29] The Schlitz brand was the number one selling beer in the U.S. in 1956 and was the second largest brewer in the U.S., behind Anheuser-Busch, from 1957 until 1977. Problems at Schlitz began in the mid 1970s when Schlitz lowered production costs by secretly lowering product quality. Initially, this proved to be a profitable strategy, but not once consumers caught on to the deception. Growing consumer awareness of lower quality, coupled with a series of unsuccessful advertising campaigns, caused the company's market share to decline from nearly 16 percent in 1976 to less than 8 percent by 1981. These missteps forced Schlitz to exit the market by 1982.

[29] See Tremblay and Tremblay (2005) for a review of the demise of the Schlitz Brewing Company.

In this paper, we investigate the financial effect of a major product recall on the stock returns of the Toyota Motor Corporation. In the first decade of the 21st century, Toyota had grown to be a very successful corporation. It became the world's largest car manufacturer, replacing General Motors. From Table 4.1, one can observe that the operating revenues of Toyota surpassed those of Ford Motor Company in 2005 and those of General Motors in 2007. Table 4.2 shows that Toyota had the largest U.S. market share in light vehicle sales in the years 2007 and 2008. [30]

Much like the Schlitz case, Toyota's problems were internal in nature. From January 2000 to January 2010, there were reports of 52 deaths linked to Toyota vehicles with uncontrolled acceleration.[31] This led to recalls in 2007 and in 2010 involving approximately 7.5 million Toyota vehicles. Initially, there was uncertainty regarding the cause of the problem.

Toyota initially announced that the problem was minor in nature, but engineers at the National Highway Traffic Safety Administration were concerned that the problem was due to a major design flaw. It was not until early 2011 that a 10-month government study concluded that Toyota had appropriately corrected

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[30] The number of cars, sport utility vehicles and light trucks that are sold over a given period. The category includes pick-up trucks, but excludes heavy trucks – Financial Times Lexicon at http://markets.ft.com/research/Lexicon/Term?term=light-vehicle-sales accessed March 29, 2013

[31] Stephen Manning and Tom Raum, "U.S. May Require Brakes That Can Override Gas Pedals In New Cars," *USA Today*, March 2, 2010 at http://usatoday30.usatoday.com/money/autos/2010-03-02-toyotadeaths_N.htm, accessed October 11, 2012.

the defect. Thus, the Toyota case provides an opportunity to study the effect of both company error and a government report that lifted the cloud of suspicion that Toyota automobiles are unsafe.

Our goal in this paper is to use the event study method to estimate the effect on Toyota's stock returns of the events surrounding Toyota's accelerator pedal problems. Section 4.2 discusses the timeline of events. Section 4.3 discusses the event study method. Section 4.4 describes the data and empirical results. Section 4.5 provides concluding remarks.

4.2 Toyota and the Accelerator Pedal Recall

Problems with Toyota vehicles first became public in March 2007 when the National Highway Traffic Safety Administration (NHTSA) began an investigation in response to consumer complaints of unintended acceleration in Toyota's Lexus ES 350 model of automobile. Concerns with Toyota vehicles escalated because it took so long to identify the source of the problem. The scope of the investigation widened after Troy Johnson was killed in July of 2007 when a Toyota Camry accelerated out of control, reaching a speed of approximately 120 mph, and hit Johnson's car.[32] This event was probably the tipping point which caused the NHTSA to look closely at unintended acceleration problems in Toyota vehicles. After detailed investigations, Toyota concluded that the accident was

[32] We investigate the abnormal returns of Toyota following Troy Johnson's accident, but did not find abnormal returns that were significant. However, this accident was widely covered in press and eventually led to first recall linked to unintended acceleration problems.

caused by unsecured (rubber all-weather) floor mats that could shift forward and trap the accelerator pedal. This led Toyota to recall the all-weather floor mats on 55,000 Lexus and Camry models on September 26, 2007.

On August 28, 2009, Toyota's reputation was tarnished further when another fatal highway accident received a great deal of media attention. Mark Saylor, an off-duty highway patrolman, and his family died in the crash of his Lexus ES350. In response, on September 29 of 2009 Toyota issued a consumer safety advisory that instructed owners of Toyota and Lexus models (2007 – 2010 Camry, 2005 – 2010 Avalon, 2004 – 2009 Prius, 2005 – 2010 Tacoma, 2007 – 2010 Tundra, 2007 – 2010 ES350, 2006 – 2010 IS250 and IS350) to take out any removable floor mats and not replace them until Toyota found a solution. The investigation continued, however, as concerns were raised that unsecure floor mats were not the sole cause of the accelerator problem.

On January 21, 2010, Toyota instituted a major recall, admitting that the accelerator problem was also caused by a design problem with its accelerator pedal. As Akio Toyoda, CEO of Toyota, admitted,

> Toyota has, for the past few years, been expanding its business rapidly. Quite frankly, I fear the pace at which we have grown may have been too quick…. We pursued growth over the speed at which we were able to develop our people and our organization…. I regret that this has resulted in safety issues described in the recalls we face today.[33]

News of the recall spread quickly, which tarnished Toyota's reputation for engineering excellence. According to the Project for Excellence in Journalism, the Toyota recall was the fifth most reported story in the week of January 25-31 and the second most reported story in the week of February 1-7, 2010.[34]

According to Toyota, the accelerator pedal on certain models suffered from mechanical problems. Wear and environmental conditions could cause a nylon friction device to stick and prevent the accelerator pedal from returning to idle. Thus, the fix was minor and required only 30 minutes of work. Nevertheless, persistent concerns that the problem was electronic rather than mechanical led the U.S. Congress to request that NHTSA continue its investigation of the causes of

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[33] This testimony is available at http://www.toyota.com/about/news/corporate/2010/02/24-1-testimony.html, accessed October 2, 2011.

[34] See "On State of the Union Week, It's All About Obama," Journalism.org, http://www.journalism.org/index_report/pej_news_coverage_index_january_2531_2010 and "With Budget as Backdrop, Economy Leads the News," Journalism.org, at http://www.journalism.org/index_report/pej_news_index_report, accessed October 2, 1011.

unintended acceleration of Toyota automobiles in March, 2010.[35] To complete their investigation, NHTSA enlisted the help of NASA engineers. After a 10 month investigation, NHTSA released its study on February 8, 2011, which concluded that (1) there was no evidence of an electronics flaw, (2) most of the accidents were the result of driver error (i.e., drivers stepping on the accelerator instead of the brake, called pedal misapplication), and (3) the remaining accidents resulted from problems corrected by previous recalls (regarding accelerator entrapment and mechanical defects in the accelerator pedal).

Because these events provide investors with different information, each event is expected to have a different effect on Toyota's stock returns. Corporate error led to recall announcements in 2007 and 2010 and would be expected to adversely affect the firm's financial returns. However, recalls are common in the automobile industry. In 2007 alone, NHTSA records indicate that there were approximately 7,300 recalls affecting millions of vehicles. Thus, the minor recall of 2007 that affected only 55,000 Toyota vehicles is likely to have a small effect relative to the 2010 recall that involved 2.3 million Toyota vehicles. Given the extensive media coverage it received, the death of Mark Saylor may have had a significant negative effect on Toyota's returns. Finally, when the NHTSA study

[35] For a discussion of possible political motives for NHTSA's continued investigation of Toyota, see Ramsey and Mitchell (2010).

lifted the cloud of uncertainty surrounding the reliability of Toyota automobiles, one might expect that this information would substantially lift Toyota's returns.

4.3 Event Study Analysis

We use the event study method to appraise the effect of each event on Toyota's stock returns.[36] It is based on the market model, which assumes the price of a stock reflects all currently available information in the marketplace (x_t). In particular, the return of a security such as a stock i at time t (R_{it})[37] is a function of all available market information, which is typically measured as the market return on a large portfolio of stocks (R_{mt}).[38] The market model assumes a stable linear relationship:

(4.1) $$R_{it} = \alpha_i + \beta_i R_{mt} + \varepsilon_{it}, \quad \varepsilon_{it} \sim N(0,\ \sigma^2),$$

where the error term ε_{it} depends on unanticipated random events and is, purely white noise.[39]

Our goal is to test the null-hypothesis that an event such as a product recall has no effect on a company's abnormal returns. An abnormal return is defined as

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[36] This methodology was developed by Ball and Brown (1968) and Fama et al. (1969). For more recent reviews of these methods, see Thomson (1985), Armitage (1995), MacKinlay (1997), and Bhagat and Romano (2002a, 2002b). This method has been widely used to study product recalls. Examples include Jarrell and Peltzman (1985), Hoffer et al. (1988), Mitchell (1989), Davidson and Worrell (1992) and Govindraj et al. (2004).

[37] It is defined as the percentage change in the stock price (plus dividends per share) from one period to the next.

[38] In applications, the Standard & Poor 500 Index (S&P Index) is used for the market portfolio. The S&P 500 is an index of stock values for 500 large publicly traded companies and is considered an indicator of the health of the U.S. economy.

[39] Another model is the "multifactor model," which includes an industry index as well as a market index. According to MacKinlay (1997, 18), "the gains from employing multifactor models for event studies are limited."

the actual ex post return minus the normal return. The normal return is defined as the expected return, conditional on the event never taking place. Formally, the abnormal return for firm i at event date τ is

(4.2) $$AR_{i\tau} = R_{i\tau} - E(R_{i\tau}|R_{m\tau}),$$

where $E(R_{i\tau}|R_{m\tau})$ is the expected normal return and $R_{m\tau}$ is the pre-event conditioning information for the normal return model. In other words, $R_{m\tau}$ is the information that is used to forecast the expected return assuming the event had never occurred.

To successfully measure and analyze abnormal returns, we first need sufficient stock price (and dividend) data before and after the event date. Let $\tau = 0$ be the event date and W_{pre} be the pre-event time period or estimation window.[40] Let T_{pre} be the number of days in W_{pre}. The event window (W_{event}) identifies the time it takes for the event information to affect returns. In a perfectly efficient financial market, this will be a very short length of time and would include just one time period. With real world imperfections, however, there may be information leaks before the event and lags in response to the event. With information leaks, W_{event} starts before $\tau = 0$; if it takes time for investors to evaluate the economic consequences of an event, then W_{event} ends after $\tau = 0$.

[40] When daily return data are used, the pre-event window typically includes 100 to 250 trading days (Mackinlay, 1997; Bhagat and Romano, 2002a). A longer period reduces the variance of possible sampling error. However, a longer period may capture the effect of previous unexpected abnormal events.

The next step in evaluating the financial effect of an event is to accurately estimate expected normal returns. This requires estimation of the market model in equation 4.1. Under the conditions of the model, the parameters can be estimated with data from W_{pre} using ordinary least squares (OLS). Parameter estimates ($\widehat{\alpha}_i$ and $\widehat{\beta}_i$) and data from W_{event} are used to predict abnormal returns during the event window, $(R_{i\tau}|R_{m\tau})$. Thus, the abnormal return at time t is

(4.3) $$AR_{i\tau} = R_{i\tau} - E\left(\widehat{R}_{i\tau}|R_{m\tau}\right) = R_{i\tau} - \left(\widehat{\alpha}_i + \widehat{\beta}_i R_{m\tau}\right).$$

When W_{event} includes more than one period, sample abnormal returns are added up to obtain cumulative abnormal return, $CAR_{i\tau}$. If W_{event} ranges from $t = \tau_1 < 0$ to $t = \tau_2 > 0$, then

(4.4) $$CAR_{i\tau} = \sum_{t=\tau_1}^{\tau_2} AR_{it}.$$

This measures the total effect on abnormal returns for a multi-period event window. If the event has no effect on the value of the firm, then $AR_{i\tau}$ (and $CAR_{i\tau}$) will not be significantly different from zero, because actual returns will not significantly differ from normal returns. With a negative (positive) event, however, both $AR_{i\tau}$ and $CAR_{i\tau}$ will be negative (positive) and significantly different from zero. We use parametric and non–parametric tests of these hypotheses for the four events discussed above.

4.3.1 Traditional Parametric Tests[41]

In traditional parametric tests, we assume that AR_{it} is independently and identically distributed with mean zero and variance $\sigma^2(AR_{it})$. In this case,

(4.5) $$\sigma^2(AR_{it}) = \sigma^2\left(1 + \frac{1}{T_{pre}} + \frac{(R_{mt} - \bar{R}_m)^2}{\sum_{\tau \in W_{pre}} (R_{m\tau} - \bar{R}_m)^2}\right)$$

where $\bar{R}_m$ is the mean of market returns over the estimation window. We assume that the event has an effect on the mean only and not the variance of abnormal returns during the event window. Thus the null hypothesis is that the event has no impact on the behavior of returns (mean or variance). We can use the distributional properties of abnormal returns to make statistical inferences on abnormal returns for the event window. The null hypothesis is that the corresponding abnormal return for day τ is not significantly different from zero. In order to compute the test statistic for abnormal returns, we standardize each daily abnormal return

(4.6) $$SAR_{i\tau} = AR_{i\tau}/\sigma(AR_{i\tau}).$$

$SAR_{i\tau}$ follows a t-distribution with T_{pre}-2 degrees of freedom. This statistic is used to test the null hypothesis.

$CAR_{i\tau}$ is assumed to be distributed independently and identically with mean zero and variance $\sigma^2(CAR_{i\tau})$. The variance of CAR on day τ is given by the following expression

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[41] For details on traditional parametric tests, see Brown and Warner (1985), Salinger (1992), Mackinlay (1997), McWilliams and Siegel (1997) and McWilliams and McWilliams (2000).

(4.7) $$\sigma^2(\mathrm{CAR}_{it}) = \sigma^2\left(k + \frac{k^2}{T_{pre}} + \frac{\sum_{\tau_1}^{\tau_2} R_{m\tau} - k(\bar{R}_m)^2}{\sum_{\tau \in W_{pre}}(R_{m\tau} - \bar{R}_m)^2}\right),$$

Here 'k' is the day in the event window and other symbols are as defined before. The null hypothesis is that each cumulative abnormal return is not significantly different from zero. The test statistic that is used to test the null hypothesis above is given by the following expression[42]

(4.8) $$\mathrm{SCAR}_{i\tau} = \mathrm{CAR}_{i\tau}/\sigma(\mathrm{CAR}_{i\tau})$$

4.3.2 Nonparametric Rank Test

We also use a non-parametric test which dispenses with the distributional assumptions about abnormal returns. This test was initially developed by Corrado (1989, 2011). In this test, we calculate abnormal returns for the estimation period and arrange the abnormal returns in increasing order, ranking them from one (lowest value) to T_{pre} (highest value). We define $\zeta_{i\tau}$ as the rank of the abnormal return for event day τ. Because $\zeta_{i\tau}$ can vary with equal probability from 1 to T_{pre}, the statistic $u_{i\tau} = \frac{\zeta_{i\tau}}{1+T_{pre}}$ follows a discrete uniform distribution (in a discrete uniform distribution, every observation is equally likely to be observed). The test statistic is constructed as:

(4.9) $$Z_\tau = \frac{4.91}{\sqrt{m}}\left(u_{i\tau}^{0.14} - (1 - u_{i\tau})^{0.14}\right),$$

where m is the number of firms, when pooling more than 1 firm considered in event study and Z_τ is close to the standard normal distribution even for small

[42] For details see Patell (1976)

values of m. The null hypothesis is that AR for day τ is not significantly different from zero.

4.4 The Data and Estimation Results

We use stock price data for Toyota and the market index, measured as the Standard & Poor 500 Index (S&P Index), obtained from the Center for Research in Security Prices (CRSP). Returns on the S&P Index are defined as the daily percentage change in the value of the S&P Index, and Toyota's returns are defined as the daily percentage change in Toyota's stock price (plus dividends per share).[43] We investigate the effect of four events:

Event 1: the minor floor-mat recall of September 26, 2007

Event 2: the Mark Saylor highway accident of August 28, 2009

Event 3: the major recall of January 21, 2010

Event 4: the release of the NHTSA Report of February 8, 2011

Details surrounding each event are summarized in Table 4.3.

Dates of the estimation and event windows are presented in Table 4.4. The estimation window equals 250 trading days for events 1 through 3.[44] The

[43] During the estimation window for event 1, dividends were paid out on December 7, 2006 (79.96 cents) and July 5, 2007 (105.2 cents), for event 2 on December 8, 2008 (126.03 cents) and July 6, 2009 (67.48 cents), for event 3, dividends were paid out on July 6, 2009 (67.48 cents per share) and on December 8, 2009 (42.64 cents per share) and for event 4, dividends were paid out on December 6, 2010 (44.09 cents) and June 30, 2011 (69.47 cents). No dividends were paid out during any event windows.

[44] For the major recall (event 3), we also consider an event window of 79 trading days. This avoids possible contamination from the Mark Saylor highway accident. This window starts

estimation window for the NHTSA Report (event 4) is only 230 days. The starting date is March 12, 2010 in order to avoid contamination from new information about whether or not Toyota had corrected their accelerator pedal problem. For example, Toyota's Chairman testified before Congress on February 24, 2010 that the problem was fixed. Thus, the beginning of this estimation window began 12 trading days after this testimony. Because each event is expected to be unanticipated, the event window begins on the event date (t = 0)[45] and ends 10 trading days after the event. Ten days may be appropriate for the major recall because there was new information related to the major recall for almost a week. Hence, all event windows were 10 days each.[46]

Table 4.5 provides summary statistics for the data that were used to analyze the recalls for estimation windows of the four events. For the first event, mean daily returns were 0.0350 percent for Toyota and 0.0542 percent for the S&P 500 Index. For the second event, mean daily returns were 0.0457 percent for Toyota and -0.0466 percent for the S&P 500 Index. For the third event, mean daily returns were 0.1683 percent for Toyota and 0.1309 percent for the S&P 500 Index. For the fourth event, mean daily returns were 0.0517 percent for Toyota and 0.0659 percent for the S&P 500 Index.

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20 days after the accident. Whether we use a window of 250 or 79 days, the results are essentially the same.

[45] To account for possible leaks in information related to recall announcements, we also used a 21-day event window starting 10 days prior to the event day. We find no evidence of leakage of information in any of the four events. These results are presented in Appendix A.

[46] Eight days may be more appropriate for the 2010 recall, because there were rumors of a Prius recall in early February (Takahashi and Kachi, 2010).

OLS estimates of the parameters from the market model for the four events are listed in Table 4.6. In each case, there is a positive and significant association between market returns and Toyota returns. Parameter estimates from each model are used to generate estimates of abnormal returns and of cumulative abnormal returns for 10 trading days following the event.

Table 4.7 presents the estimates of the Abnormal Returns (ARs) and the Cumulative Abnormal Returns (CARs). For the floor mat recall (event 1), only one AR (day 2) is significantly different from zero (but is positive) at 5 percent significance level. None of the CARs are significantly different from zero. This result is not surprising, given that minor recalls such as this are common in the automobile industry and may have already been factored into stock values by investors.

For the Saylor highway accident (event 2), CAR reaches a value of -7 percent by day 10, but none of the CARs are statistically significant at 10 percent. Thus, in spite of the considerable publicity that this event received, Toyota's ARs and CARs was not significantly different from zero.

The major recall of 2010 (event 3) had a much greater impact, however. Two ARs (days 3 and 8) were negative and different from zero at the 1 percent level of significance. AR for day 7 was negative and significant at the 5 percent level. Eight of the eleven CARs are significant at the 1 percent significance level (days 3-10). By day eight, CAR fell to 19.09 percent, a drop in value that was statistically significant at 1 percent. Thus, Toyota lost a substantial amount of market value, suggesting that the event was unanticipated and significant enough to lower expected future profits.

The NHTSA Report (event 4) also had a substantial effect on Toyota's returns. Two ARs were positive and significant at 1 percent, while one AR was positive and significant at 10 percent. Nine CARs are significant at 1 percent and two CARs were significant at 5 percent, and CAR reached a peak of 8.7 percent on day six. This suggests that investors were reassured by the report that Toyota's previous recalls had properly corrected its accelerator pedals.

We also carried out non-parametric rank tests for the significance of ARs in each event. These tests also support the conclusions from the parametric test statistics. For event 1 (minor recall), negative abnormal returns are not significantly different from zero (at 10 percent). For event 2 (highway accident), abnormal returns are not significantly different from zero. The AR for day 4 is significant and negative at 10 percent. For event 3 (major recall), ARs for day 1 – 8 are all negative. ARs for days 3 and 8 are significant at 1 percent, AR for day 7 is significant at 5 percent and AR for day 6 is significant at 10 percent. For event 4 (release of NHTSA document), ARs for day 1 and 4 are positive and significant at 1 percent and AR for day 2 is positive and significant at 10 percent. These results are reported in Appendix B.

All these results are broadly consistent with our expectations. To see this, CARs for each event are presented in Figure 1. It shows that of the three negative events (events 1-3), the major recall had the greatest negative impact on Toyota's returns. The NHTSA Report of 2011 led to substantially higher returns. This suggests that the report lifted the cloud of suspicion regarding the safety of Toyota automobiles. It also demonstrates how a government ruling in a product recall case can reduce market uncertainty and influence corporate returns.

To test for consistency of these results, we used various multifactor models and the Capital Asset Pricing Model and found the same results.

4.5 Concluding Remarks

The damage to a company's reputation may be far greater for a negative event that is caused by management error than one that is exogenous in nature. Investors understand that external events are outside the control of the firm and are a part of the normal course of business. On the other hand, investors are likely to punish companies more severely for management error, as it implies a deficient management team and corporate structure.

We estimate the extent to which accelerator pedal recalls affected the financial returns of the Toyota Motor Corporation. These involve a minor (floor mat) recall in 2007 and a major recall in 2010 to fix a mechanical problem with accelerator pedals on many Toyota models. Because of lingering concerns that

Toyota had not adequately fixed the problem, NHTSA continued its investigation, which culminated in a formal report in February of 2011. We also estimate the financial impact of this report on Toyota's returns.

This evidence supports three main conclusions. First, the 2007 minor recall had no significant effect on Toyota's returns. Second, the 2010 recall that involved 7.5 million vehicles lowered Toyota's returns by approximately 19 percent. Third, investors appear to place a high value on information that derives from unbiased experts. For Toyota, the cloud of uncertainty regarding the safety of its accelerator pedals was lifted once the NHTSA report confirmed that Toyota had corrected the problem. This confirmation pushed up Toyota's returns by almost 9 percent. The Toyota case is interesting because it shows how company error and government action can affect company returns.

Table 4.1 Operating Revenues by Company ($, Million)

Company	2000	2005	2006	2007	2008	2009	2010
Ford	170,064	176,896	160,123	172,455	146,277	118,308	128,954
General Motors	180,557	190,215	207,349	181,122	148,979	104,589	135,592
Honda[a]	52,170	84,338	94,310	119,801	100,971	91,854	107,985
Nissan[a]	49,110	80,584	88,717	108,405	85,093	80,485	106,006
Toyota[a]	106,030	179,083	202,864	262,394	208,995	202,901	229,503

Source : Standard and Poor's Automotive Sector Report, 2011
[a]: reported in March of the next year

Table 4.2 Share of US New Light Vehicle Sales

Year	Toyota	General Motors	Ford	Honda	Other Foreign Manufacturers[47]
2007	19.9	19.6	11.0	11.6	16.1
2008	19.9	18.5	10.5	12.9	17.4
2009	19.5	16.2	11.7	13.0	20.6
2010	17.1	14.3	12.4	12.3	23.3
2011	14.7	15.6	11.9	10.0	26.4

Source : Standard and Poor's Automotive Sector Report, 2011

[47] "Other foreign manufacturers" includes the US market share of foreign manufacturers and includes BMW, Hyundai, Kia, Mercedes/ Daimler and Volkswagen.

Table 4.3 Significant Events that May Have Affected the Economic Value of the Toyota Motor Corporation

Event	Date of the Event	Event Description
Event 1	September 26, 2007	55,000 Toyota Camry and Lexus ES350 vehicles were involved in an all-weather floor mat recall.
Event 2	August 28, 2009	Mark Saylor, an off-duty highway patrolman and his family die in a crash of Lexus ES350 because the accelerator was stuck to the floor mat.
Event 3	January 21, 2010	2.3 million vehicles (Camry, Corolla, RAV4, Matrix, Avalon, Highlander, Tundra, Sequoia) were recalled due to sticking accelerator pedals. This was in addition to a recall of 4.2 million vehicles to reduce entrapment of accelerator pedal by floor mat. 1.7 million vehicles were involved in both cases.
Event 4	February 8, 2011	NHTSA and NASA complete their study on electronic causes of unintended acceleration issues with Toyota vehicles and conclude that no electronic faults were involved.

Table 4.4 Estimation and Event Windows for Four Events with 11 Days in Event Window

Event	Estimation Window Date from-to (number of days)	Event Window Date from-to (number of days)
Event 1	09/27/2006 – 09/25/2007 (250 days)	09/26/2007 – 10/10/2007 (11 days)
Event 2	09/02/2008 – 08/27/2009 (250 days)	08/28/2009 – 09/14/2009 (11 days)
Event 3	01/23/2009 – 01/21/2010 (250 days)	01/22/2010 – 02/05/2010 (11 days)
Event 4	03/12/2010 – 02/07/2011 (230 days)	02/08/2011 – 02/23/2011 (11 days)

Table 4.5 Summary Statistics for Four Events

	Variable	Description	N	Mean ($\times 10^2$)	Std. Dev. ($\times 10^2$)	Min ($\times 10^2$)	Max ($\times 10^2$)
Event 1	R_{it}	returns from Toyota stock	250	0.0350	1.1346	-3.4261	3.7683
	R_{mt}	returns from S&P 500 index	250	0.0542	8.2573	-3.4725	2.9208
Event 2	R_{it}	returns from Toyota stock	250	0.0457	3.4204	-16.5236	14.1708
	R_{mt}	returns from S&P 500 index	250	-0.0466	2.8605	-9.0350	11.5800
Event 3	R_{it}	returns from Toyota stock	250	0.1683	2.0612	-5.4822	7.8878
	R_{mt}	returns from S&P 500 index	250	0.1309	1.6292	-4.9121	7.0758
Event 4	R_{it}	returns from Toyota stock	230	0.0517	1.2455	-2.8524	2.9449
	R_{mt}	returns from S&P 500 index	230	0.0659	1.1236	-3.8976	4.3974

Summary statistics are for the minimum (Min), mean, maximum (Max), and standard deviation (Std. Dev.).

TABLE 4.6 Regression Results for Four Events

	Event 1	Event 2	Event 3	Event 4
Dependent Variable	R_{it}	R_{it}	R_{it}	R_{it}
Intercept	-0.0001 (0.0006)	0.0009 (0.0013)	0.0006 (0.0010)	0.0001 (0.0006)
R_{mt}	0.7888[a] (0.0714)	0.9627[a] (0.0450)	0.8605[a] (0.0589)	0.7149[a] (0.0561)
N	250	250	250	230
$\bar{R}^2$	0.3268	0.6468	0.4604	0.4133

Standard errors in parentheses
[a]$p<0.001$, [b]$p<0.01$, [c]$p<0.05$.

Table 4.7 Abnormal Returns and Cumulative Abnormal Returns for Four Events of Toyota

Events 1 and 2

	Event 1 Floor Mat Recall		Event 2 Highway Accident	
Event Day	**Abnormal Return (SAR)**	**Cumulative Abnormal Return (SCAR)**	**Abnormal Return (SAR)**	**Cumulative Abnormal Return (SCAR)**
0	-0.0077	-0.0077	-0.0050	-0.0050
	(-0.830)	(-0.724)	(-0.245)	(-0.246)
1	0.0056	-0.0021	-0.0055	-0.0105
	(0.602)	(-0.143)	(-0.272)	(-0.369)
2	0.0212[b]	0.0191	0.0136	0.0031
	(2.277)	(1.112)	(0.666)	(0.089)
3	0.0058	0.0249	-0.0027	0.0004
	(0.615)	(1.170)	(-0.132)	(0.009)
4	-0.0041	0.0208	-0.0235	-0.0231
	(-0.439)	(0.894)	(-1.153)	(-0.510)
5	-0.0141[c]	0.0067	-0.0024	-0.0256
	(-1.510)	(0.271)	(-0.120)	(-0.510)
6	-0.0002	0.0065	-0.0104	-0.0359
	(-0.022)	(0.243)	(-0.509)	(-0.660)
7	0.0044	0.0109	-0.0151	-0.0510
	(0.471)	(0.373)	(-0.740)	(-0.873)
8	0.0000	0.0109	0.0155	-0.0355
	(0.002)	(0.357)	(0.760)	(-0.571)
9	-0.0196[b]	-0.0087	-0.0172	-0.0527
	(-2.098)	(-0.268)	(-0.842)	(-0.802)
10	-0.0131[c]	-0.0218	-0.0171	-0.0698
	(-1.402)	(-0.644)	(-0.841)	(-1.010)

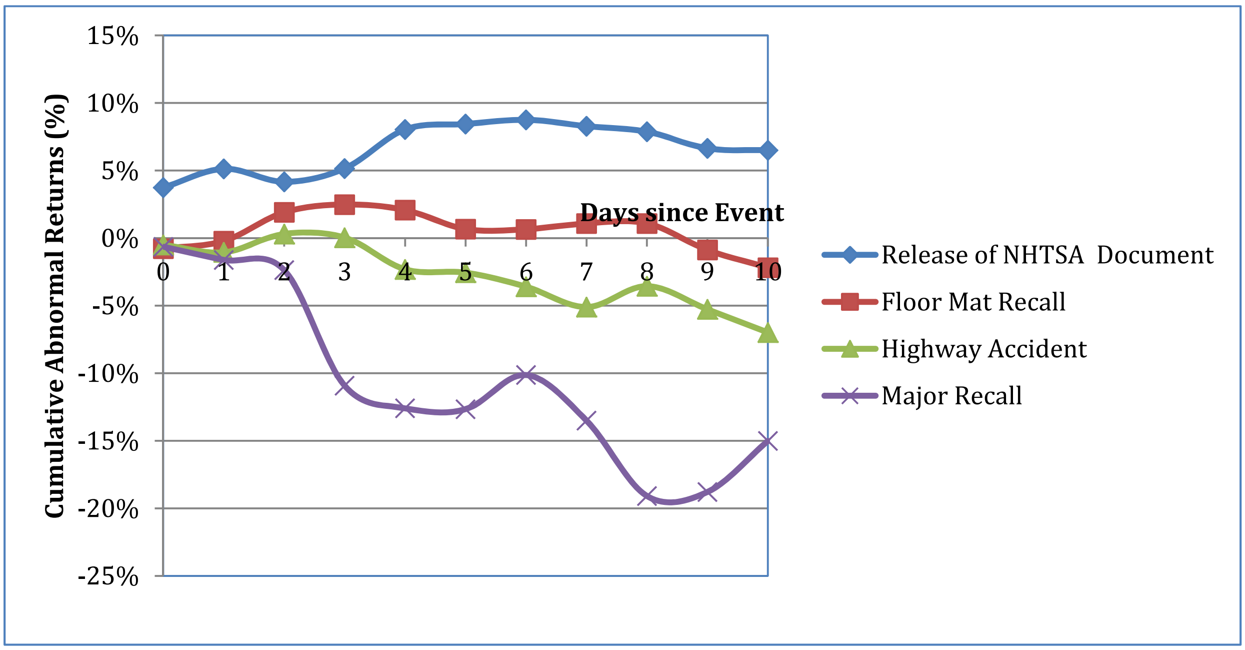
Standard errors in parentheses
[a]p<0.01, [b]p<0.05, [c]p<0.10.

Events 3 and 4

	Event 3 January 2010 Major Recall		Event 4 Release of NHTSA Document	
Event Day	**Abnormal Return (SAR)**	**Cumulative Abnormal Return (SCAR)**	**Abnormal Return (SAR)**	**Cumulative Abnormal Return (SCAR)**
0	-0.0064	-0.0064	0.0374 [a]	0.0374[a]
	(-0.419)	(-0.516)	(3.908)	(3.655)
1	-0.0097	-0.0161	0.0139 [c]	0.0513[a]
	(-0.641)	(-0.805)	(1.455)	(3.740)
2	-0.0075	-0.0237	-0.0096	0.0417[a]
	(-0.497)	(-0.950)	(-1.006)	(2.475)
3	-0.0855[a]	-0.1092[a]	0.0099	0.0515[a]
	(-5.638)	(-3.696)	(1.031)	(2.595)
4	-0.0167	-0.1259[a]	0.0289[a]	0.0804[a]
	(-1.100)	(-3.850)	(3.023)	(3.610)
5	-0.0007	-0.1266[a]	0.004	0.084[a]
	(-0.048)	(-3.547)	(0.417)	(3.500)
6	0.0254[b]	-0.1013[a]	0.0031	0.0875[a]
	(1.669)	(-2.560)	(0.326)	(3.314)
7	-0.0337[b]	-0.135[a]	-0.0047	0.0828[a]
	(-2.221)	(-3.136)	(-0.492)	(2.921)
8	-0.0558[a]	-0.1909[a]	-0.0041	0.0787[a]
	(-3.679)	(-4.186)	(-0.429)	(2.613)
9	0.0030	-0.1879[a]	-0.0123	0.0664[b]
	(0.194)	(-3.990)	(-1.277)	(2.165)
10	0.0378[a]	-0.1501[a]	-0.0014	0.065[b]
	(2.490)	(-3.017)	(-0.147)	(2.034)

Standard errors in parentheses
[a]p<0.01, [b]p<0.05, [c]p<0.10.

Figure 4.1 Cumulative Abnormal Returns of Toyota for Four Events Over Eleven day Event Window



Chapter 5

Conclusion

This dissertation investigated the effect of firm behavior on economic performance in three industries. Chapter 2 empirically investigated the effect of a decreasing number of firms in the mass producing segment of U.S. brewing industry. Chapter 3 analyzed the product life cycle of movies. It focused on the effect of advertising, product quality and substitutes on decay of movie sales over time. Chapter 4 estimated the effect of accelerator problems at Toyota on its market value and on the effect of a government investigation of this problem on Toyota's stock value.

The main result of Chapter 2 was that even though concentration in the mass producing segment of the U.S. macro-brewing industry increased, market power did not increase. We based this conclusion on two separate methods: the conventional New Empirical Industrial Organization (NEIO) approach and the method of Relative Profit Differences (RPD). To use the NEIO approach, we divided the period of study into different regimes based on intensity of advertising. We found that the Lerner Index of market power did not change significantly. The RPD approach required data from at least three different firms. We used variable profit data for the Anheuser Busch, Miller, Coors, Genesee and Boston Beer companies. The results from both methods led to the same conclusion. We found that the degree of competition did not decrease after the war of attrition came to an end in the 1990s. Hence, the industry remained competitive.

In Chapter 3, our main objective was to find out the effect of quality, advertising and substitutes on movie sales. We concluded that high advertising expenditures and movie quality helped prevent decay in sales. On the other hand, a greater number of new substitute movies shortened the life cycle of a movie. However, when we broke these effects down by genre, the effects were less palpable. Substitutes from the same genre seemed to have lower influence on the decay of movie sales as compared to substitutes from all genres. We found evidence of significant effect of the weekly decay parameters on change in movie sales. There was further evidence that this effect was consistent across genres and models.

In Chapter 4, we studied the effect of product recalls on the market value of Toyota. Toyota grew rapidly from 2000 to 2007, but Toyota's Chairman admitted that growth may have come at the expense of product quality. This led to a series of recalls due to problems with Toyota's accelerator pedals. We studied the effect of these recalls and found that the major recall of 2010 caused a significant loss in shareholder value. In addition, the National Highway Traffic Safety Administration conducted a study to determine Toyota had correctly fixed the problem. When results of this investigation concluded that Toyota' fix was correct, we found that the market value of Toyota increased.

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Appendices

Appendix A Regression Results for Movie Sales with Interacted Weekly Dummy

	Model 1 All	Model 2 All	Model 3 Action	Model 4 Comedy	Model 5 Drama	Model 6 Children
$\rho_{2,1}$	-5.267	-5.407	0.171	-9.874	-6.109	0.288
	(14.286)	(14.277)	(28.321)	(24.567)	(29.112)	(43.889)
$\rho_{3,2}$	15.083	15.211	-4.080	2.682	43.837	62.968
	(14.286)	(14.293)	(28.404)	(24.558)	(29.052)	(43.928)
$\rho_{4,3}$	62.510[a]	62.377[a]	63.766b	81.987[a]	54.095[c]	-18.515
	(14.286)	(14.279)	(28.201)	(24.571)	(29.058)	(45.137)
$\rho_{5,4}$	13.629	13.758	38.098	15.457	-6.335	-19.626
	(14.286)	(14.276)	(28.229)	(24.616)	(29.045)	(44.361)
$\rho_{6,5}$	40.647[a]	40.765[a]	30.335	13.956	53.175[c]	170.601[a]
	(14.286)	(14.276)	(28.220)	(24.566)	(29.050)	(44.420)
$\rho_{7,6}$	49.863[a]	50.323[a]	38.004	52.540[b]	98.723[a]	5.902
	(14.286)	(14.283)	(28.210)	(24.563)	(29.073)	(43.809)
$\rho_{8,7}$	19.042	21.700	6.784	31.052	45.219	7.701
	(14.286)	(14.299)	(28.268)	(24.615)	(29.045)	(43.804)
$\rho_{9,8}$	32.329[b]	33.356[b]	35.800	57.812[b]	35.729	-110.362[b]
	(14.286)	(14.280)	(28.192)	(24.559)	(29.220)	(43.844)
$\rho_{10,9}$	23.209	25.146[c]	41.861	21.131	22.764	50.561
	(14.286)	(14.291)	(28.193)	(24.610)	(29.057)	(43.829)
$a_{1\ 2,1}$	-0.000	-0.004	-0.001	0.111	-0.104	0.001
	(0.266)	(0.265)	(0.446)	(0.703)	(0.533)	(0.744)
$a_{1\ 3,2}$	0.010	0.009	-0.082	0.058	0.059	0.553
	(0.266)	(0.265)	(0.445)	(0.702)	(0.532)	(0.748)
$a_{1\ 4,3}$	-0.125	-0.129	0.487	-0.528	-1.166b	-0.161
	(0.266)	(0.265)	(0.446)	(0.704)	(0.538)	(0.747)
$a_{1\ 5,4}$	-0.359	-0.367	0.650	-0.338	-1.360b	-1.460[c]
	(0.266)	(0.266)	(0.445)	(0.702)	(0.535)	(0.750)
$a_{1\ 6,5}$	0.393	0.400	0.381	0.301	0.682	0.706
	(0.266)	(0.266)	(0.448)	(0.703)	(0.531)	(0.747)
$a_{1\ 7,6}$	0.145	0.144	0.485	-0.331	-0.050	0.323
	(0.266)	(0.265)	(0.445)	(0.702)	(0.532)	(0.744)
$a_{1\ 8,7}$	-0.336	-0.330	-0.296	-0.243	-0.480	0.093
	(0.266)	(0.265)	(0.446)	(0.703)	(0.533)	(0.744)
$a_{1\ 9,8}$	-0.414	-0.446[c]	-0.767[c]	0.752	0.266	-1.505[b]
	(0.266)	(0.266)	(0.445)	(0.705)	(0.533)	(0.744)
$a_{1\ 10,9}$	0.171	0.163	0.591	0.742	-0.046	-0.114
	(0.266)	(0.265)	(0.445)	(0.702)	(0.535)	(0.744)

	Model 1 All	Model 2 All	Model 3 Action	Model 4 Comedy	Model 5 Drama	Model 6 Children
$a_{2\ 2,1}$		-1.736	0.009	-2.795	-2.484	0.012
		(3.609)	(7.066)	(6.259)	(6.708)	(11.176)
$a_{2\ 3,2}$		0.584	1.801	-0.393	0.137	-1.697
		(3.333)	(6.595)	(5.387)	(6.609)	(9.828)
$a_{2\ 4,3}$		-1.244	2.761	-9.210	-1.881	2.465
		(3.412)	(6.482)	(5.603)	(6.560)	(12.895)
$a_{2\ 5,4}$		-2.419	-0.191	-5.824	-3.416	0.170
		(3.428)	(6.317)	(5.907)	(6.597)	(11.015)
$a_{2\ 6,5}$		-1.922	7.406	-8.345	-4.719	-5.894
		(3.212)	(6.214)	(5.290)	(6.366)	(9.759)
$a_{2\ 7,6}$		-3.026	-5.552	-3.052	-2.440	2.154
		(3.340)	(6.690)	(5.423)	(6.272)	(10.571)
$a_{2\ 8,7}$		-10.459[a]	-12.793[b]	-11.167[c]	-14.587[b]	10.333
		(3.306)	(6.358)	(5.770)	(6.162)	(10.024)
$a_{2\ 9,8}$		-8.860[a]	-16.930[a]	-7.992	-1.550	-6.537
		(3.289)	(6.313)	(5.416)	(6.464)	(10.281)
$a_{2\ 10,9}$		-9.611[a]	-18.912[a]	-6.433	-3.340	1.317
		(3.363)	(5.950)	(5.804)	(6.673)	(11.797)
$\alpha_{2,1}$	0.189	0.241	0.002	0.139	0.724	0.013
	(1.025)	(1.030)	(2.039)	(1.965)	(2.023)	(2.423)
$\alpha_{3,2}$	1.868[c]	1.851[c]	2.729	1.829	1.195	0.707
	(1.025)	(1.029)	(2.035)	(1.962)	(2.021)	(2.418)
$\alpha_{4,3}$	4.408[a]	4.443[a]	3.268	5.196[a]	7.425[a]	0.953
	(1.025)	(1.029)	(2.019)	(1.962)	(2.036)	(2.418)
$\alpha_{5,4}$	4.839[a]	4.934[a]	3.744[c]	2.624	7.841[a]	5.107[b]
	(1.025)	(1.034)	(2.022)	(1.967)	(2.050)	(2.457)
$\alpha_{6,5}$	3.673[a]	3.754[a]	2.176	5.932[a]	4.111[b]	3.864
	(1.025)	(1.034)	(2.012)	(1.977)	(2.044)	(2.462)
$\alpha_{7,6}$	3.404[a]	3.615[a]	3.555[c]	4.349[b]	3.140	1.931
	(1.025)	(1.051)	(2.092)	(1.977)	(2.054)	(2.547)
$\alpha_{8,7}$	4.179[a]	4.747[a]	6.292[a]	4.451[b]	3.557[c]	3.202
	(1.025)	(1.040)	(2.051)	(1.984)	(2.076)	(2.421)
$\alpha_{9,8}$	4.613[a]	5.278[a]	9.873[a]	1.717	-0.292	7.970[a]
	(1.025)	(1.054)	(2.054)	(2.026)	(2.074)	(2.469)
$\alpha_{10,9}$	2.459[b]	3.250[a]	1.104	3.496[c]	4.285[b]	3.104
	(1.025)	(1.061)	(2.067)	(1.999)	(2.155)	(2.488)

	Model 1 All	Model 2 All	Model 3 Action	Model 4 Comedy	Model 5 Drama	Model 6 Children
λ_1	13.335	16.793	-0.771	30.914	16.603	-1.221
	(46.844)	(47.355)	(92.973)	(80.111)	(101.002)	(152.186)
λ_2	-79.517[c]	-80.951[c]	-26.633	-34.718	-174.586[c]	-256.746[c]
	(46.844)	(47.517)	(93.647)	(79.678)	(99.524)	(154.091)
λ_3	-277.531[a]	-274.848[a]	-300.096[a]	-318.997[a]	-244.721[b]	45.765
	(46.844)	(47.381)	(91.741)	(80.190)	(99.668)	(163.763)
λ_4	-110.632[b]	-107.085[b]	-234.293[b]	-72.677	-33.906	49.717
	(46.844)	(47.075)	(91.101)	(80.383)	(99.887)	(151.736)
λ_5	-225.163[a]	-222.728[a]	-186.952[b]	-134.100[c]	-276.390[a]	-694.068[a]
	(46.844)	(46.983)	(91.069)	(79.566)	(99.854)	(152.009)
λ_6	-243.244[a]	-241.185[a]	-209.544[b]	-234.191[a]	-412.924[a]	-83.259
	(46.844)	(46.861)	(90.967)	(79.266)	(99.266)	(153.046)
λ_7	-141.968[a]	-138.274[a]	-105.595	-159.445[b]	-200.222[b]	-124.157
	(46.844)	(46.821)	(90.915)	(79.099)	(99.394)	(153.356)
λ_8	-190.052[a]	-183.958[a]	-234.535[b]	-255.156[a]	-149.319	305.244[b]
	(46.844)	(46.861)	(91.096)	(79.272)	(99.189)	(153.118)
λ_9	-152.043[a]	-150.109[a]	-186.996[b]	-148.299[c]	-166.041[c]	-254.999[c]
	(46.844)	(46.811)	(90.973)	(79.084)	(99.211)	(151.757)
N	11538	11538	3762	3960	2790	1026

Standard error in parenthesis

[c] $p<0.10$, [b] $p<0.05$, [a] $p<0.01$

	Model 7 Action	Model 8 comedy	Model 9 drama	Model 10 Children
$\rho_{2,1}$	0.168	-9.805	-5.146	0.295
	(28.273)	(24.630)	(29.059)	(43.654)
$\rho_{3,2}$	-2.317	2.467	43.783	64.968
	(28.414)	(24.596)	(29.085)	(43.713)
$\rho_{4,3}$	64.060[b]	83.024[a]	53.985[c]	-19.914
	(28.266)	(24.611)	(29.126)	(44.025)
$\rho_{5,4}$	38.618	17.078	-6.029	-20.534
	(28.271)	(24.586)	(29.063)	(44.013)
$\rho_{6,5}$	33.556	11.401	57.305[b]	167.665[a]
	(28.327)	(24.647)	(29.183)	(43.588)
$\rho_{7,6}$	37.194	51.963[b]	97.701[a]	3.881
	(28.253)	(24.612)	(29.075)	(43.658)
$\rho_{8,7}$	3.758	27.407	45.379	0.657
	(28.294)	(24.607)	(29.077)	(43.751)
$\rho_{9,8}$	37.155	57.229[b]	34.994	-108.936[b]
	(28.264)	(24.594)	(29.062)	(43.647)
$\rho_{10,9}$	39.824	21.731	23.701	50.995
	(28.268)	(24.806)	(29.076)	(43.577)
$a_{1\ 2,1}$	-0.001	0.119	-0.086	0.001
	(0.446)	(0.706)	(0.534)	(0.742)
$a_{1\ 3,2}$	-0.060	0.059	0.056	0.534
	(0.447)	(0.703)	(0.536)	(0.740)
$a_{1\ 4,3}$	0.486	-0.439	-1.146[b]	-0.169
	(0.446)	(0.705)	(0.534)	(0.742)
$a_{1\ 5,4}$	0.679	-0.339	-1.342[b]	-1.454[c]
	(0.449)	(0.704)	(0.534)	(0.742)
$a_{1\ 6,5}$	0.444	0.384	0.742	0.649
	(0.446)	(0.706)	(0.533)	(0.740)
$a_{1\ 7,6}$	0.483	-0.331	-0.047	0.353
	(0.446)	(0.703)	(0.532)	(0.742)
$a_{1\ 8,7}$	-0.334	-0.195	-0.399	0.030
	(0.446)	(0.705)	(0.533)	(0.741)
$a_{1\ 9,8}$	-0.824[c]	0.812	0.274	-1.493[b]
	(0.446)	(0.705)	(0.533)	(0.743)
$a_{1\ 10,9}$	0.494	0.735	0.063	-0.167
	(0.446)	(0.703)	(0.535)	(0.741)

	Model 7 Action	Model 8 comedy	Model 9 drama	Model 10 Children
$a_{2\ 2,1}$	0.015	-1.676	-7.030	-0.040
	(16.553)	(11.154)	(11.342)	(26.298)
$a_{2\ 3,2}$	12.779	2.771	0.696	13.252
	(14.229)	(9.613)	(13.137)	(33.965)
$a_{2\ 4,3}$	9.580	2.217	-1.013	4.865
	(13.713)	(9.971)	(13.581)	(42.734)
$a_{2\ 5,4}$	7.333	-1.841	-4.092	5.982
	(13.236)	(9.684)	(15.643)	(36.190)
$a_{2\ 6,5}$	11.866	-19.479[b]	18.839	-62.600c
	(13.982)	(9.661)	(13.860)	(36.404)
$a_{2\ 7,6}$	-5.868	-2.574	-6.667	-22.877
	(13.541)	(9.708)	(13.545)	(37.606)
$a_{2\ 8,7}$	-10.562	-4.264	7.763	49.730
	(13.988)	(10.900)	(11.624)	(38.022)
$a_{2\ 9,8}$	20.389	-5.095	-0.778	-2.833
	(13.479)	(9.796)	(12.482)	(26.198)
$a_{2\ 10,9}$	-19.894	7.357	18.454	-80.462[b]
	(13.426)	(10.239)	(14.312)	(35.559)
$\alpha_{2,1}$	0.002	0.054	0.554	0.013
	(2.016)	(1.957)	(2.032)	(2.408)
$\alpha_{3,2}$	2.664	1.795	1.198	0.562
	(2.023)	(1.955)	(2.021)	(2.432)
$\alpha_{4,3}$	3.319[c]	4.839[b]	7.359[a]	0.932
	(2.016)	(1.956)	(2.023)	(2.422)
$\alpha_{5,4}$	3.599[c]	2.415	7.754[a]	5.038b
	(2.031)	(1.963)	(2.052)	(2.451)
$\alpha_{6,5}$	2.072	5.690[a]	3.683[c]	4.814[c]
	(2.025)	(1.958)	(2.026)	(2.511)
$\alpha_{7,6}$	3.214	4.212[b]	3.028	2.127
	(2.040)	(1.960)	(2.022)	(2.408)
$\alpha_{8,7}$	5.567[a]	3.846[c]	2.499	3.426
	(2.019)	(1.967)	(2.024)	(2.408)
$\alpha_{9,8}$	8.501[a]	1.060	-0.397	7.670[a]
	(2.023)	(1.974)	(2.025)	(2.413)
$\alpha_{10,9}$	-0.133	2.898	3.723[c]	3.116
	(2.024)	(1.961)	(2.026)	(2.407)

	Model 7 Action	Model 8 comedy	Model 9 drama	Model 10 Children
λ_1	-0.755	27.033	13.087	-1.210
	(91.691)	(80.101)	(99.359)	(151.054)
λ_2	-36.693	-36.730	-174.410[c]	-267.080[c]
	(92.878)	(79.299)	(99.186)	(151.743)
λ_3	-302.106[a]	-341.771[a]	-247.562[b]	54.530
	(91.700)	(79.286)	(99.194)	(153.378)
λ_4	-240.933[a]	-85.477	-39.171	52.500
	(91.855)	(79.509)	(99.265)	(152.022)
λ_5	-192.125[b]	-128.166	-307.344[a]	-692.932[a]
	(92.113)	(79.772)	(100.515)	(151.074)
λ_6	-209.870[b]	-234.674[a]	-409.688[a]	-70.323
	(91.257)	(79.749)	(99.739)	(151.739)
λ_7	-103.963	-158.568[b]	-223.401[b]	-93.272
	(91.137)	(79.771)	(99.655)	(151.162)
λ_8	-264.018[a]	-258.790[a]	-148.268	293.549[c]
	(91.585)	(79.627)	(99.322)	(151.729)
λ_9	-181.849[b]	-160.368[b]	-182.853[c]	-237.688
	(91.710)	(81.011)	(99.864)	(151.231)
N	3762	3960	2790	1026

Standard error in parenthesis
[c] $p<0.10$, [b] $p<0.05$, [a] $p<0.01$

Appendix B Abnormal Returns and Cumulative Abnormal Returns for Four Events of Toyota with Twenty One Day Event Window

Events 1 and 2

	Event 1 Floor Mat Recall		Event 2 Highway Accident	
Day	Abnormal Return (SAR)	Cumulative Abnormal Return (SCAR)	Abnormal Return (SAR)	Cumulative Abnormal Return (SCAR)
-10	-0.0010	0.0138	0.0056	0.0264
	(-0.104)	(-0.104)	(0.276)	(0.282)
-9	-0.0135[c]	0.0002	-0.0014	0.0250
	(-1.457)	(-0.983)	(-0.069)	(0.152)
-8	0.0070	0.0072	0.0150	0.0400
	(0.754)	(-0.430)	(0.736)	(0.552)
-7	-0.0003	0.0069	0.0015	0.0415
	(-0.031)	(-0.407)	(0.072)	(0.509)
-6	-0.0144[c]	-0.0075	-0.0022	0.0393
	(-1.512)	(-0.897)	(-0.107)	(0.403)
-5	0.0103	0.0028	-0.0313[c]	0.0080
	(1.107)	(-0.440)	(-1.530)	(-0.251)
-4	0.0041	0.0070	-0.0072	0.0008
	(0.446)	(-0.277)	(-0.354)	(-0.364)
-3	-0.0058	0.0012	0.0067	0.0075
	(-0.625)	(-0.451)	(0.329)	(-0.225)
-2	0.0008	0.0019	0.0025	0.0101
	(0.083)	(-0.412)	(0.125)	(-0.171)
-1	0.0060	0.0079	-0.0051	0.0050
	(0.645)	(-0.209)	(-0.249)	(-0.239)
0	-0.0079	0.0000	-0.0050	0.0000
	(-0.854)	(-0.429)	(-0.245)	(-0.300)
1	0.0055	0.0055	-0.0056	-0.0056
	(0.589)	(-0.258)	(-0.273)	(-0.364)
2	0.0213[b]	0.0268	0.0135	0.0079
	(2.293)	(0.324)	(0.661)	(-0.171)
3	0.0054	0.0321	-0.0027	0.0052
	(0.576)	(0.443)	(-0.133)	(-0.199)
4	-0.0041	0.0280	-0.0235	-0.0183
	(-0.444)	(0.328)	(-1.150)	(-0.481)
5	-0.0140[c]	0.0140	-0.0024	-0.0207
	(-1.508)	(-0.018)	(-0.119)	(-0.493)
6	-0.0003	0.0137	-0.0104	-0.0310
	(-0.033)	(-0.025)	(-0.507)	(-0.596)
7	0.0041	0.0178	-0.0151	-0.0461
	(0.441)	(0.069)	(-0.738)	(-0.745)
8	0.0000	0.0178	0.0155	-0.0306
	(0.003)	(0.068)	(0.759)	(-0.556)
9	-0.0199[b]	-0.0020	-0.0172	-0.0478
	(-2.136)	(-0.359)	(-0.841)	(-0.722)
10	-0.0131[c]	-0.0151	-0.0171	-0.0649
	(-1.408)	(-0.625)	(-0.839)	(-0.878)

Standard error in parenthesis, [a] $p<0.01$, [b] $p<0.05$, [c] $p<0.10$.

Events 3 and 4

	Event 3 January 2010 Major Recall		Event 4 Release of NHTSA Document	
Day	Abnormal Return (SAR)	Cumulative Abnormal Return (SCAR)	Abnormal Return (SAR)	Cumulative Abnormal Return (SCAR)
-10	-0.0160	-0.0886	0.0041	-0.0378
	(-1.022)	(-0.995)	(0.434)	(0.432)
-9	0.0208[c]	-0.0678	-0.0217[b]	-0.0595
	(1.331)	(0.213)	(-2.303)	(-1.270)
-8	0.0034	-0.0644	0.0134[c]	-0.0461
	(0.219)	(0.298)	(1.424)	(-0.247)
-7	0.0461[a]	-0.0182[b]	-0.0133[c]	-0.0594
	(2.943)	(1.729)	(-1.405)	-0.972)
-6	-0.0108	-0.0290	0.0046	-0.0548
	(-0.689)	(1.223)	(0.488)	(-0.615)
-5	0.0172	-0.0118[c]	0.0016	-0.0532
	(1.100)	(1.553)	(0.172)	(-0.466)
-4	0.0114	-0.0004[b]	0.0224[a]	-0.0307
	(0.726)	(1.724)	(2.376)	(0.429)
-3	-0.0039	-0.0043[c]	-0.0055	-0.0362
	(-0.248)	(1.507)	(-0.579)	(0.203)
-2	-0.0174	-0.0217	-0.0012	-0.0374
	(-1.108)	(1.067)	(-0.132)	(0.149)
-1	0.0278[b]	0.0061[c]	0.0000	-0.0374
	(1.769)	(1.581)	(0.003)	(0.141)
0	-0.0061	0.0000[c]	0.0374[a]	0.0000
	(-0.388)	(1.405)	(3.962)	(1.258)
1	-0.0094	-0.0094	0.0139[c]	0.0139[c]
	(-0.598)	(1.164)	(1.473)	(1.612)
2	-0.0072	-0.0166	-0.0096	0.0043
	(-0.460)	(0.990)	(-1.017)	(1.282)
3	-0.0852[a]	-0.1017	0.0099	0.0142[c]
	(-5.437)	(-0.492)	(1.049)	(1.491)
4	-0.0164	-0.1181	0.0289[a]	0.0432[b]
	(-1.046)	(-0.745)	(3.064)	(2.179)
5	-0.0004	-0.1185	0.004	0.0471[b]
	(-0.026)	(-0.729)	(0.422)	(2.215)
6	0.0258[c]	-0.0928	0.0032	0.0503[b]
	(1.643)	(-0.307)	(0.335)	(2.212)
7	-0.0333[b]	-0.1261	-0.0047	0.0456[b]
	(-2.127)	(-0.787)	(-0.494)	(2.035)
8	-0.0555[a]	-0.1816[c]	-0.0041	0.0416[b]
	(-3.543)	(-1.560)	(-0.431)	(1.886)
9	0.0032	-0.1784[c]	-0.0124[c]	0.0292[c]
	(0.204)	(-1.488)	(-1.303)	(1.589)
10	0.0381[a]	-0.1402	-0.0014	0.0277[c]
	(2.435)	(-0.925)	(-0.151)	(1.525)

Standard error in parenthesis, [a] $p<0.01$, [b] $p<0.05$, [c] $p<0.10$

Appendix C Significance Levels of Abnormal Returns for Toyota Reported with Rank Test

Events 1 and 2

	Event 1 Floor Mat Recall	Event 2 Highway Accident
Event Day	**Abnormal Return (SAR)**	**Abnormal Return (SAR)**
0	-0.0077	-0.0050
	(-0.830)	(-0.245)
1	0.0056	-0.0055
	(0.602)	(-0.272)
2	0.0212[b]	0.0136
	(2.277)	(0.666)
3	0.0058	-0.0027
	(0.615)	(-0.132)
4	-0.0041	-0.0235[c]
	(-0.439)	(-1.153)
5	-0.0141[c]	-0.0024
	(-1.510)	(-0.120)
6	-0.0002	-0.0104
	(-0.022)	(-0.509)
7	0.0044	-0.0151
	(0.471)	(-0.740)
8	0.0000	0.0155
	(0.002)	(0.760)
9	-0.0196[b]	-0.0172
	(-2.098)	(-0.842)
10	-0.0131[c]	-0.0171
	(-1.402)	(-0.841)

Standard error in parenthesis
[a] $p<0.01$, [b] $p<0.05$, [c] $p<0.10$

Events 3 and 4

Event Day	Event 3 January 2010 Major Recall Abnormal Return (SAR)	Event 4 Release of NHTSA Document Abnormal Return (SAR)
0	-0.0064	0.0374[a]
	(-0.419)	(3.908)
1	-0.0097	0.0139[c]
	(-0.641)	(1.1455)
2	-0.0075	-0.0096
	(-0.497)	(-1.006)
3	-0.0855[a]	0.0099
	(-5.638)	(1.031)
4	-0.0167	0.0289[a]
	(-1.100)	(3.023)
5	-0.0007	0.0040
	(-0.048)	(0.417)
6	0.0254[c]	0.0031
	(1.669)	(0.326)
7	-0.0337[b]	-0.0047
	(-2.221)	(-0.492)
8	-0.0558[a]	-0.0041
	(-3.679)	(-0.429)
9	0.003	-0.0123[c]
	(0.194)	(-1.277)
10	0.0378[b]	-0.0014
	(2.490)	(-0.147)

Standard error in parenthesis
[a] p<0.01, [b] p<0.05, [c] p<0.10