2014

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

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January 05, 2014

Abstract: We analyze the effect of Toyota's faulty accelerator pedal on stockholder wealth. Using the event study methodology, we show that a major recall in January of 2010 caused the company's cumulative abnormal returns to fall by 19%. 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 and caused Toyota's cumulative abnormal returns to rise by almost 9%. The Toyota case provides an opportunity to study a product recall with both company error and a government action that addressed concerns about the safety of the product.

JEL Classification: G140, K130, L620

Keywords: Toyota recall, event study analysis, product liability

Acknowledgements: We wish to thank Rolf Färe, Shawna Grosskopf, and Carol Tremblay for their helpful comments on an earlier version of the paper.

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I. Introduction

There is a saying in business that if a company loses its resources but retains its reputation, it can rebuild, but money cannot bring back a company that loses its reputation. To build consumer loyalty, a company must offer reliable products at a reasonable price. The process of building a reputation for reliability and value can take decades, and a major misstep can tarnish a company's reputation for many years. Product recalls are potential reputation harming events.

Large cross-sectional studies on product recalls (for example see Kini, Shenoy, and Subramaniam 2013) suggest that firms experience significant declines in sales, often increase advertising to counter the lost reputation, and can use their brand loyalty to offset some of the adverse consequences. But the problem with large cross-sectional studies is that the number of incidents is so high that the market may be insensitive to many of these frequent events. In fact, the market may believe it is just part of the normal business cycle. The sample used by Kini, Shenoy, and Subramaniam had 816 events over a five year period, or approximately one recall every two and a half days. Others have elected to review a specific industry for more insight. The auto industry recalls have been examined by Jarrell and Peltzman (1985), Hoffer, Pruitt and Reilly (1988), and Barber and Darrough (1996). The drug industry recalls by Amned, Gardella, and Nonda (2002). The food industry recalls by Thomsen and McKenzie (2001). All find that, in general, recall events are value destroying events. But clearly, with an event every two days or so, not all recalls are value destroying events. What does it take for a recall to rise to the level that it harms the firm?

When looking at a firm specific case, an individual recall might not have a negative impact on the company or one that is short-lived. A classic example is Johnson and Johnson's recall of its non-aspirin pain reliever, Tylenol (Dowdell, Govindaraj, and Jain (1992) and Mitchell, (1989)). During a three day period beginning 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 all Tylenol brands to immediately fall from 37 to 7 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 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.

In this paper, we investigate the financial effect of a major product recall on the stock returns of the Toyota Motor Corporation. We select this case because unlike the Tylenol case with Johnson and Johnson, the recall was based on internal issues with manufacturing and not external issues outside the control of the company. From January 2000 to January 2010, there were reports of 52 deaths linked to Toyota vehicles with uncontrolled acceleration (Manning and Raum, 2010). This led to recalls in 2007 and in 2010 involving approximately 7.5 million Toyota vehicles. At first, there was uncertainty regarding the cause of the problem.

Toyota initially announced that the defect 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 the defect. Thus, the Toyota case provides an opportunity to study the effect of four distinct events around the product recall. The initial event is an announced investigation by the National Highway Traffic Safety Administration (NHTSA) following consumer complaints. The second event is a news event surrounding a highway fatality linked to the acceleration problem. A third event is the company announcement of a design flaw in the accelerator. The fourth event is study released by NHTSA completed by NASA engineers that absolved Toyota. By studying these four incidents in a case study format we can provide additional insight into when a recall incident may have a negative, long lasting impact and when a recall incident may have no impact. .

Our goal in this paper is to use a case study of Toyota and the event study method to estimate the impact on Toyota's stock returns of the events related to Toyota's accelerator pedal problems. We want to see if these four events have an impact given the high brand loyalty for Toyota, source of the information (public or company release) and if a good outcome (NHTSA report) after the fact, can reverse the original negative impact. Our results indicate that all events are not the same and products recalls may require special circumstances to elicit a negative reaction by the market. Section II discusses the timeline of events. Section III discusses the event study method. Section IV describes the data and empirical results. Section V provides concluding remarks.

II. Toyota and the Accelerator Pedal Recall

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 1, one can observe that the operating revenues of Toyota surpassed those of the Ford Motor Company in 2005 and General Motors in 2007. Table 2 shows that Toyota had the largest U.S. market share in light vehicle sales in 2007 and 2008.[1]

[Insert Tables 1 and 2 About Here]

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. 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 before it hit Johnson's car.[2] This event was probably the tipping point that caused the NHTSA to look closely at the accelerator problems with Toyota vehicles. After detailed investigations, Toyota concluded that the accident was 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

[1] These include cars, sport utility vehicles, and light trucks (pick-up trucks but not heavy trucks). Source: *Financial Times Lexicon* at http://markets.ft.com/research/Lexicon/Term?term=light-vehicle-sales accessed March 29, 2013

[2] We also investigated the abnormal returns of Toyota following Troy Johnson's accident but abnormal returns were small and insignificant.

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 several Toyota and Lexus models (2007-2010 Camry, 2005-2010 Avalon, 2004-2009 Prius, 2005-2010 Tacoma, 2007-2010 Tundra, 2007-2010 Lexus ES350, and 2006-2010 Lexus IS250 and Lexus IS350) to remove and not replace their floor mats 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 problem was also caused by an accelerator pedal design flaw. 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.[3]

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.[4]

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

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

[4] 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.

minutes of mechanic time to complete. Nevertheless, there remained persistent concerns that the problem was electronic rather than mechanical in nature. This led the U.S. Congress to request that NHTSA continue its investigation of the causes of unintended acceleration of Toyota automobiles in March, 2010.[5] 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 stock 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 minor effect relative to the 2010 recall that involved 2.3 million Toyota vehicles. Given the extensive media coverage that it received, the death of Mark Saylor may have had a significant negative effect on Toyota's returns. Finally, when the NHTSA study lifted the cloud of uncertainty surrounding the reliability of Toyota automobiles, one might expect that this information substantially lifted Toyota's returns.

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

III. Event Study Analysis

We use the event study method to appraise the effect of each event on Toyota's stock returns. This methodology was developed by Ball and Brown (1968) and Fama et al. (1969). For more recent reviews of this method, see Thomson (1985), Armitage (1995), MacKinlay (1997), Bhagat and Romano (2002a, 2002b) and Corrado (2011). 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). 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 stock i at time t (R_{it}), is a function of all available market information, which is typically measured as the market return on a large portfolio of stocks (R_{mt}).[6] The market model assumes a stable linear relationship:

$$R_{it} = \alpha_i + \beta_i R_{mt} + \varepsilon_{it}, \qquad (1)$$

$$\varepsilon_{it} \sim N(0,\ \sigma^2),$$

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

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

$$AR_{i\tau} = R_{i\tau} - E(R_{i\tau}|R_{m\tau}), \qquad (2)$$

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 that the event had never occurred.

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[6] In applications, the Standard & Poor 500 Index (S&P Index) is used for the market portfolio.

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.[7] Let T_{pre} be the number of observations (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} extends into several periods after $\tau = 0$.

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 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 market data from W_{event} are used to forecast normal returns during the event window, $(R_{i\tau}|R_{m\tau})$. Thus, the abnormal return at time t is

$$AR_{i\tau} = R_{i\tau} - E\left(\widehat{R}_{i\tau}\middle|R_{m\tau}\right). \tag{3}$$

For the classic market model,

$$AR_{i\tau} = R_{i\tau} - \left(\widehat{\alpha}_i + \widehat{\beta}_i R_{m\tau}\right). \tag{4}$$

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

$$CAR_{i\tau} = \sum_{t=\tau_1}^{\tau_2} AR_{i\tau}. \tag{5}$$

[7] 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.

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 Toyota events discussed above.

Following the classic market model, we can estimate CARs using alternate specifications. In another specification, we use the Fama French 3-factor model, regressing stock returns on index of market capitalization (SMB_{mt}) and index of value to growth stocks (HML_{mt}) in addition to the S&P 500 market returns.

$$R_{it} = \alpha_i + \beta_i R_{mt} + \beta_i^{SMB} SMB_{mt} + \beta_i^{HML} HML_{mt} + \varepsilon_{it} \quad (6)$$

In yet another specification, the 3-factor model is augmented by a momentum factor (MOM_{mt}) on winners and losers for the market in addition to SMB_{mt}, HML_{mt} and R_{mt}.

$$R_{it} = \alpha_i + \beta_i R_{mt} + \beta_i^{SMB} SMB_{mt} + \beta_i^{HML} HML_{mt} + \beta_i^{MOM} MOM_{mt} + \varepsilon_{it} \quad (7)$$

To account for risk, we also employ the Capital Asset Pricing Model, which uses the correlation of riskiness of a stock to the riskiness of the market to predict AR and CAR. This model uses risk free rate (the interest rate on the 1-month treasury bill) in the equation below,

$$R_{it} = R_{ft} + \beta_i (R_{mt} - R_{ft}) + \varepsilon_{it} \quad (8)$$

Some Robustness Tests

1. Traditional Parametric Tests

Traditional parametric tests have been discussed in Patell, 1976; Brown and Warner, 1985; Salinger, 1992; Mackinlay, 1997; McWilliams and Siegel, 1997; McWilliams and McWilliams,

2000. These tests generally assume that AR_{it} is independently and identically distributed with mean zero and variance $\sigma^2(AR_{it})$. In this case,

$$\sigma^2(AR_{it}) = \sigma^2\left(1 + \frac{1}{T_{pre}} + \frac{(R_{mt} - \bar{R}_m)^2}{\sum_{\tau \in W_{pre}} (R_{m\tau} - \bar{R}_m)^2}\right) \quad (9)$$

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. 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 abnormal returns are not significantly different from zero during the event window. In order to compute the test statistic for abnormal returns, we standardize each daily abnormal return

$$SAR_{i\tau} = AR_{i\tau}/\sigma(AR_{i\tau}). \quad (10)$$

$SAR_{i\tau}$ 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

$$\sigma^2(CAR_{it}) = \sigma^2\left(k + \frac{k^2}{T_{pre}} + \frac{\sum_{\tau_1}^{\tau_2} R_{m\tau} - k(\bar{R}_m)^2}{\sum_{\tau \in W_{pre}} (R_{m\tau} - \bar{R}_m)^2}\right), \quad (11)$$

Parameter k is the day within the event window. 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 for standardized cumulative abnormal returns (SCAR)

$$SCAR_{i\tau} = CAR_{i\tau}/\sigma(CAR_{i\tau}) \quad (12)$$

2. Nonparametric Rank Test

We also use a non-parametric test which dispenses with a distributional assumption for abnormal returns. This test was initially developed by Corrado (1989, 2011). It requires that we calculate abnormal returns for the event window and arrange abnormal returns in increasing order, ranking these returns 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. The test statistic is constructed as:

$$Z_\tau = \frac{4.91}{\sqrt{m}}\left(u_{i\tau}^{0.14} - (1 - u_{i\tau})^{0.14}\right), \tag{13}$$

where m is the number of firms in the sample (which equals 1 here) and Z_τ is close to the standard normal distribution even for small values of m. The null hypothesis is that AR for day τ is not significantly different from zero.

IV. The Data and Estimation Results

The raw data include stock prices 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 the Toyota's stock price (plus dividends per share). We investigate the four events that were discussed above.

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 3.

[Insert Table 3 About Here]

Dates of the estimation and event windows are presented in Table 4. The estimation window equals 250 trading days for events 1 through 3.[8] The estimation window for the NHTSA Report (event 4) is only 230 days.[9] The starting date is March 12, 2010 in order to avoid contamination from news associated with the January recall. 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) and ends 10 trading days after the event.[10] Eleven day event window may be appropriate for the major recall because the dissemination of new information about the recall continued for more than a week. We consider 11 day event windows for each event.[11] Table 5 provides summary statistics of the data for each event. 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.

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[8] 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 20 days after the accident. Whether we use a window of 250 or 79 days, the results are essentially the same.

[9] In order to account for a possible change in relationship between R_{it} and R_{mt} due to previous events, we also used a common estimation window of 250 days which was used for the first event to predict abnormal returns and cumulative abnormal returns for all event windows. This did not change the results. We also performed the CUSUM test of the hypothesis that there was a structural break during each estimation window. No evidence of a structural break was detected.

[10] 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.

[11] 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).

[Insert Tables 4 and 5 About Here]

OLS parameter estimates of the using data from the event window for each event are listed in Table 6.[12] 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 7 presents estimates of the Abnormal Returns (ARs) and the Cumulative Abnormal Returns (CARs). To analyze the null hypothesis that each event had no effect on excess returns, we first use parametric tests. For the floor mat recall (event 1), only one AR (day 2) is significantly different from zero, but it is positive. 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 company values and returns 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 were 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 5 percent level. The CARs are negative and are significantly different from zero at 1 percent for days 3 through 10. By day eight, CAR fell to 19.09 percent. Thus, Toyota lost a substantial amount of market value, suggesting that the event was

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[12] We tested for autocorrelation in the model with the S&P 500 Index using the Durbin Watson test, but found no evidence of autocorrelation.

unanticipated and significant enough to cause investors to believe that this would cause a drop in 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 are significant at 5 percent. 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 pedal problem.

[Insert Tables 6 and 7 About Here]

Next, we carry out non-parametric rank test for the significance of ARs in each event. The test produces results that are consistent with those from the parametric test and are available from the authors upon request. To test the robustness of our results, we also estimated excess returns using various multifactor models. Each specification produced the same results.

The empirical results are broadly consistent with our expectations. To visualize this, Figure 1 plots the CARS for each event during the event window. 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.

[Insert Figure 1 About Here]

V. Concluding Remarks

The damage to a company's reputation may be far greater from an event that is caused by management error than from a negative exogenous event. 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.

The evidence supports three conclusions. First, the 2007 minor recall had no significant effect on Toyota's returns and illustrates that not all recalls are harmful to the firm but rather normal business. Second, the negative news event of the highway crash did not have a significant impact on share prices. Apparently it was not clear that the crash was in fact the result of design problems with the automobile. Third, the 2010 recall that involved 7.5 million vehicles and had acknowledgement from the company of a potential design flaw had a significant impact on Toyota's returns with a negative 19 percent change. Fourth, 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 had a significant and positive impact on Toyota's returns by almost 9 percent.

The questions now become, what additional information beyond the product recall itself is necessary for a harmful impact to a firm? Can a subsequent major news release following the recall on the potential problems illicit a negative reaction by the market? And, what role does outside reviewers (government agencies or other organizations looked upon as experts in the field) play in mitigating or exacerbating the reaction to product recalls?

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Table 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 each year

Table 2: Market Share of New Light Vehicle Sales in the U.S.

Year	Toyota	General Motors	Ford	Honda	Other Foreign Manufacturers[a]
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
[a]These include BMW, Hyundai, Kia, Mercedes/Daimler, and Volkswagen.

Table 3: Important Events Associated with Toyota's Accelerator Pedal Problems

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: 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 5: Summary Statistics for the 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

Table 6: Regression Results for the Four Events

	Event 1	**Event 2**	**Event 3**	**Event 4**
Dependent Variable	R_{it}	R_{it}	R_{it}	R_{it}
Intercept	-0.0001	0.0009	0.0006	0.0001
	(0.0006)	(0.0013)	(0.0010)	(0.0006)
R_{mt}	0.7888[a]	0.9627[a]	0.8605[a]	0.7149[a]
	(0.0714)	(0.0450)	(0.0589)	(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 7: Abnormal Returns and Cumulative Abnormal Returns for Events 1-4

	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 (-0.830)	-0.0077 (-0.724)	-0.0050 (-0.245)	-0.0050 (-0.246)
1	0.0056 (0.6020)	-0.0021 (-0.143)	-0.0055 (-0.272)	-0.0105 (-0.369)
2	0.0212[b] (2.277)	0.0191 (1.112)	0.0136 (0.666)	0.0031 (0.089)
3	0.0058 (0.615)	0.0249 (1.170)	-0.0027 (-0.132)	0.0004 (0.009)
4	-0.0041 (-0.439)	0.0208 (0.894)	-0.0235 (-1.153)	-0.0231 (-0.510)
5	-0.0141[c] (-1.510)	0.0067 (0.271)	-0.0024 (-0.120)	-0.0256 (-0.510)
6	-0.0002 (-0.022)	0.0065 (0.243)	-0.0104 (-0.509)	-0.0359 (-0.660)
7	0.0044 (0.471)	0.0109 (0.373)	-0.0151 (-0.740)	-0.0510 (-0.873)
8	0.0000 (-0.002)	0.0109 (0.357)	0.0155 (0.760)	-0.0355 (-0.571)
9	-0.0196[b] (-2.098)	-0.0087 (-0.268)	-0.0172 (-0.842)	-0.0527 (-0.802)
10	-0.0131[c] (-1.402)	-0.0218 (-0.644)	-0.0171 (-0.841)	-0.0698 (-1.010)

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

Table 7, Continued

	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]	0.0040	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]	-0.1350[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	0.0650[b]
	(2.490)	(-3.017)	(-0.147)	(2.034)

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

Appendix A: Abnormal Returns and Cumulative Abnormal Returns for Events 1-4, Twenty One Day Event Window

	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)

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

Appendix A, Continued

	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	0.0040	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)

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

Figure 1: Cumulative Abnormal Returns of Toyota for Four Events Over Eleven day Event Window