THE IMPACT OF AUTOMOBILE RECALLS ON STOCK PRICES

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UCSB
Allen Chris Stephan
Advisor: Prof. Ted Frech

Abstract

The impact of automobile recalls on stock prices hasn't been investigated on a large scale since the 1980s. Based on a sample size of 201 recalls spanning from 1980 to 2016 in the United States, we investigate the impact of a recall on stock prices using event study methodology. We found that the automobile recall announcements generated statistically insignificant Average Cumulative Abnormal Returns (ACAR) in the main event windows (-5,5), (-2,2). Furthermore, we investigated whether the impact depends on overall market conditions, and found no significant difference in the ACAR generated by recalls during periods of economic expansion or recession.

Introduction

An automobile recall occurs when a car has a defect (often, a safety related one). The automaker alerts the owners to the problem and usually offers a free repair. The automaker bears a direct financial cost related to the repairs of the affected cars, and indirect financial losses due possibly to the deterioration of its brand image, litigation, etc. There is no doubt then that automobile recalls result in negative cash flows for the automaker.

It is difficult to estimate the financial loss that is due to a deterioration of the company's image. But if we place ourselves in the model of an efficient market, the impact of automobile recalls should be quantifiable by looking at their immediate effect on stock prices. One could study such an effect with the use of event study methodology. Our research question becomes: how does an automobile recall impact stock prices? As a follow-up question, we shall also test whether the impact depends on outside conditions, such as whether the recall occurs in a period of recession or a period of expansion. Our sample size contains over 200 recalls from the United States, by far

the largest sample size of any paper investigating the impact of automobile recalls on stock prices.

First, we shall review literature pertaining to the research question. Second, we shall present our empirical strategy. Third, we shall describe the collected data and how it was cleaned. Fourth, we shall present the results of our research. And fifth, we shall discuss conclusion and further possible questions.

Literature Review

Jarrell and Peltzman (1985) were the first researchers to examine the impact of product recalls on shareholders' wealth. They used event study methodology on a sample of 63 automobile recalls from 1975 to 1981 and found that the affected companies bore greater financial costs than the direct costs of the recalls. The direct costs of the recalls are difficult to estimate directly; Jarrell and Peltzman made the assumption that the cost of each recalled unit is the market value of the unit at the time of the recall. They also found that the competitors of the auto firms with recalled products also bear significant losses.

Hoffer, Pruitt and Reilly (1988) recreated the Jarrell and Peltzman study. After reclassifying the original data and correcting some methodological problems by defining "clean windows" for recalls (a recall with a "clean window" doesn't overlap with any other recall), the sample size was reduced to 29 recalls. The study period remained the same. The researchers found that only one recall had a significant effect on the stock price of the affected company, and found no significant effect on the competitors.

These are the only two papers focusing on the impact of automobile recalls on stocks in the United States. The literature is clearly not abundant. There are other papers that study the impact of a single automobile recall on the company stock, given special conditions (law verdicts, government actions, etc.). Besides lacking in quantity, the current literature also presents several limitations. First, the sample size for both papers is small – less than 100. Second, the study periods only spanned a period of 6 years. Third, the studies were conducted 30 years ago, in the 1980s. An additional limitation is that the studies do not agree with one another regarding the effect of automobile recalls on stock prices.

These four limitations alone are sufficient to justify a re-examination of the effect of automobile recalls on stock prices, with an expanded study period from 1980 to 2016. Due to the length of the study period, the data sample will be considerably larger than any of the previous studies, which is a considerable advantage.

It is also important to note that the current literature does not interest itself in figuring out whether the effects are different in periods of recession or expansion. To the best of our knowledge, no paper has attempted to look at whether negative events affects stock prices in the same way in period of recession and expansion. This would be the first paper to do so, using automobile recalls as negative events.

The methodology used to determine the impact of an event on a stock price is called event study methodology, and is well-documented. This paper shall use the same methodology, which shall be explained in detail in the following section.

Empirical Strategy

Event study methodology is a well-documented methodology used to study impact of events on stock prices. We shall follow the steps in event study methodology that were used in Zhao, Lee, Ng and Stephen (2009), in their paper which estimated the impact of product recalls on the stock prices publicly listed companies in China. These steps are taken from the aforementioned paper and outlined below.

Step 1: Obtaining the estimated parameters for computing the expected normal return of stock i on day t.

The market model is derived from the Capital Asset Pricing Model (CAPM), which posits a linear relation between a firm's stock return and the market return as the following equation (1):

(1): $$R_{it^*} = \alpha_i + \beta_i \cdot R_{mt^*} + \varepsilon_{it^*}$$

R_{it^*} is the actual return of stock i on each day t* of the estimation period; α_i is the intercept of the relationship for stock I; β_i is the slope of the relationship of stock I with the market return; ε_{it} is the error term with $E(\varepsilon_{it})=0$ and $V(\varepsilon_{it})=S_i^2$.

We'll estimate α_i, β_i, S_i^2 (hats) using ordinary least squares (OLS), over an estimation period of 120 trading days. Wet the day of product recall announcements to be day 0 and used a 5-day and 1-day event period, , which includes day 0 and the four days (and 1 day, for the 1-day event period) following the recall announcement. To prevent any bias through the potential leakage of information, we make the estimation period end 10 trading days before the announcement; that is, the estimation period will be days (-130,-11)

Step 2: We compute the normal return of stock i on each day t of the event period.

We use the parameters estimated in the first step to compute the normal return of stock i on each day t of the event period, using equation (1) below:

(1) : $E(R_{it}) = \hat{\alpha}_i + \hat{\beta}_i \cdot R_{mt}$

Step 3: We compute the abnormal return (AR) of stock i on each day t of the event period.

In event study methodology, the abnormal return is an important index for measuring the impact of the unanticipated information release on the security price. We derive estimates of daily abnormal return (AR) for the i^{th} company as the difference between the actual return of stock on day and the estimated normal return of stock on day i, which is shown in equation (2). The daily average abnormal return for all sample companies on day t is shown in equation (3), with N the number of sample companies on day t. We'll use a t-test to test the statistical significance of the average abnormal return, shown in equation (4).

(2): $AR_{it} = R_{it} - \alpha_i - \beta_i \cdot R_{mt}$; (3): $AAR_t = \sum_{i=1}^{N} AR_{it} / N$; (4): $t = \sum_{i=1}^{N} \frac{AR_{it}/S_i}{\sqrt{N}}$

Step 4: We'll compute the cumulative abnormal return (CAR) of stock i in the event period, using equation (5).

(5): $CAR_i(t_1, t_2) = \sum_{t=t_1}^{t_2} AR_{it}$

Step 5: We compute the average cumulative abnormal return (ACAR) of the sample firms in the event period, using equation (6). We then use a t-test to test the statistical significance of the average cumulative abnormal return – see equation (7).

(6): $ACAR_t(t_1,t_2)=\frac{1}{N}\sum_{i=1}^{N}CAR_i(t_1,t_2)$; (7): $t=\sum_{i=1}^{N}\frac{\sum_{t=t_1}^{t=t_2}AR_{it}\Big/\sqrt{\sum_{t=t_1}^{t=t_2}\hat{S}_i^{\,2}}}{\sqrt{N}}$

Data

3 main datasets are required for the completion of the steps outlined in the section above.

The first data set contains all automobile-related recalls in the United States from 1967 to 2016. The source of the data set is the National Highway Traffic Safety Administration (NHTSA), an official government unit. The data includes many variables, with the relevant ones being: vehicle make, vehicle model, model year, vehicle manufacturer, recall type, recall component, manufacture start date, manufacture end date, estimated units, recall manufacturer, and recall notification date. The raw data includes over 150,000 rows of data, which was cleaned following a few criteria. We only included recalls with more than 250,000 estimated cars recalled – smaller recalls might not have large effects on stock prices. We only included recalls occurring after 1980. We also eliminated recalls by Chrysler – it was owned by many companies during the estimation period, and following the effect of the recall on the parent companies wouldn't be accurate. We converted the data into time-series data with each event representing the total estimated units recalled by manufacturer (and not by model). The data set was reduced to a clean 201 observations. Below is a table detailing the size and frequency of the automobile recalls, followed by a table with descriptive statistics.

Bin	*Number of Recalls*
250k - 500k	109
500k - 750k	37
750k - 1M	16
1M - 1.25M	13
1.25M - 1.5M	7
1.5M - 1.75M	3
1.75M - 2M	3
2M - 2.5M	3
2.5M - 3M	3
3M+	7
Total	201

Table 1: Size and frequency of automobile recalls included in our dataset.

Sample Size	201
Mean recalled units per recall	748,423
Study Period	1980-2016
Max # of recalled units	6,281,043
Min # of recalled units	250,433

Table 2: Descriptive statistics regarding the automobile recalls included in our dataset.

The second data set is a compilation of stock prices for all automobile companies that suffered a recall from 1980 to 2016. This time-series data was downloaded from Thomson Reuters Eikon and contains daily closing prices. Also included in this data set is the daily market return for countries in which the companies are based, also downloaded from Thomson Reuters Eikon.

The third data set is time-series data, with a daily frequency, which takes the value of 1 if in a recessionary period, 0 otherwise. This data will be superimposed with the first data set, and will allow us to estimate the difference in the impact of similar automobile recalls in periods of recession and expansion. The data set was downloaded from the Federal Reserve Bank of St. Louis.

Results/Evidence

We ran multiple event-studies and with 5 different event windows. A smaller event window, in theory, better captures the effect of the event on stock prices, because it would allow only the events contained in the event window to affect the stock prices. A larger event window contains more events that might affect the stock prices, thus diluting the effect of the studies effect (the automobile recall). However, additional information regarding the recall is sometimes released a few days after the initial announcement of the recall. So, we've decided to run the event-studies with both very narrow and somewhat wide event windows.

The results of the 5 event-studies are presented in the table below.

Grouping	Event Window	ACAR	pos:neg CAR	Sample Size	t-value	# Significant Events	Is the ACAR significant?
All	(-5, 5)	0.003	99:102	201	0.8589	19	No
All	(-2, 2)	0.0006	103:98	201	0.2323	26	No
All	(0, 5)	0.0004	96:105	201	0.1575	16	No
All	(0, 2)	0.0003	108:93	201	0.1695	19	No
All	(0, 1)	-0.0007	110:91	201	-0.3707	23	No

Table 3: Results of the 5 event-studies with 5 different event windows

The second column clarifies the event window used. The third column, ACAR, is the Average Cumulative Abnormal Return (ACAR). It is the additional return, on average over the sample size of 201, that would be due to an automobile recall. The fourth column, "pos:neg CAR", describes the number of events that led to a positive Cumulative Average Return and a negative Cumulative Average Return. The two last columns present the number of recalls that had a significant effect on the stock prices, and whether the ACAR is significant.

From the table above, we can see the for all event windows, the ACAR is not significant. This means that the firms lost an average of 0.00% of their share price as a result of a recall. In other words, automobile recalls have no effect on the stock prices, on average. While there were a few significant events in each sample size, the majority of the events were not significant. We took a closer look at the 26 significant events for the (-2,2) event window to determine whether they had shared characteristics. The average size of the recall for that sample was c.897k, compared to c.750k, which is larger, but not significantly so. The proportion of recalls with over a million units was roughly the same in both samples. The distribution of the companies present in the samples were fairly similar, with Toyota being represented more in the significant events sample. The details are presented below in the form of a table.

Company	# Units Recalled	Description of Defect
BMW	516,791	ELECTRICAL SYSTEM: ELECTRICAL SYSTEM:BATTERY:CABLES: FUSES AND CIRCUIT BREAKERS
GM	554,328	ELECTRICAL SYSTEM:IGNITION
GM	3,141,731	ELECTRICAL SYSTEM:IGNITION
GM	290,241	SUSPENSION:REAR
GM	426,593	SERVICE BRAKES, HYDRAULIC:PEDALS AND LINKAGES
GM	429,170	EXTERIOR LIGHTING:HEADLIGHTS
Honda	748,481	AIR BAGS
Honda	350,083	PARKING BRAKE
Hyundai	364,502	SUSPENSION:REAR
Hyundai	883,000	POWER TRAIN:AUTOMATIC TRANSMISSION
Nissan	268,229	FUEL SYSTEM, GASOLINE:STORAGE:TANK ASSEMBLY
Nissan	377,000	FUEL SYSTEM, GASOLINE:STORAGE:TANK ASSEMBLY
Nissan	276,000	ELECTRICAL SYSTEM:IGNITION:MODULE
Nissan	500,552	STEERING:COLUMN
Nissan	625,400	LATCHES/LOCKS/LINKAGES:HOOD:LATCH
Toyota	627,858	AIR BAGS:FRONTAL:SENSOR/CONTROL MODULE
Toyota	366,572	LATCHES/LOCKS/LINKAGES:DOORS:LATCH
Toyota	977,839	STEERING:LINKAGES:ROD:RELAY:CONNECTING
Toyota	4,445,056	VEHICLE SPEED CONTROL:ACCELERATOR PEDAL
Toyota	1,128,659	ENGINE AND ENGINE COOLING
Toyota	342,451	SEAT BELTS
Toyota	1,486,413	AIR BAGS:FRONTAL:DRIVER SIDE INFLATOR MODULE
Toyota	419,520	TIRES:TEMPORARY/EMERGENCY SPARE TIRE
Toyota	1,069,055	AIR BAGS
Toyota	1,814,284	VISIBILITY:POWER WINDOW DEVICES AND CONTROLS
Average	897,192	

Table 4: Size & Description of the recall for the significant recalls in the (-2,2) window

We also looked into the type of defect for every recall, and found no trend or uncommonness compared to the original sample.

Maybe the impact of the recalls on the stock prices depend on outside market conditions. Whilst there is no literature that investigated this, maybe the impact of the recalls depends on whether the economy is in a recession or an expansion. The intuition behind this is that in a period of expansion in which the overall economy is doing well and the outlook looks positive, it might be possible that investors/shareholders sweep the recall under the rug, since a recall usually doesn't affect the long-term outlook of a company. The results of the event-studies are shown in the table below.

Grouping	Event Window	ACAR	pos:neg CAR	Sample Size	t-value	Is the ACAR Significant?
Expansion	(-5, 5)	0.0027	89:94	183	0.7672	No
Expansion	(-2, 2)	0.0008	93:90	183	0.3054	No
Expansion	(0, 5)	0.0004	87:96	183	0.1437	No
Expansion	(0, 2)	0.0005	100:83	183	0.2242	No
Expansion	(0, 1)	-0.0006	102:81	183	-0.3278	No

Grouping	Event Window	ACAR	pos:neg CAR	Sample Size	t-value	Is the ACAR Significant?
Recession	(-5, 5)	0.0062	10:8	18	0.3782	No
Recession	(-2, 2)	-0.0013	10:8	18	-0.12	No
Recession	(0, 5)	0.0008	9:9	18	0.0632	No
Recession	(0, 2)	-0.0008	8:10	18	-0.0868	No
Recession	(0, 1)	-0.0012	8:10	18	-0.1782	No

Table 5: Results of the event-studies looking at differences in periods of recession and expansion

We see from the table above that there is no significant difference between the average impact of automobile recalls in periods of recession and expansion. Whilst the events that occurred in the period of recession have more negative Average Cumulative Abnormal Returns (ACAR), these

ACARs are not significantly different than 0. Also, we note that all individual significant events occurred in a period of expansion. This might be due to the fact that a lot more recalls occurred in periods of expansion (183) compared to periods of recession (18).

Overall, we see that on average, the impact of an automobile recall on stock prices is not significantly different than 0, regardless of overall market conditions. To test our methodology, we conducted multiple placebo tests by taking random dates, and (thankfully) found all the ACARs not to be significantly different than 0. Let's now compare our results to those of the two papers presented in the literature review sections, shown in the table below.

Author	ACAR on (-5,5)
Jarrell & Peltzman	-2.48%***
Hoffer, et al.	-0.31%

*** p<.01

Table 6: Results of the two papers investigating the impact of recalls on stock prices

In the Jarrell & Peltzman paper, the authors found that the firms lost an average of 2.48% of the share price as a result of a recall. This result was found to be significantly different than 0. In the Hoffer, et al. paper, the authors found that the firms lost an average of 0.31% of the share price as a result of a recall. This result was found not to be significantly different than 0. Another paper, "Impact of Automobile Recalls on Stock Prices: A Study in the Indian Context," by Jagandeep Singh, published in the Global Business Review on November 21, 2017, also found that the impact of automobile recalls on stock prices to be insignificant.

As described in the literature review section, the second paper corrected the methodology of the first paper, mainly by making sure that no two events are within 120 days of each other, as the

impact of one event can affect the impact of another for windows of time smaller than 120 days. Our results therefore agree with the conclusion of the second paper, that the ACAR is not significantly different than 0. The reason why our ACARs are even smaller than those of the second paper is that the recall systems in the U.S. had time to mature since the 1980s. Companies have had time to prepare for recalls and have put in place specific protocols to follow in the case of a recall, both in how to repair the vehicles and how to address the recall in the PR sphere. Another reason why our ACARs were lower than Hoffer's might be that due to the recurring nature of recalls, these events are now expected by shareholders, and thus already priced in the share prices.

Conclusion

The study found that automobile recall announcements generated small and insignificant Average Cumulative Abnormal Returns (ACAR) in all the event studies considered. Furthermore, the study found no statistically significant difference in the ACAR generated during recalls in an expansion or recession period. A possible explanation is that since the U.S. has seen over a thousand automobile recalls, shareholder now expect their occurrence, and thus price in the probability of recalls into stock prices. A possible way to improve the analysis would be to create a new variable which captures the relative scale of the size of the recall depending on the size of the company: number of cars recalled divided by numbers of cars produced by the firm. This can be useful because a 250,000-car recall for Kia is not the same as a 250,000-car recall for Ford, given that Ford is considerably larger than Kia. We have already identified a way to scrape the

necessary data for the number of cars each firm produces, from the International Organization of Motor Vehicle Manufacturers (OICA).

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