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An Analysis of the Impact of Product Recall on Stock Prices based on Google Trend Search Counts

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ABSTRACT

Purpose: Recall can have a critical impact on a company's image and reputation, and is one of the biggest issues for customers. In this study, we take the Event Study approach to analyze the impact of recall on corporate stock prices. In previous works, conflicting conclusions were drawn depending on the recall case and data collection process.

Design/methodology/approach: To alleviate such issues, we utilize data as a more objective Google Trends. Specifically, we study the effects of product recall on stock prices from multiple aspects including (1) Google Trend search volume, (2) type of recall, (3) industry category, and (4) by country.

Findings: Though we find that recall does not have a statistically significant effect on company share prices, we identified that recalls of companies with high search volume has a greater impact than those with low search volume. We also find that involuntary recalls have a greater impact than voluntary recalls, and non-automobile industries have a greater impact than the automobile industry.

Research limitations/implications: The limitation of the research is that Google cannot accurately represent the world. It may not be fully reflected because there are countries that cannot use Google due to lack of IT infrastructure or government regulations. Also, it is not possible to know exactly when the information will leak when an event occurs. This is because if information had already leaked through people's oral traditions before it spread to the news, its influence would be reduced.

Originality/value: For studies using traditional event studies, the choice of events was very likely to be chosen according to the choice of researchers. This study is significant in that it tried to solve this problem with Google Trends and investigated all the data mentioned on the Internet except for countries that could not access Google due to lack of government regulations or IT infrastructure.

Keywords: Google trend, Product recall, Event study, Automobile, Non-Automobile

1. Introduction

The recent transition to autonomous cars in the automobile industry driven by emerging technologies

such as artificial intelligence and machine learning has highlighted many issues related to defects. These defects have a great ripple effect due to the nature of the product directly relating to mortality and safety, and the fact that many components and parts are shared to produce large quantities of products to achieve economies of scale. Therefore, automobile recalls have heightened consumer interest than any

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other product. One of the main reasons for large-scale recalls in the auto industry is the expansion of production quantities and areas as well as commonization of parts for cost reduction as a response to intense competitions in the industry. Commonization of these components has had a negative impact on effective quality control. In addition, the transition to various electronic devices propelled by the development of environmentally friendly or fuel-efficient vehicles has resulted in poor quality control (Jain and Garg, 2007).

In non-automobile industries, product recalls were caused by bacterial infections and the detection of harmful substances in food products, fires due to electronic or battery issues in appliances and electronic devices, etc (Korea Consumer Agency 2018). According to the OECD's Global Recall (Sep 2019), there were 129 recalls related to furniture in 2019, 133 in 2018, and 123 in 2017. In addition, 28 recalls related to pharmaceuticals were reported in 2019, 59 in 2018, and 38 in 2017. While recalls of such products do not happen as frequently as automobile recalls, they still have been steadily occurring. This is because the product life cycle in such industries has become much faster than before that led to the rapid development and stabilization of many core components making up new products (Gaimon and Singhal, 1992).

Product recalls in any industry have a negative impact on the image or reputation of the focal company (Nagaich and Sadna, 2015). Moreover, it is often the case that news of recall events and that they have made a negative impact on the company's stock price spread quickly through various traditional and social media outlets. This requires a more accurate look at the recall event with respect to both quantitative as well as qualitative factors. Using the Event Study methodology, our goal is to analyze the extent to which product recalls in both automobile and non-automobile industries (IT products, home appliances, pharmaceutical, food and beverage products) affect stock prices for the 50 largest companies worldwide.

Previous studies that used conventional Event Study methodologies targeted recall events from limited sources using specific keywords as shown in Tables 1 and 2. As a result, the severity to which

the incident occurred and whether it was a national or an international issue is not clarified. To alleviate these problems, we collected data using Google Trends, which enables us to discern the intensity and reach of the recall event by searching using different country, period, and keywords and the recorded search volume. Because Google Trend collects and proceeds data from all countries that use Google, it has the advantage of being able to produce unbiased results than data selection conducted in other studies. In addition, we compare groups according to the type and characteristics of the recall to determine whether any meaningful differences exist among them.

II . Literature Review

Table 1 describes the process through which Event Study is used in previous studies. The Event study methodology has been widely used and analyzed by replacing it with a structural equation (Jun & Choi, 2014) or a result value (Rao & Mishra, 2020). It is also used to analyze the impact of an event on a company's stock prices on a variety of topics, such as IT Investment, CEO Succession, Patent, and Fraudulent Accounting. However, a closer look at the analysis results is divided into cases in which significant results were derived using Event study and those that were not. Especially, existing studies have produced different results depending on the sample of studies analyzed for the same events (Dos Santos et al, 1993; Im et al, 2001).

Unlike previous studies (Perez-Rodriguez & Lopez Valcarcel, 2012; Graffin et al, 2011), the study by Noh (2019) was conducted using the average share price for each quarter to avoid bias that could be considered in changes in share prices. For accurate identification, the methodology was used by organizing a study to investigate a clearer influence through a one-on-one comparison between the share price of the entity in which the event exists and the entity without the event. Event study (Hino and Takeda,

Table 1. Event study in previous studies.

Topic	Reference	Duration	Cases	Case Selection Method	Estimated Period	Prediction Period	Result
IT Investment	Dos Santos et al. 1993	1981-1988	97	PR Newswire, PTS Prompt	200	0	Not support
IT Investment	Im et al. 2001	1981-1996	238	PR Newswire, PTS Prompt and Business and Industry	200	0	Partial support
CEO Succession	Graffin et al. 2011	1999-2004	100	PR Newswire and LexisNexis	250	-1, 0, +1	Partial support
Chemical (Product R&D)	Perez-Rodriguez and Lopez Valcarcel 2012	1994-2008	46	Obtained the relevant information through the news and surveyed 6 companies included in NYSE.	2	0	Partial support
Software patent	Ren and Duprez 2019	-	33	U.S. Supreme Court	0, -1, -2	0, +1, +2	Partial support
Sport sponsorship	Hino and Takeda 2019	1991-2014	188	Nikkei, Nikkei Business Daily and Nikkei MJ	0, -160	0, 1, -10	Partial support
Supplier sustainability Risk	Kim and Wagner 2019	1985-2014	129	Wall Street Journal	200	-5 ~ 5	Partial support
About Sustainability	Noh 2019	1996-2010	174	New York Times, Wall Street Journal, Washington Post, and Chicago Tribune	1 year	-2 ~ 2	Partial support
Fraudulent Financial effect	Eryigit 2019	2005-2015	176	Capital Market Board of Turkey	150	-10 ~ 10 (per 5)	Partial support

2019; Eryigit, 2019; Kim and Wagner, 2018) and Taken in calculating Coefficient, mainly used AR (Abnormal Return) and CAR (Cumulative Abnormal Return). Ren and Duprez (2019) also calculated using AAR (Average Abnormal Return) and CAAR (Cumulative Average Abnormal Return). The analysis of the above confirmed that the results may vary depending on the choice of the case and that the same results will not be produced even if they are the same case. In addition, the same values were not seen in the calculation of the coefficients. Therefore, data was collected through Google trend to secure an objective source of data so that more objective figures could be obtained from existing studies. In addition, the most commonly used AR and AAR were used as the methodologies for this study to calculate the impact of stock prices on the day of events.

Existing recall studies using event study are shown in Table 2. Table 2 summarizes how the occurrence of the recall affected the company's share prices. The last column of the table confirms only the day of the event based on the efficient market hypothesis

(Fama et al, 1969) that unexpected events, such as recalls, are immediately reflected in the company's share prices. Among the nine papers presented, there were two studies that had no effect at all, so it can be confirmed that the occurrence of the recall is a factor affecting stock prices.

III. Research Proposition

Recall has a negative meaning for the name itself of the word from a corporate perspective. Of course, action can be taken before an event occurs, but it is hard to say if the company is a large, global product. From a consumer's point of view, it will also have a negative impact on the brand image of the company and may have a negative impact on future purchases (Park et al, 2013). This, in turn, has a negative impact on company sales.

Toyota's recall, which is well known around the

Table 2. A study on existing recall using Event study

Topic	Reference	Duration	Cases	Case Selection Method	Result
Automobile, Drug, Financial and Tele-communication Recall	Baek & Han 2008	1999-2005	85	Selected based on five leading Korean dailies and investigated 45 recall cases and 40 service-related incidents around the product.	Partial support
Automobile Recall	Shin et al. 2012	-	3	Examined three specific recall cases of Toyota, a Japanese car.	Not support
Automobile Recall	Singh 2018	2010-2015	13	Investigated recall cases of three automakers in India without specific criteria.	Partial support
Food Recall	Seo et al. 2013	Past 25 years	40	The news from Marler Clark's (news report on food related events) and Google also investigated the news, and if it differs from the date it was first investigated, change it to obtain data.	Partial support
Food Recall	Kong, Shi and Yang 2019	2008-2016	25	Investigated using Shanghai and Shenhzen Stock Exchanges and reports.	Support
Product Recall (China & USA / Automobile, Food, Electronics and Pharmaceuticals)	Zhao et al. 2013	2002-2012	42	Related keywords were searched through specific Chinese press releases.	Not support
Industrial products, Food, Automobile Recall	Park et al. 2013	2000-2010	101	Korea's leading search engine (Naver) is used to investigate 34 industrial products, 32 dietary drugs, and 35 automobiles.	Partial support
Product Recall	Noack et al. 2019	1999-2009	197	Wall Street Journal, New York Times, Washington Post, and surveyed top-250 companies selected by Fortune.	Support
Chemical Recall	Makino 2016	2005-2012	18	Select 18 cases from the Chemical Accidents Database, except for old data and not very serious cases.	Partial support

world, was subject to more than 10 million recalls from 2009 to 2010 due to errors in electronic control systems in cars. As a result, Toyota quickly lost credibility in the industry, and Toyota's used car prices plunged 45 percent. The recall would cost \$2 billion, but would cost at least \$5 billion, including reputations, marketing and consumer lawsuits, the Wall Street Journal said. On the contrary, Mattel, a company famous for Barbie dolls, suffered more than 100 million dollars in damages after finding more than the standard amount of lead in toys, but its performance increased by 15 percent a year later with the trust of consumers.

In the two cases, the results can be determined differently depending on the entity's response to the recall. However, neither case is a matter that can determine the recall on the day the incident occurred, and no matter how fast a response is taken, stock prices will be hurt on the date the incident occurs.

In other words, even if the recall has had positive results due to the timing of the recall declaration or follow-up measures from the announcement of the measures, the stock price falls on the day the incident occurred. Combining existing studies and examples, it is judged that the occurrence of the recall will have a negative impact on the company's share prices, so Hypothesis 1 is proposed.

Hypothesis 1. The recall will have a negative impact on the company's stock prices.

Google is known to be a company that arranges and organizes information distributed around the world, making it easier for all users to use and utilize it. Google Trends is a collection of all Google-generated data from all over the world, and if you enter a specific search term, you can find out how strong the content was over a period of time. Setting a

specific period of time would indicate that users have been searched at a relatively high frequency over that period. In other words, the higher the number of Google Trends, the higher the level of interest and interest in the case. Thus, if a keyword is found in a particular news, a method of collecting data from existing papers, it may be more objective than adopting it as an event. Previous studies so far (Table 1) have collected news found on specific sites, but subjectivity cannot be ruled out.

Most of all, according to the efficient market hypothesis (Fama et al, 1969), if a particular event occurs, it affects the stock price the following day if the day of the incident or the market is closed. By referring to this theory, we can also measure the impact of events on the values shown through Google Trends, which integrates all news (in China and abroad). Samples of data from studies conducted using existing event studies as methodologies were assigned specific newsletters and examined the occurrence of events. The method is an arbitrary choice of researchers, and as noted in the theoretical background, it is confirmed that different results can be obtained even if the same data is used. Thus, the paper proposes Hypothesis 2 in an objective way rather than conventional methodology by means verified using Google Trends.

Hypothesis 2. Recall request of groups above trend Median have larger effect on stock prices as compared to those below Median in Google Trends.

Worldwide, recalls can be categorized into up to four types. First, voluntary recalls are not enforced on legal grounds, but when the operator voluntarily recalls defective products and previous studies suggest that voluntary recalls result in better results than forced recalls (Park et al., 2013). Recall recommendations are based on legal grounds but do not have enforceability of enforcement, and forced recalls follow legal grounds and are subject to formal procedures. Finally, an emergency recall is based on legal basis and is mandatory for enforcement, which may omit formal procedures. As such, recalls

can be handled in very different ways depending on the case. In the study, these types were classified as voluntary and involuntary recalls, and sub-adopted contents were based on legal classification (recommendations, forced recalls, emergency recalls), but recalls considering the atmosphere of public opinion were also classified as involuntary recalls.

Existing relevant studies show that voluntary recalls have a less negative impact than forced recalls (Jun & Choi, 2014). In other words, forced recalls can be more fatal to companies. In particular, this effect is bound to be stronger when the entity's main products have a significant impact on life. According to Mowen (1980), consumers are more responsible for companies that have implemented voluntary recalls. In other view, consumers are more tolerant of product defects (Siomkos & Kurbard, 1994) as companies with higher expectations are more sensitive to product defects (Dawer & Pillutla, 2000) and are more brand-recognized. In addition, mutual trust between suppliers and consumers is very important, and in situations such as recalls, customers are likely to accept the recall as a very large situation if it is determined by third-party government representation rather than voluntary. Therefore, Hypothesis 3 is proposed based on the above contents.

Hypothesis 3. Involuntary recalls have larger effect on stock prices as compared to voluntary recalls.

The automobile industry is an industry in which many companies are involved compared to other industries, and the factor that shows this is that the number of parts used in a single car is 20,000 to 30,000. This means that the production line is very closely connected to the upstream company Supplier. Also, cars are melted into everyday life. According to the Korea Automobile Manufacturers Association (2017), 42.5 percent of every 1,000 people owned vehicles in Korea, 83.7 percent in the United States, 59.8 percent in Britain, 59.7 percent in Japan and 59.6 percent in Germany. Although the figure is in the form of owning a car directly, it is not limited to ownership due to rapid technological development but is also used as a variety of services such as

car sharing.

However, the non-automobile industry is just as important as the automobile industry. As a non-automobile industry, we can look at IT products, home appliances, pharmaceutical · bio, food and beverage industries. Specially, IT products have short and fast product life cycles due to the rapid development of new technologies or the emergence of substitutes (McIntyre, 1988). Therefore, IT products may lose control of the industry if the variable of recall is applied. In addition, the variables can be very costly to rapidly develop and produce new products, which can be difficult to invest in the cost and time required for new products to be developed in the future. A study by Lee et al. (2009) that validated differences between IT and non-IT entities confirmed differences between IT and non-IT entities during the market stabilization period. Recalls of households are not subject to frequent occurrences, but Ikea's recall of drawers in 2016 is a case in point. It was a phenomenon in which a drawer made by Ikea was opened and put more than a certain weight on it when it fell toward a person. For this reason, a total of 29 million closets were recalled in the United States and Canada. Compared with other industries, the pharmaceutical · bio industry is very fatal for each event, rather than having less impact, even if the same event occurred earlier (Park et al, 2013). This is because the name "drug" can be used to cure the disease, which can become a poison. For example, Johnson & Johnson killed seven people who took Tylenol in 1982, which not only cost consumers confidence but also led to market share and stock price declines. The recall of food and beverage products is a threat to public health, and the main factors are allergens, labeling errors, quality and underweight. Examples include losses from the outbreak of salmonella in the United States in 2008 (Kim, 2018) and recalls from packaging problems in Canada in 2019.

Previous studies have shown that the results of most studies on automobiles have been of little significance (Shin et al., 2012; Zhao et al., 2013; Singh, 2018), and that the food industry (Seo et al., 2013, Kong et al., 2019) and the chemical industry

(Makino, 2016) have become more significant. Therefore, it is judged that the recall has a greater impact on stock prices in the non-automobile industry than in the automobile industry, so it proposes Hypothesis 4.

Hypothesis 4. Recall of non-automobile industries have larger effect on stock prices as compared to recall of the auto industry.

Globalization has created a structure that provides anytime access to products from all over the world. This is due to different regulations on products in each country, which may change the behavior of exporting countries in trade. If you look at Table 3 for more details of each country, regulations on recalls in the United States and the United Kingdom are more systematically manualized. These standards disprove that if the country's recall system is not as strict as that of other countries, problems can arise in exporting relatively.

A notable feature of the U.S. recall system is the Involuntary reporting of defect information by operators, seeking to activate recalls. It induces this obligation to lead to voluntary recalls, which also affects consumer safety. As such, Hypothesis 5 is proposed assuming that attitudes toward recalls may vary depending on each country's methods.

Hypothesis 5. Asian companies' recalls have larger effect on stock prices as compared to U.S. or European companies.

IV. Data and Methodology

In this section, we discuss our data collection method and Event Study approach.

A. Data collection method

The paper made the procedure as Figure 1 to select the data needed for the study. The procedure selected

Table 3. Comparison of recall systems by country

Country	Field	Law basis	Department	Main agent	Recall Type	Requirement	Method
South Korea	All goods and services	Consumer basic law	Central administrative related agency (entrusted by the local government)	Business operators (manufacturing, importing, selling, and providing services)	Voluntary recall, recall recommendation, forced recall	Where there is a risk of harming or harming the life, body, or property of consumers	Collection, destruction, repair, exchange, refund, and no service provided
	Manufactured goods	Consumer Product Safety Act	Ministry of Trade, Industry and Energy	Manufacturer, importer, or seller	Forced, voluntary recall	Specific products or household goods that do not meet safety standards	Reclamation or necessary emergency measures
Japan	Automobile products	Road Transport Vehicle Act	Ministry of Transportation	Automobile manufacturer	Voluntary recall	the structure or performance is unsuitable for safety standards and the cause of the defect is in the manufacturing process	-
	Food and beverage goods	Food sanitation act	Ministry of welfare	-	-	-	-
America	Manufactured goods	Consumer Product Safety Act	CPSC	Manufacturer, distributor, importer, retailer	Forced, voluntary recall	Critical product risk	Repair, exchange, refund
	Automobile products	Motor vehicle safety law	NHTSA	Manufacturer	Forced, voluntary recall	Failure to comply with federal safety or safety related defects	Repair, exchange, refund
	Food and beverage goods	Food and Drug Act	FDA	Manufacturer, distributor	Voluntary recall	Products that cause personal damage or temporary injury.	exchange, refund
United Kingdom	Manufactured goods	Consumer Protection Act	Ministry of Trade and Industry	Manufacturer, importer, wholesaler, retailer		Product threats	
	Automobile products	Code of Conduct for Motor Vehicle Safety Defects	Automobile inspection office	Manufacturer	Voluntary recall	Design or structural characteristics that cause significant risks, such as personal injury or death	Repair, exchange, refund
	Food and beverage goods	Food safety act	Ministry of agriculture, food and rural affairs	-		-	

Source: Korea Institute for Industrial Economics and Trade (2011).

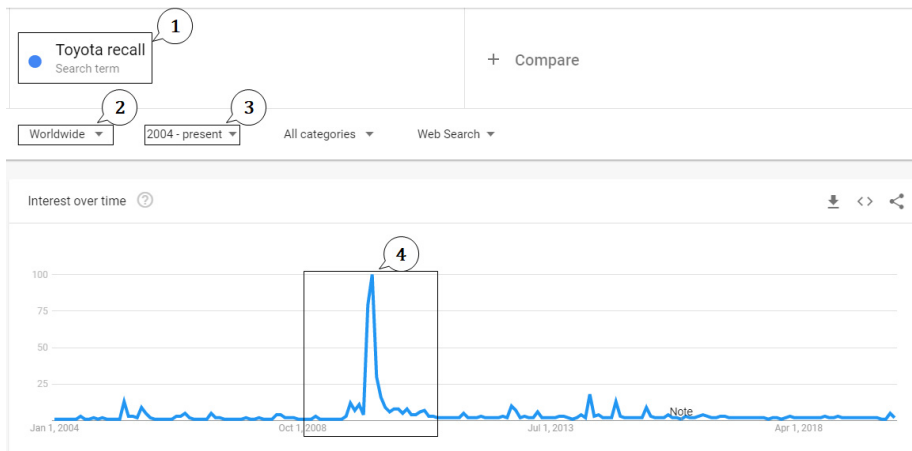


Figure 1. Search Method of Google Trends

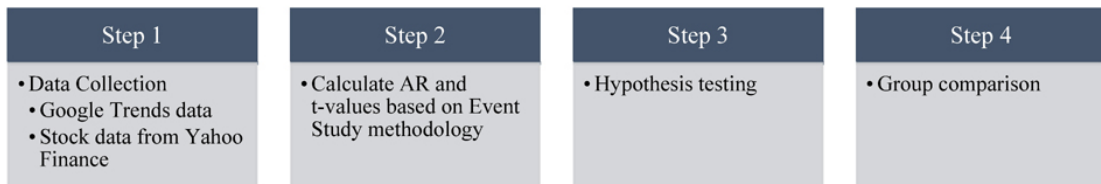


Figure 2. Data collection process

each case objectively rather than the data collection method described in the previous study (Tables 1 and 2). Most of all, as the target progresses worldwide as seen in Number 2 of Figure 1, it can be compared using standardized values from 0 to 100 even though the specific keyword or meaning is different.

Figure 2 summarizes the results from basic data collection to inspection, and Step 1 selected the data secured from 2004 to July 2019 from Google Trends on the date of the incident for the 50th largest companies by market capitalization in each industry as basic data. Among them, in case of more than 30 Google Trends and recall articles were selected. Thus, in this study a total of 11 companies were selected, including Toyota to represent the automotive industry, and 28 companies to represent the non-automobile industry, including Apple (see Appendix A). When collecting data based on Google Trends, if you look at the order listed in Figure 2, the search term (1) was carried out with the results of the

corresponding company name + recall (ex) TOYOTA RECALL, the reason why ‘company name + recall’ was because there were many cases in which articles were written based on the company name rather than the product name in the data collection. The results of the search by ‘company name + recall’ were compared with the results of the search by ‘product name + recall’ in the same case, and the results of the search by the same case showed that the former was more frequent, so ‘company name + recall’., the search criteria were set at worldwide (2) and the period was set from 2004 to 2019 (3). From 2004 to July 2019, the period of events with significant figures was narrowed and confirmed over and over again.

In order to prevent noise from being produced due to other articles or advertisements the stable value should be defined. Therefore, more than 1 value was identified to determine to what extent the number generated by each event should rise to eliminate noise.

Among the values at the low numbers shown in Google Trends the value without noise is more than 30. Stock prices (automobile industry, non-automobile industry (manufacturing) and indices (EURO50, NASDAQ, Nikkei, KOSPI) used R in Yahoo Finance to collect charts that an enable analysis of the estimated period of 60 days and the forecast period of 1 day based on the date the event occurred. Using data from Google Trends and Yahoo Finance, we checked Google News about the incident. Step 2 and 3 then calculated each identified event using the methodology of Event study, using the share price of each entity and the index to which the entity belongs. Five Hypotheses were validated based on the significance calculated from a total of 100 events (50 for the automotive industry and 50 for the non-motor vehicle industry).

For the first Hypothesis, the Google Trend score is a figure that has been repeated on many Internet sites around the world, for the following reasons: In the case of Apple, one of the top 50 companies in market capitalization, the trend figure for about five years shows that in the case of Apple, the skewness is larger than zero. Therefore, it was confirmed that 1 to 15 events occurred without extreme values, except for the highest number(100) for each company, but the median was carried out due to the large proportion of the extreme value 100. The median is the most reasonable way to conduct comparisons between groups using Google trends (Kirchberger et al, 2017).

Domestic and foreign companies were selected for the subject target, and the first news to be reported was selected within three days, not exactly the same day, based on the date when the trend figure was the highest. The first reason for choosing three days is that the world does not use the same time and takes into account if information is leaked. The second reason is that I considered the weekend. In addition, if the most recently reported article occurred before the opening of the market, the stock price of the day was selected.

The development of the event was carried out on the basis of market opening, taking into account. However, if another event occurs between the estimated

period of 60 days and the forecast period, it is excluded even if the higher conditions are satisfied, and the contents of each sample are as shown in Table 3. In the last Step 4, the assumptions of the rest, except for the first, were further checked and compared to see if differences existed for each group in Figure 3. Basic statistics for each data are written in Appendix B.

B. Research Methodology: Event Study

Share prices are almost instantaneous reflection of the entity's internal and externalities (Fama et al, 1969), using event studies as the best way to see how the occurrence of a recall has affected corporate share prices (McWilims & Siegel, 1997). Event study can be described as a method of quantifying the economic impact of an event's excess rate of return. The excess rate of return is calculated by deducting the rate of return that would have been realized when no event had occurred in the actual rate of return, and the actual rate of return is calculated by estimating the normal rate of return.

According to Brown and Warner (1980, 1985), the event research methodology is excellent at discovering excess yields using market models and is widely used in many existing papers (Im et al, 2001; Zhao et al, 2013). In the paper, the calculation of the figures for each forecast period is as follows, using the share price of the entity for 60 days (based on market opening) per event and the index to which the share belongs. The market model is based on the expected return model, which is based on the actual return on the market (index) of the entity in which the event occurred and its correlation with the benchmark market for the entity's shares. Therefore, we use the formula of normal return because we need to understand the stock price when the original incident did not occur. Normal return uses the following formula:

$$AR_{it} = R_{it} - \beta_i R_{mt},$$

where t is the daily normal return for the i -th

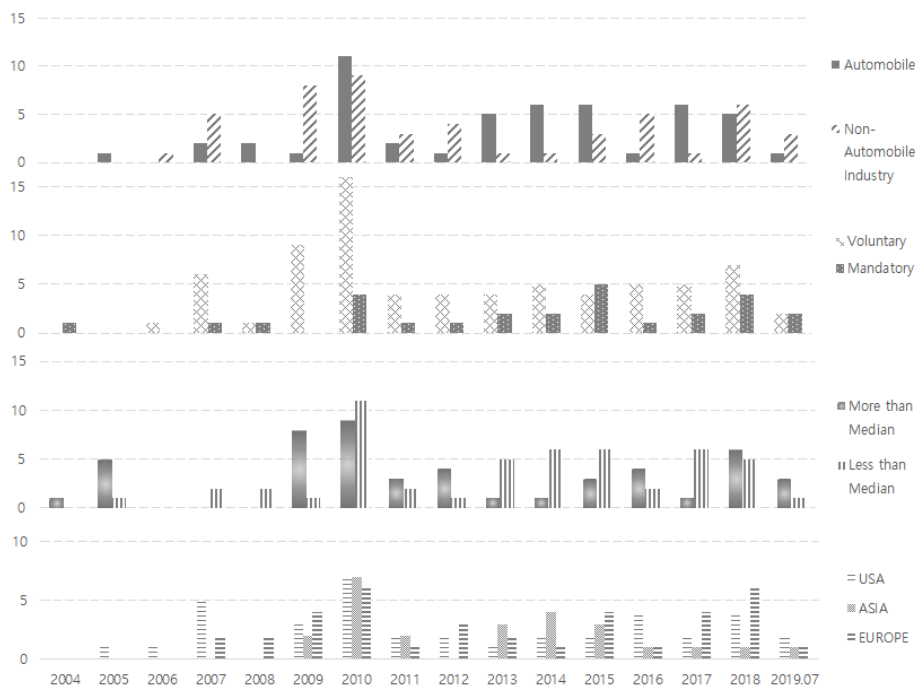


Figure 3. Case distribution of each group.

company as the difference between the actual yields of shares i to work and the estimated normal return of shares i to t . Where R_{it}^* means the price-earnings ratio of entity i on t -day, and R_{mt} is the market-earnings ratio on t -day. β_i represents the regression constant and the regression coefficients of entity i estimated using the stock return data from the estimated period before the event occurred t is the sum of the dates of the estimated period and R_m is the average of the corresponding indices over the measurement period.

The typical excess yield associated with a different point in time before or after the date of the event shall be expressed in the following formula:

$$AAR_t = \sum_{i=1}^N AR_{it} / N,$$

where AAR_{it} is the average abnormal return at t -day, which means the average of the abnormal rate of return at the day of the event. Later, a t-test ($t = \sum_{i=0}^N (AR_{it} / SD_{it}) / \sqrt{N}$) was conducted to test the

statistical significance of the excess yield. To test each hypothesis, the t-test of each event was then summed up and divided by the number of events added to test the significance.

V . Discussions

According to McWilliams & Siegel (1997), it is very important to calculate the estimated period of event events. Using an estimated period that is too long reduces power. This is because the impact of the event is insufficient due to the overlap of events caused by other events, and on the contrary, if it is too short, it will be difficult to test significant effects. Therefore, the study was conducted with the main transaction period set at 60 days, but the estimation period was confirmed for an additional 30 days and 90 days, taking into account the period during which events were not overlapped in the same

entity, to exclude the possibility of noise or variables that were not considered.

The details derived through the above research methods are as follows. Table 4 shows the significance of the share price at the date of the event when the estimated period is 30, 60, and 90 days. According to the results of the forecast period calculated by setting the estimated period at 60 days as of the day of the incident, the overall industry was 1.028, 0.783 (automobile) and 1.272 (non-automobile), 0.867 (USA), 1.018 (Asia, 1.199 Europe), 0.560 (voluntary), 0.840 (Involuntary), and 1.331 (More than Median), 0.736(Less than Median) when comparing the trend. In addition, the results of the 30-day and 90-day estimated period were equally insignificant.

However, the results of comparisons between groups (except Hypothesis 1) were derived as follows: The difference between the two groups was significant (0.028 significance level) when comparing the values shown in Google Trend Analysis with those of Median and Median groups (0.022) and between groups of involuntary and voluntary recalls. Verification of group

differences between cars and non-motor vehicles also showed a level of 0.07. According to a study by Pinsonneault and Kraemer (1993), it is not necessary to verify at a 90% level that each industry has its own characteristics in comparison between industries, but that there is a common share. Therefore, it was confirmed that group differences between motor vehicles and non-motor vehicles were significant. That is, the analysis of the results of cross-group comparisons was made to determine which features of the recall had a more negative effect, although the existing hypothesis was not significant. In addition, there was no significant difference between groups in each region (US, Europe, Asia) (0.57 significance level). As a result of calculating differences between groups, there was no difference in share prices for the recall except for national differences, but differences between groups were confirmed. In other words, a recall does not affect share prices, but varies depending on the characteristics and circumstances of the recall.

When aggregating the results, it was confirmed that the recall did not have a significant impact on

Table 4. Results summary and group comparison for the estimated period of 60 days and the date of the forecast period event

Category	T-value (estimated period 30/60/90 day)			Significant rest (1.96-criteria, 30/60/90day)			Intergroup comparison (0.10level)/group difference
Full Sample(100)	1.037	1.028	0.886	NS	NS	NS	-
<i>Google trends*</i>							
More than Median(49)	1.428	1.331	1.447	NS	NS	NS	0.02 (S)/ M(1.33)>L(0.74)
Less than Median (51)	0.834	0.736	0.757	NS	NS	NS	
<i>Voluntary / Involuntary</i>							
Voluntary(73)	0.945	0.560	0.787	NS	NS	NS	0.02 (S)/ V(0.84)>I(1.53)
Involuntary (27)	1.616	0.840	1.929	NS	NS	NS	
<i>Industry</i>							
Automobile(50)	1.384	0.783	1.487	NS	NS	NS	0.07 (S)/ (0.78)<NA(1.27)
Non-Automobile(50)	0.867	1.272	0.704	NS	NS	NS	
<i>Country</i>							
USA(38)	0.967	0.867	0.784	NS	NS	NS	0.57 (NS)/ (0.87)<AS(1.02) <E(1.20)
ASIA(25)	1.093	1.018	0.947	NS	NS	NS	
EUROPE(37)	1.310	1.199	1.515	NS	NS	NS	

* The median was calculated as 66 and the case with 66 was 3, with the exception of 66 being calculated by adding the median (3 data) to the small group because 49 were larger than the median and 48 were derived for smaller cases.

**NS(Not supported), S(Supported), M(More than Median), L(Less than Median), V(Voluntary), I(Involuntary), A(Automobile), NA(Non-Automobile), U(USA), AS(ASIA), E(EUROPE)

the stock price of the company, but differed by Google trend level, recall type, and industry. Google Trends can be said to be an interest in specific In other words, a high level of interest in a particular subject means that the value of Google Trends increases and, consequently, it is frequently exposed and repeated. If the products or services produced by the entity or the services provided result in failure or inconvenience, the public exposure of the information will negatively affect recognition and deal a heavy blow to perceived quality. As a result, not only will the value of the brand mentioned by Farquar (2009) be reduced, but the valuation of the entity will also affect the share price (Barth et al, 1998), i.e. at this point, many entities treat recalls as important, but it should not be overlooked that continuous repeated and exposure of negative information will affect the entity.

Second, voluntary and involuntary seizures presented as recall types also appear in human psychology. As the Prospect theory also states, they fail to accurately assess risks, respond more sensitively to losses than gains, and recognize them as relative figures, not absolute figures for gains or losses. In other words, in accounting procedures, where this sentiment is partly applied by entities, voluntary audits are accepted as positive signals but as negative signals for entities that avoid audits (Lennox and Pittman, 2011). Given this, it is important to ensure that the recall event occurs and that consumers clearly respond to the entity's response.

Third, in comparison by industry, there is a difference in size due to the characteristics of each industry. Considering that the market capitalization of the top 10 companies in each industry alone is \$68.6 billion for automobiles, \$598.1 billion for IT, \$155.7 billion for food and beverage products, and \$182.2 billion for pharmaceutical bio, each industry has its own characteristics and its size is different. A study by Hrebiniak and Snow (1980) also found that invisible areas, such as environmental uncertainties, affect the enterprise, depending on the industry. In this study, differences in each industry were found in the order of automobiles (1.27), food and beverage products

(0.93, pharmaceutical bio (0.75), home appliances (0.72), and IT products (0.64). Overall, it was confirmed that differences exist in industry characteristics, industry size, and growth rate, and that differences exist between industries, with no significant impact on recalls.

Combining this, the overall hypothesis was not supported, but in common, it can be seen that companies are aware of and responding to the information age. This is because anyone has equal access to information anywhere through a network that is available worldwide. Therefore, it disproves that companies are making more efforts to reduce the negative effects of high-risk factors. In addition, there is a greater risk of doing certain things (high-cost R&D, etc.) from a large company to a small company, while from a small company to a large company, there is less burden of doing so. Considering that the subjects of the paper are not small companies with high-risk high returns, but rather large companies with low-risk high returns, it is very interesting that companies have differences in each group even though they cannot draw statistically meaningful differences in recalls.

As a result of considering these events from various points of view, it is very important to manage the risks of an entity from a practical point of view, which also emerges as a management issue at various agencies. Risks have changed from war or major accidents to consumer boycotts, environmental and labor-management issues, depending on the times. The Risk will be an ever-occurring element, but it will be easier to solve these problems through writing or educating manuals tailored to businesses, using the crisis-altering capabilities that companies have done in the past. Harry Markowitz's (1952) portfolio theory also reflects the risk management aspect of the entity, which calls for the entity to invest in various areas to manage risk. In other words, this means that many companies are prepared to respond to the recall in advance, which has no significant impact on share prices. Also, the recall is that everyone is well aware of the financial impact of the recall due to the high frequency of events.

VI. Conclusion

This paper can largely explain the contribution in two ways. The Google trend's search volume was used to cover the arbitrariness of data collection shown in traditional event studies and to increase objectivity. This suggests an alternative to objective data collection methods. Each Hypothesis was identified through a more objective process, away from the existing ambiguous method, and this process was based on objective data more than any other paper's results. For example, existing data only selected prominent journals in the country where the event occurred and selected specific events. Existing studies have been conducted through a wide variety of selection methods, which can lead to a mix of bias in. Second, according to the efficient market hypothesis (Fama et al, 1969), a particular event has the greatest impact on the day of the event. However, according to previous studies, the significance of the event is confirmed using multiple dates based on the event. This is the part that sets up the study focusing on the results of the value, which in turn violates the theory of efficient market hypothesis. The paper can solve these existing problems by supplementing weaknesses (McWilims & Siegel, 1997) in the event study and presenting the reference point. The third is that even if you are not careful about each event, you should check to see if there are any differences for each group. The emphasis has been on identifying significant levels for each event, with few studies looking at differences between groups. Thus, further research is needed, further from the study of Event study.

One of the most important criteria for the study is Google Trends. Currently, Google Trend provides the first year in 2004. To add support to this study, it is better to compare events in the 20th century with events in the 21st century, but the inability to proceed with the limitations of the data is a limitation. The event study assumes that no events occur in the share price during the estimated period when calculating each event, and McWilliams & Siegel (1997) said unexpected events may occur. These

events affect the estimated period of time, which, as a result, did not control the event accurately.

The limitations of this study can be summarized in two ways. First of all, Google Trends is a software run by a global company that has many users, but it cannot be fully generalized because it is difficult to use Google when the penetration rate of China or the Internet is low. That is, Google Trends cannot cover the search intensity of the global population. Second, it cannot be exactly confirmed that virtually all events occurred on that date just because the article was published on that date. It is difficult to control all of them, given that even if it is not an article, related aides may be aware of it only by oral tradition. In same perspective, it is also difficult to check all possible news not the order in which the search volume is checked first, because it is targeted worldwide. Existing studies have limited publishers and searched events, but this not only excludes the verifiability of events if they are not major issuers, but also differs from the reason why this study uses Google Trends. The next study will be very good if we proceed with a way to control all of this.

VII. Limitation

The limitations of this study can be summarized in three ways. First of all, Google Trends is a software run by a global company that has many users, but it cannot be fully generalized because it is difficult to use Google when the penetration rate of China or the Internet is low. That is, Google Trends cannot cover the search intensity of the global population. Second, it cannot be exactly confirmed that virtually all events occurred on that date just because the article was published on that date. It is difficult to control all of them, given that even if it is not an article, related aides may be aware of it only by oral tradition. In same perspective, it is also difficult to check all possible news not the order in which the search volume is checked first, because it is targeted worldwide.

Existing studies have limited publishers and searched events, but this not only excludes the verifiability of events if they are not major issuers, but also differs from the reason why this study uses Google Trends. The next study will be very good if we proceed with a way to control all of this. Finally, it is a limitation on the data provided by Google Trend. The Google Trend search counts are that it does not consider how to track search volume for specific keywords or external changes (company response, policy, etc.)(Nature, 2013). When using Google Trends in future studies, it would be desirable to investigate external and internal environmental changes and reflect them in the numbers.

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References

- Aaker, D. A. (2009). *Managing Brand Equity*. Simon and Schuster.
- Baek, S. I., & Han, S. L. (2008). The Impact of Product and Online Service Failure Announcements on Firm's Market Value: The Case of Korean Firms. *Entrue Journal of Information Technology*, 7(2), 23-32.
- Barth, M. E., Clement, M. B., Foster, G., & Kasznik, R. (1998). Brand values and capital market valuation. *Review of Accounting Studies*, 3(1-2), 41-68.
- Brown, S. J., & Warner, J. B. (1980). Measuring security price performance. *Journal of Financial Economics*, 8(3), 205-258.
- Brown, S. J., & Warner, J. B. (1985). Using daily stock returns: The case of event studies. *Journal of Financial Economics*, 14(1), 3-31.
- Dawar, N., & Pillutla, M. M. (2000). Impact of product-harm crises on brand equity: The moderating role of consumer expectations. *Journal of Marketing Research*, 37(2), 215-226.
- Declan, B. (2013, February 13). When Google got flu wrong. *Nature*. <https://www.nature.com/news/when-google-got-flu-wrong-1.12413>
- Dos Santos, B. L., Peffers, K., & Mauer, D. C. (1993). The impact of information technology investment announcements on the market value of the firm. *Information Systems Research*, 4(1), 1-23.
- Eryigit, M. (2019). Short-term performance of stocks after fraudulent financial reporting announcement. *Journal of Financial Crime*, 26(2), 464-476.
- Fama, E. F., Fisher, L., Jensen, M. C., & Roll, R. (1969). The adjustment of stock prices to new information. *International Economic Review*, 10(1), 1-21.
- Gaimon, C., & Singhal, V. (1992). Flexibility and the choice of manufacturing facilities under short product life cycles. *European Journal of Operational Research*, 60(2), 211-223.
- Graffin, S. D., Carpenter, M. A., & Boivie, S. (2011). What's all that (strategic) noise? Anticipatory impression management in CEO succession. *Strategic Management Journal*, 32(7), 748-770.
- Hino, Y., & Takeda, F. (2019). Market reactions to sport sponsorship announcements: Comparison between sponsors and their rivals. *Sport Management Review*.
- Hrebiniak, L. G., & Snow, C. C. (1980). Industry differences in environmental uncertainty and organizational characteristics related to uncertainty. *Academy of Management Journal*, 23(4), 750-759.
- Im, K. S., Dow, K. E., & Grover, V. (2001). Research Report: A Reexamination of IT Investment and the Market Value of the Firm. *Information Systems Research*, 12(1), 103-117.
- Jain, S., & Garg, R. K. (2007). *Business competitiveness: strategies for automobile industry*. Doctoral dissertation, Indian Institute of Management Kozhikode.
- Jun, S., & Choi, E. (2014). Consumers' Confidence and Purchase Intentions for Product Recalls Based on Recall Spontaneity and Communication - Interaction Effects of Product Types and Consumers Sociological Characteristics. *Crisisonomy*, 10, 243-263.
- Kahneman, D., & Tversky, A. (1979). Prospect theory: An analysis of decision under risk. *Econometrica*, 47, 263-291.
- Kim, S., Wagner, S. M., & Colicchia, C. (2019). The impact of supplier sustainability risk on shareholder value. *Journal of Supply Chain Management*, 55(1), 71-87.
- Kirchberger, M. C., Heppt, M. V., Eigentler, T. K., Kirchberger, M. A., Schuler, G., & Heinzerling, L. (2017). The tanning habits and interest in sunscreen of Google users: what happened in 12 years?. *Photodermatology, photoimmunology & photomedicine*, 33(2), 68-74.
- Kong, D., Shi, L., & Yang, Z. (2019). Product recalls, corporate social responsibility, and firm value: Evidence from the

- Chinese food industry. *Food Policy*, 83, 60-69.
- Lee, S. G., Cho, N., & Kim, C. S. (2009). The Effect of Earning Announcement Between IT and non-IT Companies Based on Prospect Theory. *Korean Journal of Business Administration*, 22(6), 3149-3168.
- Lennox, C. S., & Pittman, J. A. (2011). Voluntary audits versus mandatory audits. *The Accounting Review*, 86(5), 1655-1678.
- Makino, R. (2016). Stock market responses to chemical accidents in Japan: An event study. *Journal of Loss Prevention in the Process Industries*, 44, 453-458.
- Markowitz, H. (1952). Portfolio selection. *Journal of Finance*, 7(1), 77-91.
- McIntyre, S. H. (1988). Market Adaptation as a Process in the Product Life Cycle of Radical Innovations and High Technology Products. *Journal of Product Innovation Management*, 5(2), 140-149.
- McWilliams, A., & Siegel, D. (1997). Event studies in management research: Theoretical and empirical issues. *Academy of Management Journal*, 40(3), 626-657.
- Mowen, J. C. (1980). Further information on consumer perceptions of product recalls. *Advances in Consumer Research*, 7(1), 519-523.
- Nagaich, U., & Sadhna, D. (2015). Drug recall: An incubus for pharmaceutical companies and most serious drug recall of history. *International Journal of Pharmaceutical Investigation*, 5(1), 13.
- Noack, D., Miller, D. R., & Smith, D. (2019). Let me make it up to you: understanding the mitigative ability of corporate social responsibility following product recalls. *Journal of Business Ethics*, 157(2), 431-446.
- Noh, Y. (2019). The Effects of Corporate Green Efforts for Sustainability: An Event Study Approach. *Sustainability*, 11(15), 4073.
- Park, M. S., Lee, K. H., & Koh, D. Y. (2013). Analysis on the Effect of the Recall on the Enterprise Value. *Journal of Consumer Policy Studies*, 44(1), 27-44.
- Pérez-Rodríguez, J. V., & López-Valcárcel, B. G. (2012). Does innovation in obesity drugs affect stock markets? An event study analysis. *Gaceta Sanitaria*, 26(4), 352-359.
- Pinsonneault, A., & Kraemer, K. L. (1993). The Survey Research Strategy in Studies of Information Systems: Review and Critique. *Journal of Management Information Systems*, 10(2), 75-106.
- Rao, U., & Mishra, T. (2020). Posterior analysis of mergers and acquisitions in the international financial market: A re-appraisal. *Research in International Business and Finance*, 51, 101062.
- Ren, X., & Duprez, R. (2019). Financial impact of legal practice on software patent subject matter eligibility: Effectiveness of a workable standard. *Journal of High Technology Management Research*, 30(1), 50-58.
- Seo, S., Jang, S. S., Miao, L., Almanza, B., & Behnke, C. (2013). The impact of food safety events on the value of food-related firms: An event study approach. *International Journal of Hospitality Management*, 33, 153-165.
- Shin, H., Richardson, R., & Soluade, O. (2012). Assessing sales loss from automobile recalls through event study: A Toyota case study. *Communications of the IIMA*, 12(4), 4.
- Singh, J. (2018). Impact of automobile recalls on stock prices: A study in the Indian context. *Global Business Review*, 19(2), 407-423.
- Siomkos, G. J., & Kurzbard, G. (1994). The hidden crisis in product-harm crisis management. *European Journal of Marketing*, 28(2), 30-41.
- Tversky, A., & Kahneman, D. (1992). Advances in prospect theory: Cumulative representation of uncertainty. *Journal of Risk and Uncertainty*, 5, 297-323.
- Zhao, X., Li, Y., & Flynn, B. B. (2013). The financial impact of product recall announcements in China. *International Journal of Production Economics*, 142(1), 115-123.

Appendix A. Automobile and Non-Automobile Industry Recall List

Automobile Industry Recall List					
No.	Firm	Index	Event type	Google trend	Event Day
1	TOYOTA	Nikkei	Involuntary	100	2010-02-08
2	TESLA	NASDAQ	Involuntary	100	2018-03-20
3	TESLA	NASDAQ	Voluntary	39	2017-10-12
4	TESLA	NASDAQ	Voluntary	70	2017-04-21
5	TESLA	NASDAQ	Voluntary	83	2015-11-20
6	TESLA	NASDAQ	Voluntary	32	2014-01-14
7	TESLA	NASDAQ	Voluntary	33	2013-06-19
8	HYUNDAI	KOSPI 200	Involuntary	70	2019-01-17
9	HYUNDAI	KOSPI 200	Involuntary	49	2018-10-12
10	HYUNDAI	KOSPI 200	Involuntary	100	2017-04-07
11	HYUNDAI	KOSPI 200	Involuntary	70	2015-09-25
12	HYUNDAI	KOSPI 200	Voluntary	41	2014-07-30
13	HYUNDAI	KOSPI 200	Involuntary	69	2013-04-03
14	HYUNDAI	KOSPI 200	Involuntary	68	2010-09-28
15	HYUNDAI	KOSPI 200	Voluntary	40	2010-02-24
16	BMW	DAX PERFORMANCE-INDEX	Voluntary	82	2018-05-08
17	BMW	DAX PERFORMANCE-INDEX	Voluntary	51	2017-11-03
18	BMW	DAX PERFORMANCE-INDEX	Involuntary	38	2014-10-20
19	BMW	DAX PERFORMANCE-INDEX	Involuntary	37	2013-02-16
20	BMW	DAX PERFORMANCE-INDEX	Voluntary	35	2012-03-27
21	BMW	DAX PERFORMANCE-INDEX	Voluntary	100	2010-10-01
22	BMW	DAX PERFORMANCE-INDEX	Involuntary	37	2008-08-13
23	FORD	NYSE	Involuntary	30	2018-03-14
24	FORD	NYSE	Voluntary	35	2009-10-13
25	FORD	NYSE	Voluntary	63	2007-08-06
26	FORD	NYSE	Voluntary	39	2007-04-11
27	FORD	NYSE	Involuntary	67	2005-09-09
28	AUDI	DAX PERFORMANCE-INDEX	Involuntary	97	2018-04-24
29	AUDI	DAX PERFORMANCE-INDEX	Involuntary	95	2017-01-28
30	AUDI	DAX PERFORMANCE-INDEX	Involuntary	70	2015-09-22
31	BENZ(DAIM)	DAX PERFORMANCE-INDEX	Voluntary	52	2017-03-03
32	BENZ(DAIM)	DAX PERFORMANCE-INDEX	Voluntary	40	2010-10-11
33	HONDA	Nikkei 225	Involuntary	45	2015-05-15
34	HONDA	Nikkei 225	Voluntary	70	2014-10-20
35	HONDA	Nikkei 225	Voluntary	32	2013-04-15
36	HONDA	Nikkei 225	Voluntary	30	2011-12-02
37	HONDA	Nikkei 225	Voluntary	32	2011-08-05
38	HONDA	Nikkei 225	Voluntary	100	2010-02-01
39	NISSAN	Nikkei 225	Involuntary	52	2016-04-30
40	NISSAN	Nikkei 225	Voluntary	91	2015-05-14
41	NISSAN	Nikkei 225	Voluntary	78	2014-10-23

Appendix A. Continued

Automobile Industry Recall List

No.	Firm	Index	Event type	Google trend	Event Day
42	NISSAN	Nikkei 225	Involuntary	46	2014-06-23
43	NISSAN	Nikkei 225	Voluntary	67	2013-04-15
44	NISSAN	Nikkei 225	Voluntary	89	2010-10-28
45	NISSAN	Nikkei 225	Voluntary	100	2010-03-03
46	PEUGEOT	CAC 40	Voluntary	31	2010-11-16
47	PEUGEOT	CAC 40	Voluntary	32	2010-05-04
48	PEUGEOT	CAC 40	Voluntary	87	2010-02-01
49	PEUGEOT	CAC 40	Voluntary	30	2008-05-15
50	VOLKSWAGEN	DAX PERFORMANCE-INDEX	Involuntary	100	2015-09-18

Non-automobile Industry Recall List

No.	Industry	Firm	Index	Event type	Google trend	Event Day
1	IT products	APPLE	NasdaqGS	Voluntary	31	2016-01-28
2	IT products	APPLE	NasdaqGS	Voluntary	36	2014-08-25
3	IT products	APPLE	NasdaqGS	Voluntary	34	2011-12-11
4	IT products	APPLE	NasdaqGS	Voluntary	100	2006-08-24
5	IT products	SAMSUNG	kospi	Voluntary	100	2009-02-16
6	IT products	NOKIA	NYSE	Voluntary	32	2009-11-09
7	IT products	NOKIA	NYSE	Voluntary	100	2007-08-14
8	IT products	LG	kospi	Voluntary	100	2009-01-27
9	IT products	LG	kospi	Involuntary	32	2010-07-13
10	IT products	INTEL	NasdaqGS	Involuntary	100	2011-01-31
11	Home appliances	Whirlpool	NYSE	Voluntary	33	2016-08-25
12	Home appliances	Whirlpool	NYSE	Voluntary	100	2010-06-03
13	Home appliances	GE	NYSE	Voluntary	53	2012-08-09
14	Home appliances	GE	NYSE	Voluntary	69	2007-12-05
15	Home appliances	SONY	Nikkei	Voluntary	65	2011-10-12
16	Home appliances	Electrolux	NASDAQ	Voluntary	100	2009-03-28
17	Home appliances	philips	EURO50	Voluntary	44	2013-12-04
18	Pharmaceutical bio	Abbott	NYSE	Voluntary	100	2010-09-23
19	Pharmaceutical bio	Allergan	NYSE	Involuntary	42	2019-05-28
20	Pharmaceutical bio	Allergan	NYSE	Voluntary	40	2018-12-18
21	Pharmaceutical bio	Allergan	NYSE	Voluntary	66	2018-05-30
22	Pharmaceutical bio	Amgen	NASDAQ	Voluntary	100	2010-09-24
23	Pharmaceutical bio	GlaxoSmithKline	NYSE	Voluntary	66	2018-02-06
24	Pharmaceutical bio	GlaxoSmithKline	NYSE	Voluntary	100	2017-04-05
25	Pharmaceutical bio	Johnson & Johnson	NYSE	Voluntary	84	2010-05-02
26	Pharmaceutical bio	Johnson & Johnson	NYSE	Voluntary	100	2010-01-15
27	Pharmaceutical bio	Johnson & Johnson	NYSE	Voluntary	34	2007-10-12
28	Pharmaceutical bio	novartis	NYSE	Voluntary	100	2012-01-09
29	Pharmaceutical bio	Pfizer	NYSE	Voluntary	100	2010-02-01

Appendix A. Continued

Non-automobile Industry Recall List						
No.	Industry	Firm	Index	Event type	Google trend	Event Day
30	Pharmaceutical bio	Roche	SMI	Voluntary	46	2018-11-01
31	Pharmaceutical bio	Roche	SMI	Involuntary	39	2007-06-07
32	Pharmaceutical bio	Sanofi	EURO50	Voluntary	66	2015-10-28
33	Pharmaceutical bio	Sanofi	EURO50	Voluntary	100	2009-12-15
34	Pharmaceutical bio	Bayer	DAX PERFORMANCE-INDEX	Voluntary	51	2009-12-08
35	Food and beverage	Heineken	AEX	Voluntary	80	2015-04-13
36	Food and beverage	Kellogg	NYSE	Involuntary	40	2012-10-11
37	Food and beverage	Kellogg	NYSE	Voluntary	100	2010-06-25
38	Food and beverage	Kellogg	NYSE	Voluntary	84	2009-01-17
39	Food and beverage	kraft heinz	NASDAQ	Voluntary	49	2018-07-25
40	Food and beverage	kraft heinz	NASDAQ	Voluntary	35	2016-11-22
41	Food and beverage	kraft heinz	NASDAQ	Involuntary	100	2015-08-25
42	Food and beverage	McDonald	NYSE	Involuntary	100	2010-06-04
43	Food and beverage	Mondelez	NASDAQ	Voluntary	100	2018-07-21
44	Food and beverage	nestle	SMI	Voluntary	33	2016-03-10
45	Food and beverage	nestle	SMI	Voluntary	46	2012-11-08
46	Food and beverage	nestle	SMI	Voluntary	100	2009-06-19
47	Food and beverage	starbucks	NASDAQ	Voluntary	40	2016-03-07
48	Food and beverage	Tyson Foods	NYSE	Voluntary	67	2019-05-04
49	Food and beverage	Tyson Foods	NYSE	Voluntary	37	2019-01-30
50	Food and beverage	Tyson Foods	NYSE	Voluntary	100	2007-06-08

Appendix B. Basic statistics

	Variable	Frequency	Percent(%)
Industry	Automobile	-	50
	Non-Automobile	IT product	10
		Home appliances	7
		Pharmaceutical bio	17
		Food and beverage	16
	Firm	39	100
	Index	13	100
Type	Voluntary	27	27
	Involuntary	73	73
Significant or not	Significant	15	15
	Non-Significant	85	85
	Variable	Mean	Skewness
	Google trend counts	65.18	0.138