Supply chain finance and financial contagion from disruptions- evidence from the automobile industry

Introduction

In 2011, production-related recalls were ordered for Johnson and Johnson's Tylenol brand. In the following quarter, Bayer, a competitor, reported a 24% increase in sales of Aspirin brand (Kresge, 2011). In 2000, Ericsson attributed supply shortages caused by a fire at a supplier as the primary cause for a $400 million loss. At the same time, its competitor Nokia reported a 4% increase in market share (Latour, 2001). Toyota, which held the title of world's biggest auto maker since 2008, suffered a sequence of recalls and supplier problems because of the Japanese tsunami of 2011. These problems resulted in loss of sales and world's largest car-marker title to General Motors. These anecdotes could indicate that the market and operational performance of a company may be affected by disruptions experienced by its competitors.

Supply chain disruptions may benefit a company's unaffected competitors. However, market conditions may affect companies within an industry in a similar way. Many industry competitors share suppliers, transporters, and manufacturers, indicating that disruptions at one company may have negative consequences for the competitors. For example, because of lower than expected earnings forecast, Apple's stock decline of 52% in 2000 resulted in a share price decline for Dell, Compaq, HP, and IBM (Sessa, 2000). Similarly, over-production led to an 18% decline in stock price of Tommy Hilfiger at the start of 2000. This decline was accompanied by a stock selloff of other apparel makers within the industry including Jones Apparel and Liz Claiborne (Emery, 2000).

This research aims to answer the following questions: 1) How do supply chain disruptions for a company affect competitors within its industry? and 2) Do market cycles affect the consequences of supply chain disruptions? To address these issues, we study the share price impact on the affected companies and their competitors as a measure of the effects of supply chain disruptions. In related studies, Kumar, Liu, and Scutella (2015) and Hendricks and Singhal (2003, 2005a, and 2005b) document the adverse effects of supply chain disruptions on stock performance, operating performance, and profitability of affected companies. Most of the literature focuses on the effect of disruptions on affected companies. Our study adds to the existing knowledge by studying consequence of disruptions under different market cycles and that for affected companies' competitors.

For managers, it is critical to understand the impact of supply chain disruptions occurring at competitors. Such understanding could help improve the performance of a company. Supply chain as well as marketing and

finance functions could benefit by planning and mitigating the impacts, if any, of disruptions at competitors. Knowledge about a disruption's impact could also be of value to institutional and individual investors.

We chose to study the automobile industry for three reasons. First, the industry contributes a significant portion to the GDP of the U.S. and world economies. The automobile industry is considered a key indicator of a country's overall economic performance. In the U.S., automakers are the largest manufacturing employers. Second, the automobile industry is one of the best industries to study competition, as a major portion of the U.S. market is occupied by the big five automakers: General Motors (GM), Ford, Chrysler, Honda, and Toyota. These five companies account for about 70% of the U.S. automobile market (WSJ, 2011). Third, the presence of international competition enriches our data and results. The choice of automobile industry allows us study the stock performance under disruptions for three major *American* brand companies (GM, Ford, and Chrysler) and two *Japanese* brand companies (Toyota and Honda). Note that throughout this paper we will use "American automobile companies" for GM, Ford, and Chrysler, while Toyota and Honda will be referred to as "Japanese automobile companies." Also note that our research is focused only on the U.S. markets, both products and stocks.

To understand the effect on shareholder returns, event study methodology is applied to estimate abnormal returns around the date of a supply chain disruption announcement. These returns represent the actual change in stock value after adjusting for market-wide influences. The inherent design of event study methodology controls for the effect of the market-wide movements by calculating the abnormal returns. For other specific announcements related to the companies in our sample, we believe they are idiosyncratic and our sample size (408 announcements) helps control the potential contamination effect from other value-relevant announcements. We examine factors such as the market cycle and competitor announcements. The analysis also separates American and Japanese automobile companies in order to understand the difference between these companies from a shareholder's perspective.

Literature review

The literature dealing with supply chain disruptions is rich and growing. Both analytical and empirical studies have focused on planning and managing supply chain disruptions. Craighead, Blackhurst, Rungtusanatham, and Handfield (2007) and Snyder and Shen (2009) provide thoughtful literature reviews on supply chain disruptions. Craighead et al. (2007) address supply chain design characteristics and mitigation capabilities. While discussing the severity of disruptions and using case studies and interviews, they propose a sequence of prepositions related to supply chain complexity, density, node criticality, and recovery capability. A review of 67 publications by

Hohenstein, Feisel, Hartmann, and Giunipero (2015) provides an overarching definition of supply chain resilience. Their study also reveals gaps in research and motivate further development of quantitative research to address supply chain resilience. A formal and practical framework for risk identification, assessment and mitigation is developed by Kern, Moser, Hartmann, and Moder (2012).

A significant literature exists on the resilience and robustness in supply chains. Durach, Wieland, and Machuca (2015) discuss antecedents and dimensions of supply chain robustness and provide a comprehensive framework to understand the role of robustness in supply chain management. Wieland and Wallenburg (2012) show that robust supply chains have superior performance and are better at creating customer value. In contrast, traditional focus on agile supply chains create customer value but may not improve supply chain performance. Shukla, Lalit, and Venkatasubramanian (2011) using a scenario planning approach model explore tradeoffs between efficiency and robustness. A mixed integer program model is used to show significant amounts of robustness could be achieved without compromising on efficiency. While robustness and resilience in supply chains as focused by Hohenstein et al. (2015) and Durach et al. (2015) are important, these practices may require capital investment with a promise of returns in the event of a disruption. Since disruptions are low probability events, managers may face challenges in justifying investment in such practices. Disruptions can cause severe financial losses. Mitigation and recovery efforts could also be expensive. Our research help quantify the financial impacts from disruptions. A manager could use our quantification to justify small investments in resilience and robustness to help avoid potentially large losses from disruptions.

The literature relating supply chain management and financial performance is limited. Research has shown that effective supply chain management practices could lead to better shareholder value. Filbeck, Gorman, Greenlee, and Speh (2005) demonstrate that the adoption of supply chain management-enhancement tools result in a positive share price reaction, and the strength of the reaction is positively related to the degree of certainty regarding the publication date. Some studies have documented Just-in-Time (JIT) inventory policies and its effect on profitability (Fullerton, McWatters, and Fawson, 2003). Roumiantsev and Netessine (2007) studied the stockholder earnings related to responsive inventory management. Chen, Frank, and Wu (2005) relate inventory turnover with long-term stock performance.

Our research and methodology is closely related with Hendricks and Singhal (2003). They compiled announcement data involving supply chain *glitches* (events that caused production and shipment delays). The data

was then used to study its effect on shareholder wealth of the affected companies. Results show a marked decrease in shareholder value following an event. They also reveal insights such as larger firms experience less negative impact, and firms with higher growth prospects experience a more negative stock price impact. Pre-1995 and post-1995 glitches and capital structure are shown to have no difference in their effects on stock returns. Hendricks and Singhal (2005a) using similar data find that in the long term (one year pre- and post-glitches) the stock reaction to disruptions is nearly –40%. Over the long term, the equity risk was higher by 13.5% in the year following the disruption. Hendricks and Singhal (2005b) compare the performance of companies that announced disruptions to other companies (who did not announce a disruption in the event period) and make inferences about operating income, return on assets, return on sales, inventory growth, and sales growth. Companies announcing disruptions were found to experience decreased performance on all these measures.

Schmitt and Raman (2012) study the stock price effect of disruptions on companies that had announced efficiency improvements. Excessive focus on efficiency leads to supply chains that are prone to disruptions (Shukla et al., 2011; Stecke and Kumar, 2009). Investors are aware of this downside of efficiency initiatives. Schmitt and Raman (2012) argue that the higher is the rate of efficiency improvements, the more is the negative stock impact from disruptions. However, since efficiency initiatives are often *internal* to a company, the negative stock impact is limited to internal disruptions. External disruptions (that originate at suppliers or customers) do not lead to stock price decline. Their primary contribution is to show that the effect of a disruption on stock performance depend on the source of a disruption. Managers are aware of the relationship between disruptions and stock value. Schmitt and Raman (2012) also find that managers are prone to under-report disruptions that are less damaging to the firm value.

Despite scarcity in the supply chain management literature, the accounting and finance literature offer many studies on the effect of important events on competitor's stock price. Some of these events include new major orders, large dividend announcements, bankruptcy announcements, litigation, acquisitions, leveraged buyouts, new product introductions, stock repurchases, and international cross-listings.

Our research is focused on the automobile industry. A major portion of event studies related to the automobile industry deal with product recalls. Research indicates both increase and decrease in sales after automotive recalls (Hoffer, Pruitt, and Reilly, 1987). Research also seems to indicate that automobile recalls results in a negative stock impact (Jarrell & Peltzman, 1985). Besides showing a negative 0.81% abnormal return, Jarrell and Peltzman (1985) also find that the shareholders of firms producing recalled automobiles bore greater financial

losses than the direct costs of recalling the defective products. Rhee and Haunschild (2006) find that firms within the automobile industry that have a strong reputation experience greater market share downside from product defects and the release of product recall announcements than those with weaker reputation firms. Other studies relating automobile recall to stock price include Hoffer et al. (1987), who documents a 0.56% reduction in stockholder equity for *severe* automobile recalls.

For automobile companies, research has also focused on studying the effect of product recalls on competitors. Jarrell and Peltzman, (1985) while analyzing only *large* automotive recalls, show that recalled product company's competitors experienced a comparable decline in stock price. They argue that recalls may have a positive effect on the competitor; however, any favorable effects on competitors' demand from a recall were overwhelmed by negative demand effects on the entire industry. Another stream of research aims to understand the differences between stock performance of Japanese and American automobile companies under various events. Barber and Darrough (1996) examine the market's reactions to automotive recalls over different time periods and whether this reaction differs between Japanese and American companies. They conclude that Japanese automakers experience less frequent recall, but the stock reaction to the recalls is more negative when compared to American automakers. Barber, Click, and Darrough (1999) study the impact of fluctuating exchange rates and oil price on demand for Japanese and American automobiles. When compared to American automakers, Japanese automakers are shown to be more resilient to oil-price variations while a stronger Yen hurts the demand for Japanese automobiles.

Hypothesis development

Today's marketplace is competitive. Success requires managing the whole supply chain effectively. Well-managed supply chains are expected to have plans and resources to help prevent and manage disruptions. Robust and reliable supply chains lead to improved supply chain performance and create customer value (Weiland and Wallenburg, 2012). Disruptions in supply chains could be attributed to internal as well as external causes. Internal causes include poor operational, marketing, accounting, and financial planning as well as product and service design issues. Disruptions could also be caused by external factors such as regulations, catastrophes, accidents, and terrorist acts. Nevertheless, disruptions could hamper a firm's ability to fulfill customer expectations, thereby affecting short and long-term profitability of the company. Therefore, disruptions may have implications for stock returns for the shareholders. Supply chain disruptions may also negatively impact the reputation of a company, which could have implications for its financial future and ability to raise capital. Some believe that the image of the company has a

large bearing on the stock price (Rhee and Haunschild, 2006). Time and monetary resources may be needed to restore the lost reputation, which in turn reduces the potential stockholder's earnings (Chopra and Sodhi, 2004).

Managers are potentially aware of stock market consequences of disruptions. Schmitt and Raman (2012) argue that managers recognize the potential stock impact of supply chain disruption. They show that managers systematically choose to under report disruptions that are less damaging. Based on these arguments we propose our first hypothesis.

H1: *Supply chain disruptions announcements by automobile companies have a negative stock reaction.*

Hypothesis 1 is intended to show the negative consequences of disruptions announcements on stockholders of automobile companies. The hypothesis is in line with Hendricks and Singhal (2003) who, using a sample of 519 supply chain *glitches* data from various industries, estimate a stockholder equity decline of 10.28% during the event window of (-1,0), i.e., a day before and the day of disruption announcement. We test hypothesis 1 to ascertain the validity of our dataset by corroborating with results of Hendricks and Singhal (2003). Kumar, Liu, and Scutella (2015) find that negative consequences of supply chain disruptions are not limited to the companies in the United States. They extend Hendricks and Singhal's (2003) results to the Indian stock market. Despite higher stock volatility, following a disruption, statistically significant stock declines are observed for companies traded in the Indian stock market.

Our second hypothesis explores the stock performance of automobile companies in different market conditions. The stock market's reaction to various events may be state dependent and differ between bear and bull markets. Kurov (2010) conclude that stocks in bear markets are more sensitive to changes in monetary policy changes when compared to bull markets. Docking and Koch (2005) find that announcements of dividend decreases elicit a significantly smaller decrease in stock price in bull markets, relative to bear markets. Their results indicate that the firm-specific news is perceived as more important when the nature of the news goes against the recent direction of the market. Disruptions may imply lack of resilience and an inability of a firm in managing supply chain operations resulting in potentially smaller dividends for investors.

Many economists emphasize the psychological and behavioral elements of investors to be partially responsible for daily stock movements (Malkiel, 2003). These elements could differ in bear and bull markets. In bull markets, negative information may not be seen with as much skepticism about the future of a company. However, in a bear market, the stockholders may look at negative information with greater pessimism. Others have also

speculated about difference in stockholder's behavior in varying market conditions. De Bondt (1993) hypothesizes that investors return expectations are left skewed in bull markets and right skewed in bear markets. Despite strong theoretical foundation, their results are inconclusive. Kahneman and Tversky (1973) motivate the idea of an *overreaction hypothesis,* which is based on the psychological alternative to efficient market hypothesis. In support of the overreaction hypothesis, De Bondt and Thaler (1990) find that besides the investors, security analysts are also prone to overreaction in estimating earnings. Managers do take into considerations state variables while announcing disruptions.

State dependence and psychological and behavioral aspects of stock markets indicate that the news of supply chain disruptions may be perceived differently in bull and bear markets. To understand the way stockholders of automotive companies perceive disruptions news, we propose hypothesis 2. We also propose two sub hypotheses for bear and bull market, respectively.

H2: *The stock market's reaction to disruptions announcements by automobile companies is affected by market conditions.*

H2 Bear: *The negative reaction to disruptions announcements for automobile companies is more pronounced in bear markets.*

H2 Bull: *The negative reaction to disruptions announcements for automobile companies is less pronounced in bull markets.*

Our next hypothesis, H3, seeks to understand the differences between reactions by stockholders of American and Japanese automobile companies. The operations management literature seems to indicate that many of the current efficient supply chain practices were pioneered by Japanese automakers. Some of these include Total Quality Management, Kaizen, six-sigma, pull production, zero-inventory, supplier involvement, and JIT. These practices are attributed with improved operational performance of supply chains (Su, et al., 2014; Shah and Ward, 2003). Many American companies have tried to benchmark the Japanese management and operations practices to achieve operational efficiency (Ro, et al., 2008).

Lean management (more generally, a Japanese style of management) is attributed to aid in preventing and recovering from disruptions. Simplification is the essence of lean management (Hadid and Mansouri, 2014). Complexity in supply chains and systems create an increased potential for disruptions. Buffers increase complexity. Adding buffers also reduce visibility in supply chains (Christopher and Lee, 2004). Lean management systems, as

developed by the Toyota Production System, systematically reduce the level of complexity in supply chains, thereby increasing visibility across supply chain connections (Spear, 2004). Simplicity, coordination, and visibility in the supply chain are keys in managing supply chain disruptions (Stecke and Kumar, 2009). These arguments indicate that lean management can achieve both reliability and responsiveness, thereby reducing the likelihood and severity of supply chain disruptions.

Companies have realized the benefits of strategic relationships with supply chain partners. However, compared to the U.S. automakers, Japanese automakers give more importance to trust-based supplier-automaker relationship (Dyer and Chu, 2011). Nevertheless, supplier relationships have been effectively used by companies across the world. Considering a traditional perspective, Japanese automakers are considered better at managing supplier relations strategically. While dealing with suppliers, American automakers have historically used an *arm's-length* model while Japanese companies have employed a *partner* model (Dyer, Cho, and Chu, 1998). Typically in a partner model, long-term relationships are common and suppliers and manufacturers have stakes in each other's success. Even when buyers do not have a direct investment in the suppliers, indirect investment exists via the benefits of a long-term relationship. Therefore, a partner model network of suppliers inextricably links the financial health of firms in the supply chain (Swinney and Netessine, 2009). The Japanese supply chain members are also involved in heavy cooperation, which limits the defaults by the suppliers. In comparison, American companies have a short-term, non-cooperative relationship with their suppliers and thus defaults are not uncommon (Dyer et al., 1998). Moreover, excessive focus on efficiency without other Japanese supply chain attributes (such as supplier involvement, strategic partnerships, and cooperation) could lead to supply chains that are prone to disruptions (Shukla et al., 2011). The coordination and cooperation between supply chain partners may help Japanese companies effectively manage disruptions.

Japanese businesses and specifically big Japanese automobile makers may benefit from certain cultural aspects. When faced with disruptions, Japanese companies and even competitors are known to work together and cooperate so as to achieve mutual success (Kumar, Liu, and Caliskan, 2016). Using Hofstede's cultural dimensions model, Kumar et al., (2016) suggest that the better abilities of Japanese companies in managing and preventing disasters could be attributed to Japanese national culture. Considering the arguments presented in support of Japanese companies being better at preventing and managing disruptions, we expect the stock market to impose a less severe penalty (negative stock reaction) when compared to American companies. Using similar arguments we

propose sub-hypothesis for bear and bull markets.

H3: *Supply chain disruptions announcements by American automobile companies will have a higher negative stock reaction than Japanese automobile companies.*

H3 Bear: *The negative reaction to disruptions announcements for American automobile companies is more pronounced in bear market when compared to Japanese automobile companies.*

H3 Bull: *The negative reaction to disruptions announcements for American automobile companies is less pronounced in bull market when compared to Japanese automobile companies.*

Since the equity market is competitive, it is intuitive to assume that information about competitors will have an effect on the company's stock prices. Financial contagion has been observed for various value relevant events. Hertzel, et al., (2008) study share price reactions for bankruptcies declared by competitors. Stock and product market performance of a company is affected by its supply chain partners. A disruption at a company is expected to cause financial losses for its suppliers and customers. Chen, Liao, and Huang (2014) reveal contagion along supply chain members (supplier, distributors, and customers) from corporate failure resulting from the financial crisis of 2007-2008. Owing to decentralization and globalization, companies (even competitors) often share supply chain resources such as suppliers and transporters. This relationship implies that disruptions may have financial consequences for competitors. The recent financial crisis also highlighted the relationship between financial risk management and supply chain finance. Bastos and Pindado (2013) find that firms possessing greater risk attempt to avoid the threat of bankruptcy by increasing accounts receivable as they postpone payments to suppliers. These higher risk firms are more likely to use trade credit rather than bank credit as a form of financing from their suppliers. In addition, Jinjarak (2015) finds evidence of contagion effects in balance sheets for firms along supply chains during the financial crisis. In particular, industries with specific investment and contract intensity in input supplier-customer relationships are more vulnerable to credit-market shocks.

Since stock returns are affected by state variables, contagion could also be affected by market cycles. Helwege and Zhang (2013) while investigating contagion from the Lehman bankruptcy find that contagion is more prominent in recessionary (bear) market. Their analysis indicates contagion is also more prominent for companies with higher market capitalization and risk levels. Using a sample of firms experiencing asbestos litigation, Hadlock and Sonti (2012) explore the financial strength of product market competition. Asbestos liabilities were inversely related to share price reaction for competing firms. Stock market contagion is also observed in new product

introduction. Chen et al. (2002) find that new product introduction result in strong share price reactions for firms that offer substitute products. Significantly smaller stock price reactions are observed for competitors offering complements. Mergers and acquisitions result in industry synergy and result in financial contagion for competitors. Larger competitors experience positive stock returns (Croson, et al., 2004). These arguments indicate that financial performance of competitors is interlinked with the product market and stock market.

A disruption may affect the short- and long-term ability of a company to meet its customer needs. As a result, competitors of a disrupted company may improve market image and potential to generate future revenue by increasing their market share. This in turn could help stock performance of disrupted company's competitors. Our next hypothesis relates the stock performance of competitors when one of them announces a supply chain disruption. Since markets may behave differently in bear and bull market we hypothesize for these markets too.

H4: *Competitors in automobile industry experience a positive stock price reaction to announcement of supply chain disruptions.*

H4 Bear: *In bear market a more positive stock price reaction is experienced by automobile companies when a competitor announces a supply chain disruption.*

H4 Bull: *In bull market a less positive stock price reaction is experienced by automobile companies when a competitor announces a supply chain disruption.*

Japanese automakers pioneered JIT and lean manufacturing systems. Their operational efficiency and success in American automobile market is partly attributed to manufacturing practices, local supplier development, strategic partnerships (Ro et al., 2008). American automakers have tried to emulate Japanese manufacturing practices and supply chain logistics, however, American automakers have not been able to match Japanese counterparts' performance (Bhamu and Sangwan, 2014; Liker and Wu, 2006). Over time, American automakers have shifted to long-term supplier relationships. However, the results have not been at par with Japanese counterparts. Differences in culture and trust issues between companies have constrained the applicability of Japanese practices for American companies (Zhang, Henke, and Viswanathan, 2015; Helper and Sako, 1995). Japanese automobile companies are often considered to have superior performance and reputation than American automakers. They are also attributed with better management and prevention of disruptions. Stock markets are influenced by perception and reputation of companies (Rhee and Haunschild, 2006).

The practice of lean management and JIT help with operational efficiency. Owing to shorter lead time and

low inventory, these practices could also be helpful in faster recovery form disruptions (Stecke and Kumar, 2009; Marley, 2006). The practices may also help limit the losses from disruptions. Lean management along with supplier collaboration help Japanese automakers in introducing new models faster than American automakers (Helper and Sako, 1995). Such responsiveness could also help them gain market share when a competitor is down because of a disruption. Inventory and market responsiveness affect stock market returns (Roumiantsev and Netessine, 2007).

Our next set of hypotheses relates the aspects of competition as well as the native country of the automobile brand. Using the arguments presented above and that for H3 and H4, we expect Japanese companies to have a greater positive impact when American companies announce supply chain disruptions.

H5: *Japanese companies experience a more positive stock price return when a competitor announces a supply chain disruption.*

H5 Bear: *In a bear market the positive stock impact is higher for Japanese companies as compared to American companies when a competitor announces supply chain disruption.*

H5 Bull: *In a bull market the positive stock impact is lower for Japanese companies as compared to American companies when a competitor announces supply chain disruption.*

Methodology and results

Sample selection and description of disruptions

We searched the full text articles in the *Wall Street Journal* (WSJ) and the *Dow Jones News Service* (DJNS) to collect a sample of supply chain disruption announcements for the automobile industry for the period of 1990–2010. The keywords searched covered a variety of disruptions. A sample of these keywords include supplier breakdown, design issues, production delays, inventory shortfall, poor planning, inaccurate forecast, strike, transportation delay, accidents, data breach, fire, earthquake, and ethical complaints. We analyzed the resulting news announcements to determine those that resulted in disruptions in supply, demand, production, inventory, distribution, or transportation at one or more stages of a supply chain. Some examples of disruptions that we found for the automotive industry include, manufacturing problems delay Edge and Lincoln MKX, parts shortage causes trimmed output, hurricane hits supplier, recalls delay production, and demand dries up supply.

We collect 420 announcements of disruptions for the five automotive companies within the industry. Of these announcements, we delete the events if the day surrounding the event did not have return data from Center for Research in Securities Prices (CRSP) database. The final sample consists of 408 viable announcements.

To analyze whether the result is related to business cycles, we use the National Bureau of Economic Research's (NBER) data to determine the bull and bear market cycles. Specifically, we follow Kim and Burnie (2002) and identify peak and trough dates based on the NBER data. The peak dates in our study sample from NBER are July 1990, March 2001 and December 2007. The trough dates are March 1991, November 2001, and June 2009. Then, we define the trough to peak cycle as bull market periods and peak to trough as bear market periods.

Table 1

Table 1 Panel A shows the descriptive statistics of our disruptions for each of the five companies and the market periods. The statistics indicate that of the total 408 disruptions, 325 were reported in bull market period. A significant number of disruptions by American auto companies (i.e., Chrysler, Ford, and GM) were announced during bull market period. In contrast, for Japanese auto companies (i.e., Honda and Toyota) the disruptions announcements were evenly distributed in bear and bull markets. Disruption types are reported in Table 1 Panel B, while Panel C reports the primary location and responsibility of disruptions.

Table 2

Table 2 shows the summary statistics for each auto company stock during our sample period. For each auto company in each year, we calculate market capitalization as the previous year end share price times the number of shares outstanding. A company's U.S. percentage sale is calculated as the company's U.S. sales[1] divided by its total sales for that year. For each year, we also calculate annual sale growth rate compared with the previous year. From Table 2, we notice that Japanese companies are relatively larger in size and higher in growth rate compared with American companies. Also, Japanese companies have lower U.S. percentage sales compared with American companies.

Event study results

An event study is a statistical technique used to estimate the stock price impact from a value-relevant event such as mergers, bankruptcies, and earnings announcements. At its core, the purpose of event study methodology is to separate the impact of a specific information (e.g., disruption announcement) from other information that affects the market or industry (Dodd and Warner, 1983; Patell, 1976).

In this section, we examine the announcement effects associated with the supply chain disruptions. We define the announcement day as the event day (t=0). If the announcements were made during the weekend or during

[1] Starting in 1998, FASB No. 131 required firms to report certain financial information for any industry segment that comprised more than 10% of its consolidated yearly sales, assets, or profits. This industry segment information is contained in the Compustat industry segment files. The industry segments are divided into business, geographic and operational segments. We retrieve the annual sales for each company's geographic segments for this study.

a non-business day, we define the event day as the next available business day following the announcement. The practice of choosing next available business day is standard in Finance (Patell, 1976) and Operations Management (Hendricks and Singhal, 2003; Schmitt and Raman, 2012; Kumar, Liu and Scutella, 2015) literature. In order to test for possible leakage of approaching news or delayed investor response, we test the share price response to the announcements beginning five days prior to the announcement date by calculating cumulative abnormal returns (CARs) over our event window (days –5 to +5). Expected returns are estimated from the market model during the interval (–5, +5), and estimates of the parameters are calculated for the period (–326, –71). We follow Dodd and Warner (1983) and employ standard event-study methodology. For brevity we do not present details of the event-study. Readers could request the details from the corresponding author.

Table 3

Table 3 reports the results of the event study for the whole event sample and market cycle sub-samples. For the whole event sample, we observe a statistically-significant (at 1% level), negative CAR of -0.99% over the event window (–5, +5). The result supports H1. If we examine the results based on business cycle, we observe that the event sample has more negative CARs during bear market compared with CARs during the bull market. T-test results indicate that the CARs during the bear market are statistically significant (at 1% level) and lower than the statistically insignificant CARs during the bull market. The T-test results are omitted for brevity. This implies that the automobile industry's stock reaction is affected by market cycles, which supports H2, H2 Bear, and H2 Bull.

Table 4

Table 4 Panel A reports the results for American auto companies, and Panel B reports the results for Japanese auto companies. Overall, both American companies and Japanese companies yield negative abnormal returns over the event windows, and Japanese companies seem to have more negative CARs compared with American companies, counter to our hypothesis H3. For example, Japanese companies yield a CARs of –1.66% over the event window (–5, +5) while the corresponding number for American companies is –0.82%. However, T-test results indicate that the difference of CARs between American and Japanese companies are not statistically significant.

As hypothesized in H3 Bear, Table 4 also shows that business cycles have bigger impact on American companies than Japanese companies. For example, we observe a statistically-significant (at 1% level) negative CARs of –6.72% during the (–5, +5) window for American companies during the bear market period, while the corresponding figure for Japanese companies is –2.12%. During the bull market period, we do not observe

significant announcement effect on American companies but marginally significant (at 10% level) negative CARs of –1.22% over the window (–5, +5) for Japanese companies. The T-tests on whether the CARs over (–5, +5) for American and Japanese companies are different show statistically significant (at 1% level) results.

The results for H3 Bull hypothesis are not conclusive when considering a (–5, +5) window, however, during the interval (–1, 0) the stock return is negative and statistically significant at 1%. This may indicate that the markets do react to disruptions during bull markets but the negative effect dissipates quickly. This could be attributed to market dynamics and general trend of the market.

Table 5
Table 6

To examine whether the disruptions will affect their competitors, we calculate the CARs for the same event windows and report the results in Tables 5 and 6. Specifically, for each event day (announcement day), we identify the event company (e.g., Honda) and the remaining companies in the auto industry (i.e., Chrysler, GM, Ford, and Toyota) are considered as competitors. For our 408 announcements, we identify 1,440 viable competitors/events. Then we calculate the CARs for these competitors and calculate the Z-stat for test of significance.

Results of Table 5 show that overall we do not observe significant announcement effects on the competitors. However, if we compare the CARs of competitors during bear market and bull market, we observe statistically significant (at 1% level) negative CARs of –1.65% in the former while an insignificant CARs of 0.01% in the latter for the (–5, +5) window. The results for bull periods are also negative and significant but only in the interval (–1, 0). Competitors do experience negative returns in both bull and bear cycles. However, the negative returns occur for a short duration under bull market. This suggests that whether competitors are affected by the auto disruptions is dependent on the business cycles. Therefore, we did not find evidence supporting H4, i.e., markets do not reward or penalize a competitor when a disruption is announced. However, under the bull market, competitors do have a significant impact, albeit, in a direction opposite to what we hypothesized in H3 Bear.

When we divide our whole competitor sample into American competitors and Japanese competitors, from the results of Table 6 we find that American competitors are hit more by auto disruptions during the bear market when compared with Japanese competitors. Overall, we do not find significant announcement effects on Japanese competitors for the event window of (–5, +5) for all of our sub-periods. We did not find any evidence to support hypothesis H5 as neither American nor Japanese competitors registered a positive stock return following disruptions announcements by competitors. In contrast, we found that Automobile competitors are penalized when a disruption

is announced. The penalty was significant and higher for American competitors in bear market when compared to bull market or Japanese competitors.

Table 7

To test whether disruptions that come from American companies or from Japanese companies make any differences in the stock market response to the competitors, we divide our disruptions into American disruptions and Japanese disruptions. Over our whole sample period, there are 84 Japanese disruptions and 324 American disruptions. Then we divide our competitors into American competitors and Japanese competitors and test whether the competitors have different announcement effects based on where the disruptions emerge. We report the results in Table 7. The results show that overall investors do not differentiate from where the disruptions emerge, as none of our CARs over the event window (–5, +5) are significant.

Our results indicate that disruptions do have consequences for competitors. Although the results indicate that, in general, along with the affected company, competitors also experience decline in stock returns. Differences were observed between stock impact on Japanese and American companies as well as market cycle. The results are summarized in Table 8.

Table 8

Regression results

Our results indicate that the event sample yields significant negative CARs surrounding the announcement date, and this effect is more evident during bear markets. Conversely, we do not observe significant effect for competitors in the auto industry except during bear markets. However, our event study results may have a lack of independence problem, as investors may respond negatively to a particular auto company in general.

To further test whether the event study results can be explained by the business cycle, sample period and stock characteristics, we use regression analysis. In the regressions, the CARs during the window of (–5, +5) serve as the dependent variable, while the dummy independent variables include Bear (Bear=1 if the market is in bull market period, and =0 otherwise), and American (American=1 if the company is an American auto company, and =0 otherwise) as described in Table 9. We also include some stock characteristics to control for such differences in our regression model. CAP is the market capitalization and we take the log as this variable is highly skewed. Psale_U.S. is the U.S. percentage sale during the event year, and Sale_growth is the growth rate of sales during the event year.

Table 9

Table 9 Panel A reports the results for the event sample. The coefficients on the dummy variable Bear are

negative and significant at the one percent level in all models. These results indicate that investors earn negative CARs if they invest in the auto stocks during the bear market. In addition, the results show that factors such as whether the company is American and stock characteristics (e.g., firm size, growth rate of sales or U.S. percentage sales) do not have significant impact on CARs.

To provide further evidence, we conduct regressions for the whole sample and report the results in Panel B. We include a new dummy variable event (Event=1 if the stock belongs to the event sample, =0 otherwise) in the regressions. The results indicate that if an auto company was experiencing a glitch during the bear market periods, investors who invest in this stock may have negative CARs surrounding the announcement dates.

Implications and conclusions

Discussion and implications

A survey by Business Continuity Institute (2013) of industry practitioners from the world's leading economies found that 75% of the companies experienced at least one disruption in the past 12 months. Similarly, World Economic Forum (2014) concluded supply chain disruptions as a critical global economic risk. In recent years, researchers and practitioners have focused on studying disruptions and developing supply chain risk mitigation strategies (Tang, 2006). Understanding and managing disruptions in supply chains is an important but complex issue (Pfohl, Gallus, and Thomas, 2011). The complexity arises because of numerous interactions between supply chain partners as well as competitors. Companies compete for market share and operating resources. A disruption could hinder the flow of raw material, products, information, and finances and impact financial performance of a company.

Past studies have shown that supply chain disruptions result in diminished stockholder wealth. We contribute to the literature by extending the results for competitors and different economic cycles. We also explore if Japanese automakers fare better during disruptions. In studying disruption effect of competitors, two conflicting theories could be suggested. First, viewing from *market perspective*, disruptions at a company create opportunities for competitors to strengthen market share. This perspective may indicate improved future market prospects for competitors and thus could result in positive stock returns for competitors. In contrast to a market perspective, a *supply chain perspective* could imply diminished returns for competitors, too. This perspective arises as in many industries competitors share production resources such as suppliers and customers. Negative financial consequences of disruptions extend beyond the affected company. Disruptions at supply chain partners (upper and lower echelons) result in negative stock returns for a company (Hendricks and Singhal, 2003).

Our findings are in agreement with prior research. We find that a disruption, on average, reduces the shareholder value by about one percent. The potential contribution of effective supply chain management, if successful in preventing a disruption, could be one percent of shareholder value. Using market capitalization, a potential disruption prevention contribution (savings) is $312 million for GM and $1,370 million for Toyota. The quantification provides a basis to estimate the value of effective supply chain management and could help management justify investment in disruptions prevention and mitigation methods.

Similar to other value relevant event announcements (monetary policy in Kurov, 2010; and dividend announcements in Docking and Koch, 2005), automobile company's stock market reaction to disruptions is affected by market cycles. When compared to bull market cycle, investors penalize a disrupted company more during bear market cycles. On an average, following a disruption, automobile companies experience a decline of 4.48% in stockholder equity. For Toyota such a loss during bear cycle would be $6,137 million.

When accounting for market cycles as well as brand domicile of the affected company, we observe that Japanese companies suffer statistically indifferent negative returns in bull and bear market cycles. However, the American companies see a significantly larger negative return in a bear market compared to a bull market. A disruption announcement by an American company shows no abnormal return in a bull market, while a stock decline of –6.72% is observed in a bear market. For a company like GM, such losses could account for a stockholder wealth loss of $2,096 million. In contrast to our results, while studying automobile recalls, Barber and Darrough (1996) report that Japanese automakers experience less frequent recalls but a larger stock decline than American automobile makers. Our results are, however, in agreement with Barber et al. (1999) who show that Japanese automakers are more resilient to industry events such as fluctuating currency exchange rates and oil price.

When ignoring market periods as bull or bear, we did not find any evidence of contagion, and the effects of disruptions are limited to the company that announces it. However, analysis of market cycles provides an interesting and different insight. As seen in H2, during a bear market, automobile markets exhibit significant contagion. Note that we observed higher stock decline in bear markets. The contagion is specifically significant for American automakers. In contradiction to our hypothesis, we find that American companies experience a negative stock reaction when a competitor announces disruptions. In bear market, a disruption announcement by Toyota could lead to $823 million loss for GM shareholders. This finding could be attributed to complex supply chains where

competitors share resources such as suppliers, OEMs, and logistics channels. In this scenario we observe supply chain perspective to be stronger than the market perspective of supply chain contagion from disruptions. Japanese automakers did not experience contagion in either type of market cycle. We speculate that perhaps being an international domicile companies and relatively newer (than American auto makers) companies, Japanese auto makers have relatively less interconnectedness with competitors' supply chains.

Our results are in agreement with Jarrell and Peltzman (1985) who found contagion from large product recalls in automobile industry. They also reported a stock decline for competitors when an automobile company recalls products. However, they did not segregate the analysis to bear and bull markets. The financial performance of American automakers is interlinked with their competitors. Disruption mitigation practices used by competitors could also benefit a company. American automakers suffer losses when competitors have ineffective supply chains.

Our results indicate financial contagion in both vertical (suppliers and customers) and horizontal (competitors) supply chains. Here we summarize and explain the contagion and its possible reasons. Supply chain disruptions (at company C) could potentially affect a company's finances as the affected company could lose potential markets from disrupted supplies and operations. The company may also need to divert/invest funds for disruptions mitigation. These funds could have been otherwise used in efforts to generate returns for stockholders. Companies (say a supplier S) interacting with the affected company C in a vertical supply chain may also suffer consequences as these vertical (upstream and downstream) companies may (temporarily or permanently) lose supplies or customer. Therefore, as evidenced by past studies (Hendricks and Singhal, 2003), both C and S experience negative financial consequences of disruptions. Companies operating horizontally (usually competitors, say XC a competitor of C) to the affected company may also face consequences from disruptions. This may be explained by interconnectedness of competitors through suppliers of components and raw material. Companies C and XC may share supply chain resources such as the supplier S. Since disruptions at C causes negative returns at S, the consequences have the potential to negatively affect XC.

Our research underlines planning for disruption prevention and response. Not all types of disruptions could be prevented, however, with appropriate planning their potential impact could be minimized. Strategies such as alternate sourcing and flexibility have been well studied and are shown to be valuable disruptions mitigation tool (Stecke and Kumar, 2009). Several of the disruption types included in the database could be prevented or mitigated

with alternate sourcing and flexibility. Our results show that the potential benefits from such strategies are achieved more during bear market cycles. Perhaps, companies could focus more efforts on disruptions mitigation and prevention planning during bear market cycles. A temporary alternate supplier or acquiring of flexible facilities may pay greater dividends during bear markets. For automobile companies, it is not enough to plan for disruption at their own facility. Negative stock market effects of disruptions span across companies and industry competitors. Companies and even competitors may benefit by collaborative disruptions prevention and mitigation planning across the automobile industry.

Japanese automobile companies are credited for pioneering a number of efficient supply chain and operations management practices. Some of these practices help avoid and mitigate disruptions (Marley, 2006). In our data, disruptions reported by Japanese companies are much smaller in number as compared to American companies as illustrated in Table 1. One could speculate that the differences could be attributable to media bias and the greater scrutiny of American automakers. However, Barber and Darrough (1996) find that when compared to American Automakers, Japanese automakers experience less frequent recalls. Note that data on automobile recalls is reported by the U.S. Department of Transportation, which is not a media organization. In the event of a disruption during bull market cycle, we find that Japanese companies experience a higher negative return compared to American companies. Our findings are partly in contradiction to our hypothesis where we expected Japanese companies to be rewarded for efficient management practices. One possible explanation for this result is that since Japanese companies use management practices that induce efficiency and mitigate disruptions, a disruption announcement may imply a severe problem. To the investors, this may indicate a higher risk.

Toyota's Camry and Ford's Taurus are, by sales, two of the most popular cars of the last decade. Camry is 80% manufactured in the U.S.; while, for Taurus the percentage is only 65 (Cars, 2012). These facts are, however, ignored when the extant news media reports about American and Japanese automakers. In many cases, Japanese automakers are reported as "non-American." We differentiate between the disruptions announcements by Japanese and American automakers to understand if investors perceive the two companies differently. Our findings indicate that overall the stock market does not differentiate between the countries of origin of automakers. However, the distinction is apparent in bear market cycle when disruptions may cause pessimism in an already declining market.

Conclusions

Our main findings for a company that experiences and announces disruption are as follows: 1) supply chain disruptions result in statistically-significant negative CARs for affected companies. Moreover, the negative impact of disruptions is more noteworthy during bear markets and 2) American companies experience a more negative effect when compared to Japanese companies during bear markets.

By analyzing the effect of disruptions on competitors, we find that: 1) during bear markets (but not bull markets), supply chain disruption announcements negatively impact competitors' stock prices; and 2) the negative share price reaction to competitors is statistically significant for American competitors but not for Japanese competitors. Overall, investors earn negative CARs for companies experiencing a supply chain disruption if they invest in the auto event stocks during contractionary markets.

In this paper, we explore the impact of supply chain disruptions on competitors' stock performance in the automobile industry. Based on the efficient market hypotheses, we argue that such disruptions may negatively impact the shareholder value of affected firms, and ultimately positively impact the performance for competitors. We explore reaction on a short-term (announcement effect) basis and for longer holder periods. For automobile industry companies subject to supply chain distribution, we find statistically-significant, negative CARs with the largest negative returns generated during the troughs of business cycles. Supply chain disruptions result in loss of shareholder wealth. Moreover, shareholders experience higher losses during bear markets.

When separating the sample between American and Japanese companies as well as market cycle, we observe the negative announcement impact is qualitatively greater for Japanese companies than American companies, although the negative reaction to such announcements is significantly more pronounced in bear markets for American companies. During bull markets, the reaction to Japanese companies' announcements is more negative and statistically significantly different from the reaction to American companies, which runs counter to our hypothesis. Varying stock returns after disruptions indicate that investors differentiate between company domicile as well as the market cycle. Companies, based on domicile and market cycle may plan disruptions prevention and mitigation differently. Also, the returns from such efforts may vary based on the above factors.

Overall, we do not observe significant announcement effects on the competitors. However, differential reaction does occur during bear market and bull market. During bear markets, supply chain disruption announcements negatively impact competitors' stock prices. In addition, American competitors are hit more by auto disruptions during the bear market when compared with Japanese competitors, for which no share price reaction

occurs. We find that investors do not differentiate whether the disruptions themselves emerge from an American-based or Japanese-based company. Finally, we discover that investors earn negative CARs if they invest in the auto event stocks during contractionary markets, regardless of the time period or nationality of the automotive company or if the company was experiencing a supply chain disruption. Investors as well as supply chain managers may benefit by making decisions based on market cycle and company domicile. Their decisions could benefit by knowledge of competitors efforts or lack of efforts in disruptions planning and mitigation.

Our study has implications for supply chain managers who make decisions regarding investment and selection of disruptions mitigation methods. The results are also of interest to investors who may seek opportunities to take short positions on stocks within the industry based on scenarios in which negative abnormal returns occur. The study also motivates collaborative disruptions prevention and mitigation planning across industry. Extant research in supply chain management has shown potential benefits of disruptions prevention and planning investment. Our results show that potential benefits exist from such investments at competitors too. Managers across companies (even competitors within the industry) may benefit by pooling resources and collaborative planning for disruptions prevention and mitigation.

Although our research is ground-breaking, the ability to generalize to other industries that are less concentrated in leadership and competition may be limited. Our results could also be influenced by the type of disruptions that were considered in our database. Unlike our database that included a variety of supply chain disruptions, companies may benefit by selecting specific type/class of disruptions. We covered stock market and disruption data from the U.S.. To generalize the results, studies should include stock market in other countries (Kumar, Liu, and Scutella, 2015).

We focused on short-term effects of disruptions in automobile industry. Future research could explore contagion effects in longer-term. Our research could also be extended to other industries. We classified industries based on company domicile, other classifications based on size, financial-health, and product and supply chain characteristics could reveal additional insights.

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Table 1: Data
Panel A: Descriptive Statistics for the Event Sample.

Company	Bear market	Bull market
American companies		
Chrysler	6	48
Ford	24	123
GM	12	111
Japanese companies		
Honda	10	15
Toyota	31	28
Total	83	325

Panel B: Categories

Type of disruptions	Chrysler	Ford	GM	Honda	Toyota
Shortage	9	16	12	2	7
Customer order related	1	4	4	1	2
Capacity	4	19	0	0	3
Production and planning	9	22	25	2	7
Quality	12	32	31	7	14
Product recalls	9	16	20	3	5
Financial	1	1	0	0	5
Infrastructure	0	7	11	2	2
Natural events	2	0	3	1	5
Worker issues	2	8	10	0	0
Others	5	22	7	7	9
Total	54	147	123	25	59

Panel C: Primary Source/Location of Disruption

Source/Echelon of disruption	Chrysler	Ford	GM	Honda	Toyota
Supplier- Upstream	16	47	37	6	22
Internal- Company	20	54	51	12	16

Customer- Downstream	11	32	23	5	11
Other	7	14	12	2	10
Total	54	147	123	25	59

Table 2: Summary Statistics for the Event Sample.

	Market capitalization (million $)		U.S. percentage sales		Growth rate of sales	
Company	Mean	Median	Mean	Median	Mean	Median
American companies						
Chrysler	46,401.84	48,666.19	50.60	51.94	3.55	0.93
Ford	36,855.14	33,495.00	62.96	68.73	5.06	6.77
GM	31,223.66	31,776.83	71.73	72.88	3.25	4.84
Japanese companies						
Honda	66,135.72	71,190.93	45.79	46.59	11.94	11.82
Toyota	137,013.94	123,279.97	30.88	28.75	9.88	13.11

Table 3: Event Study Results for Event Sample Surrounding Disruptions Announcements.

	Whole Sample (n=408)		Bear Market (n=83)		Bull Market (n=325)	
Interval	CAR	Z-stat	CAR	Z-stat	CAR	Z-stat
(-5, -2)	-0.31	-1.36	-1.18	-1.44	-0.09	-0.44
(-1, 0)	-0.31	-1.70*	-1.14	-1.68*	-0.10	-0.65
(1, 1)	0.01	0.13	-0.19	-0.82	0.07	0.63
(-1, 1)	-0.30	-1.43	-1.33	-1.73*	-0.03	-0.18
(2, 5)	-0.39	-2.11**	-1.99	-4.27***	0.02	0.12
(-5, 5)	-0.99	-2.61***	-4.48	-3.28***	-0.09	-0.30

***,**,* indicate significance at 1, 5, and 10% levels, respectively.

Table 4: Event Study Results for American and Japanese Auto Companies surrounding Disruptions Announcements.

	Whole Sample		Bear Market		Bull Market	
Interval	CAR	Z-stat	CAR	Z-stat	CAR	Z-stat
Panel A. CAR (%) during event windows for American auto companies (n=324)						
(-5, -2)	-0.31	-1.16	-2.14	-1.45	-0.04	-0.17
(-1, 0)	-0.20	-0.89	-1.44	-1.15	-0.01	-0.04
(1, 1)	0.03	0.23	-0.08	-0.19	0.04	0.37
(-1, 1)	-0.17	-0.68	-1.52	-1.06	0.04	0.20
(2, 5)	-0.34	-1.62	-3.13	-4.48***	0.08	0.38
(-5, 5)	-0.82	-1.78*	-6.72	-2.67**	0.08	0.23
Panel B. CAR(%) during event windows for Japanese auto companies (n=84)						
(-5, -2)	-0.30	-0.78	-0.18	-0.28	-0.41	-0.93
(-1, 0)	-0.75	-2.87***	-0.82	-1.73*	-0.69	-2.74***
(1, 1)	-0.04	-0.27	-0.31	-1.61	0.22	0.96
(-1, 1)	-0.79	-2.52**	-1.13	-2.18**	-0.47	-1.29
(2, 5)	-0.57	-1.49	-0.82	-1.44	-0.33	-0.64
(-5, 5)	-1.66	-3.22***	-2.12	-2.59**	-1.22	-1.91*

***,**,* indicate significance at 1, 5, and 10% levels, respectively.

Table 5: Event Study Results for Competitor Sample surrounding Disruptions Announcements.

	Whole Sample (n=1440)		Bear Market (n=239)		Bull Market (n=1201)	
Interval	CAR	Z-stat	CAR	Z-stat	CAR	Z-stat
(-5, -2)	-0.04	-0.43	-0.18	-0.60	-0.01	-0.14
(-1, 0)	-0.15	-1.82*	0.06	0.19	-0.19	-2.73***
(1, 1)	-0.01	-0.27	-0.27	-1.58	0.04	0.73
(-1, 1)	-0.16	-1.63	-0.20	-0.49	-0.15	-1.79*
(2, 5)	-0.06	-0.63	-1.27	-4.79***	0.18	1.82*
(-5, 5)	-0.26	-1.57	-1.65	-2.83***	0.01	0.09

***,**,* indicate significance at 1, 5, and 10% levels, respectively.

Table 6: Event Study Results for American and Japanese Competitors surrounding Disruptions Announcements.

	Whole Sample		Bear Market		Bull Market	
Interval	CAR	Z-stat	CAR	Z-stat	CAR	Z-stat
Panel A. CAR (%) during event windows for American competitors (n=751)						
(-5, -2)	-0.12	-0.87	-0.72	-1.44	-0.01	-0.07
(-1, 0)	-0.11	-0.83	0.39	0.65	-0.21	-1.99**
(1, 1)	0.03	0.38	-0.19	-0.66	0.07	0.99
(-1, 1)	-0.08	-0.49	0.20	0.27	-0.13	-1.04
(2, 5)	-0.18	-1.21	-2.12	-4.83***	0.20	1.32
(-5, 5)	-0.38	-1.43	-2.64	-2.49**	0.05	0.22
Panel B. CAR (%) during event windows for Japanese competitors (n=689)						
(-5, -2)	0.05	0.39	0.38	1.20	-0.02	-0.13
(-1, 0)	-0.19	-2.10**	-0.27	-0.97	-0.17	-1.88*
(1, 1)	-0.06	-0.98	-0.34	-2.12**	0.00	-0.05
(-1, 1)	-0.25	-2.31**	-0.61	-1.84*	-0.17	-1.58
(2, 5)	0.07	0.58	-0.40	-1.46	0.16	1.26
(-5, 5)	-0.13	-0.69	-0.63	-1.41	-0.03	-0.13

***,**,* indicate significance at 1, 5, and 10% levels, respectively.

Table 7: Event Study Results of Competitors surrounding Different Disruptions Announcements.

	Japanese Disruptions (n=84)				American Disruptions (n=324)			
	Japanese Competitors (n=74)		American Competitors (n=186)		Japanese Competitors (n=615)		American Competitors (n=565)	
Interval	CAR	Z-stat	CAR	Z-stat	CAR	Z-stat	CAR	Z-stat
(-5, -2)	0.35	0.88	-0.24	-0.83	0.01	0.11	-0.09	-0.53
(-1, 0)	-0.50	-2.27**	0.00	0.00	-0.15	-1.56	-0.15	-1.02
(1, 1)	-0.08	-0.43	-0.15	-0.81	-0.06	-0.89	0.09	1.07
(-1, 1)	-0.58	-1.93*	-0.15	-0.37	-0.21	-1.82*	-0.06	-0.34
(2, 5)	-0.05	-0.13	-0.52	-1.71*	0.08	0.67	-0.07	-0.39
(-5, 5)	-0.29	-0.47	-0.91	-1.56	-0.11	-0.56	-0.21	-0.69

***,**,* indicate significance at 1, 5, and 10% levels, respectively.

Table 8: Summary of Results.

Hypothesis	Result	Table reporting results	Comments
H1	S, P	3	Automobile disruptions cause negative stock returns
H2	S, P	3	Market conditions affect stock outcome after disruptions
H2 Bear	S, P	3	Stock outcomes are more negative in bear cycle
H2 Bull	S, P	3	Stock outcomes are less negative in bull cycle
H3	C, P	4	Japanese companies have a more negative stock returns
H3 Bear	S, P	4	American companies experience more negative stock returns in bear cycle
H3 Bull	--	4	Significant negative returns are observed in (-1,0) interval only
H4	--	5	Inconclusive and insignificant result

H4 Bear	C, P	5	In bear market competitors experience negative stock returns
H4 Bull	--	5	Significant negative returns are observed in (-1,0) interval only
H5	--	6,7	Inconclusive and insignificant result
H5 Bear	C, P	6,7	American competitors experience more negative stock returns in bear cycle
H5 Bull		6,7	Significant negative returns are observed in (-1,0) interval only

Supported (S), Contradicted (C), and Significant (P)

Table 9: Regression Results of Event Days Returns.

Model	Intercept	log(CAP)	Psale_U.S.	Sale_growth	Event	Bear	American
Panel A. Regression Results for the Event Sample							
1	-8.289	0.525	0.033	0.015			
	(-1.40)	(1.05)	(1.63)	(0.43)			
2	-2.877	0.315	-0.009	0.008		-3.601	
	(-0.49)	(0.64)	(-0.42)	(0.25)		(-4.18***)	
3	-13.271	0.951	0.009	0.030			2.225
	(-2.06**)	(1.75*)	(0.38)	(0.84)			(1.91*)
4	-11.585	0.748	0.057	0.019			
	(-1.82*)	(1.43)	(2.14**)	(0.55)			
5	-10.440	0.881	0.010	0.023		-3.568	1.384
	(-1.50)	(1.56)	(0.33)	(0.65)		(-4.05***)	(1.19)
Panel B. Regression Results for the Whole Sample							
1	-0.261				-0.732		
	(-1.49)				(-1.96**)		
2	-0.070	0.016	-0.007	0.012	-0.474		
	(-0.02)	(0.07)	(-0.74)	(0.81)	(-1.32)		
3	2.152	-0.074	-0.023	0.001	-0.305	-2.476	
	(0.75)	(-0.31)	(-2.19**)	(0.09)	(-0.86)	(-5.89***)	
4	-0.558	0.063	-0.011	0.014	-0.546		0.322
	(-0.19)	(0.25)	(-1.00)	(0.94)	(-1.48)		(0.82)
5	-0.415	0.037	-0.003	0.015	-0.491		
	(-0.14)	(0.15)	(-0.24)	(0.98)	(-1.37)		
6	1.374	-0.019	-0.014	0.008	-0.352	-2.638	0.088
	(0.47)	(-0.08)	(-1.11)	(0.52)	(-0.96)	(-6.15***)	(0.22)

***,**,* indicates significance at 1, 5, and 10% levels, respectively.