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How do Crises Influence Sales: The Impact of the Diesel Scandal on Volkswagen's and the Automotive Industry's Sales

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Glossary

Consumer Reaction	The term relates to the manifold set of factors influencing a consumer's individual decision-making process as to whether a purchase is carried out or not. Deals with the purchasing behaviour of an individual. The term will be also referred to as customer reaction.
Crisis Event	Will be referred to as the potential cause of a crisis. A crisis is likely to ensue, yet it can also be prevented by taking the right measures.
Crisis	Refers to a negative situation following a crisis event, which can have different causes and different manifestations. Examples for causes can be for example natural catastrophes or accidents, but also man-made causes are possible e.g. corporate wrong-doing, or health issues caused by defective products. Also referred to as crisis situation in the study.
Volkswagen	Is a globally operating brand of the Volkswagen Group. Volkswagen is often solely linked to the diesel scandal, despite not being the only company involved. Thus, a clear distinction between Volkswagen and its parent company is necessary.
Volkswagen Group	Abbreviated by VWG in the study. It is a globally-active conglomerate in the automotive industry. It comprises inter alia: Volkswagen, Audi, Seat, Skoda, Porsche, Bugatti, MAN, Ducati, Lamborghini. In the analytical section of this study the VWG will be called a company, which means that results for the VWG depict the results for the entire conglomerate.

List of Abbreviations

GM	General Motors
VWG	Volkswagen Group
DS	Diesel Scandal
TBL	Triple Bottom Line
EPA	American Environmental Protection Agency
CAR	Cumulative Abnormal Returns
MSR	Market Share Return
GCBC	Good Car Bad Car
KBA	Kraftfahrtbundesamt

1. Introduction

1.1 Explaining the Study

In the interconnected and globalised business world, industries have grown, in which multinational, global companies have become able to operate in almost every country around the world. In this business environment, an unforeseen event, an unfortunate misjudgement or a wilful deviation from regulations in one company, can rapidly develop into a global crisis. The increasing frequency and magnitude of corporate crises has led to the research area of crisis management to expand in recent years. Here, particularly the questions of what the impacts and consequences of a crisis on a company and its industry are, and what can be done to reduce the damaging effects, have become increasingly important for governments, businesses and researchers alike (Pearson and Mitroff, 1993; Shin, Richardson and Soluade, 2012a).

1.2 Research Background

In this context, research has set a focus on identifying the magnitude and scope crises have. Crises were found to have a more negative impact if the cause was human induced, which points out that crises caused by companies cause more damage than crises occurring due to for example natural catastrophes (Pearson and Mitroff, 1993). Additionally, crises in one company are found to influence related companies, for example parent companies, business partners and also competitors (Fracarolli Nunes and Lee Park, 2016) There are numerous examples for such human induced crises and their impacts. The Enron and Arthur Andersen crises of 2001, the bankruptcy of Lehman Brothers in 2008 or the Deepwater Horizon catastrophe of 2010 are all consequences of corporate wrong-doings of different kinds. They all have had a considerable, general and unforeseeable economic, ecologic and social impact on a global scale, which has been subject to different kinds of studies (Asthana et al., 2009; Fracarolli Nunes and Lee Park, 2016).

More recent cases of fraudulent business conduct entailing global repercussions can be found in the automotive industry. In 2014 General Motors (GM) started recalling cars due to faulty ignition switches, which led to the shut-down of the engine and the deactivation of airbag systems in their cars, thereby indirectly causing potentially fatal accidents of their customers (Simpson, 2009). In the subsequent lawsuit GM decided to pay compensations to affected

customers, as it had become apparent that GM management wilfully did not solve the problem of defective ignition switches, despite knowing about potential risks of the built-in car parts for over a decade (Healey and Meier, 2014).

As opposed to this case, the most recent one, the Volkswagen Group's (VWG) Diesel Scandal (DS) contains a completely new dimension of irresponsible behaviour; deceptive manipulation through green washing (Siano, Vollero, Conte and Amabile, 2017). In 2015, German car manufacturing conglomerate VWG was convicted of manipulating emission values of their diesel-powered models in laboratory tests through a special software to cope with high environmental standards, when in fact the engines had emissions multiple times higher than allowed. Both cases differ essentially in their nature, as the GM case was dominated by self-deception, where the common belief was that although having faulty car parts no functions would be deactivated nor a life-threatening situation was possible. The DS in turn presents a case of direct customer deception, where the knowingly hampered emission values were used to promote an environmentally friendly image and sales[1].

1.3 Research Gap and Aim of the Study

Returning to the topic of crisis management, Coombs and Laufer (2018) identify the need to analyse the impact of a crisis on a company in different markets. Further, it is argued that the research is lacking findings of a comparative international crisis research approach, focusing on the crisis response strategies and the different reactions of stakeholders in different cultures. Since the VWG due to the DS faces these very issues, it becomes apparent that the case of is of high interest for the study field. Moreover, the case is also referred to as an organised crime (Levi and Lord, 2017), which highlights its general controversy and thus importance for business related research. Hitherto, scientists and economists have often used the approach of the triple bottom line, which originally claims that sustainability of e.g. a market action or a company is based on three pillars (TBL): (1) Economy, (2) Ecology, (3) Society; to analyse the implications of a crisis (Elkington, 1998). Hence, crisis management studies often rely on qualitative data. Such a qualitative investigation of the DS has been

[1] The terms self-deception and other-deception (here direct customer deception) are extracted from behavioural theory. They are related to morality and serve as explanation for non-moral behaviour. A profound discussion of self-deception in unethical behaviour can be found in Tenbrunsel and Messick (2004)

conducted by Bowen, Freidank, Wannow and Cavallone (2017), where the effect of perceived crisis response on consumers' behaviour was investigated using surveys. In accordance with Coombs and Laufer (2018) two different markets were analysed, the US market where the DS began and the VWG's domestic market. It was shown that the crisis response of the VWG was able to mitigate parts of the damage incurred by the DS in both markets. A domestic bias is found indicating that crisis response is perceived more positively in the VWG's domestic market. Facing this kind of corporate wrong-doing however, it is important to identify the wholistic impact and further potential damage caused by fraudulent behaviour to be able to absorb the shock on markets and minimise economic (e.g. any kind of monetary) or social (e.g. letting off employees) losses.

In that context, Wood et al. (2018) conducted an event study research inter alia on the effect of the DS on VWG stock returns and identified a large negative impact on the VWG. Nevertheless, it remains difficult to draw a link between the different stakeholder groups at interest in Bowden et al. (2017), namely customers, and in Wood et al. (2018), namely the shareholders.

1.4 Approach of the Study

Therefore, this study aims at complementing the findings of Bowen et al. (2017) by quantitative research. The emphasis will be set on customer reactions to the DS in both the US and German automobile market finding a suitable approach to measuring the indirect cost of a crisis caused by decreasing sales. Thus, this study will also complement the findings of Wood et al. (2018) and provide a better understanding of the impact of the DS from a market share point of view. By investigating the fluctuations of sales of the VWG the effectiveness of crisis management methods of the VWG is evaluated in both markets.

To do so, the study will in a first step consist of an extensive literature review on the topics of crisis management and corporate reputation as well as their interplay through crisis response or crisis communication will be conducted. This will be followed by an overview of the VWG and the timeline of the DS, structured in before, during and after the scandal, will be presented. Subsequently, the second part of this paper will consist of two approaches: Firstly, an analysis using a modified version of the event study approach will reveal how both markets reacted to the revelation of the DS (Campbell, Lo and MacKinlay, 1997; Shin, Richardson and

Soluade, 2012a, b). Further, the existence of possible spill-over effects between the different brands of the VWG, as suggested by Fracarolli Nunes and Lee Park (2016), will be examined. Thereby, this paper aims at finding a quantitative proof for the findings of Bowen et al. (2017), who claim that the DS and the corresponding crisis response by the VWG has caused different impacts on customers in the US and in Germany.

2. Literature Review

In order to understand the scope of this dissertation and its link to crisis management, it is necessary to explain the importance and the roles of crisis management and corporate reputation during an organisational crisis, before going in more depth on the case at hand.

2.1 Crisis Management

Hence, the term and underlying theory of crisis management needs to be explained, which requires looking at the evolution of this field of study. The first research on crisis management dates back to the 1970's and covered the possibility of an escalation of the cold war (Williams, 1976). Due to the globalisation, markets became more complex and grew larger, thereby entailing the same development for the potential impact of a corporate crisis event. In accordance with this, Müller (1985) finds that crises cannot be solved with one single action, as they are multi-dimensional and thus necessitate a more thorough approach to be resolved. Up to that point, crisis management had a political rationale or was mainly focused on crises caused by natural catastrophes. Although beginning this early, the research area stayed widely neglected among researchers, until crises started to happen more frequently in the late 1980s and early 1990s. During that time, corporate crises caused by organisational misconduct for the first time reached similar levels of scope and magnitude as natural catastrophes[2] (Pearson and Mitroff, 1993). Therefrom, companies gradually became aware that being prepared for a crisis could turn out to be pivotal for a business' survival and a form of management of crisis was called for. In 1993, Pearson and Mitroff presented a first overall framework of crisis management, in which the term crisis was first defined. According to Pearson and Mitroff (1993) a crisis poses a threat to the corporate reputation as well as to the viability of a company. Moreover, crises are identified as high magnitude events that require immediate attention and action. Crises are outside a company's control and arise surprisingly. Although organisational crises differ substantially from one another, they tend to have these aspects in common (Pearson and Clair, 1998). Contributing to this, a recent definition of crises by Snoeijers and Poels (2018) claims that a crisis exists as soon as any stakeholder in the company perceives the situation as such. This, fairly broad definition of crises, nonetheless breaks down the main aspect of crises. Although they can be caused by companies, they cannot be

[2] By today, the majority of crises are caused by organisational misconduct. Corporate misbehaviour has also led to some of the most impactful crises e.g. the Enron crisis (Asthana et al., 2009).

controlled by them. That is, a crisis begins if someone understands the given situation as a crisis situation, which can happen unexpectedly. Once recognised as crisis, companies cannot longer manage the situation. Hence, this definition tends to confirm the definition of Pearson and Mitroff (1993).

Furthermore, it can be stated that crises are not limited to one company and can easily spread over to other companies. Research shows that an organisational crisis also leads to deteriorating factors for related firms. This includes parent firms or subsidiaries, business partners as well as competitors. The fact that they suffer from negative effects stemming from the crisis, is known as the so-called inertial effect (Fracarolli Nunes and Lee Park, 2016). This implies that companies that are not directly concerned by a crisis will also be affected by it and thus need to make use of crisis management.

After defining a crisis, it is crucial to understand in how far crisis management can counteract a crisis situation. Crisis management main purpose is defined as battling crises and to weaken the negative implications from crises, therefrom it is obtained that crisis management can be constituted of four factors: Prevention, preparation, response and revision (Coombs and Laufer, 2018). As the names indicate prevention and preparation are conducted pre-crisis, the response during a crisis and the revision post-crisis (Coombs and Laufer, 2018). An emphasis needs to be set on the crisis response, as in a crisis situation, crisis management often represents the only direct communication channel for a company to its customers. Hence selecting the correct information to be transferred to the public is vital for a successful crisis management. Zheng, Liu and Davison (2018) point out that next to the crisis communication of the company itself, there is also a secondary crisis communication made by the public, for example through media (Kietzmann et al., 2011; cited in Zheng et al., 2018).

2.2 Corporate Reputation

This secondary crisis communication simultaneously links the topic of crisis management with corporate reputation, since the media coverage, also social media coverage, influences the way the public perceives and feels about a company, thereby playing a crucial role on the public's perception of a crisis. Lu and Huang (2018) point out that the perceived responsibility taken by the company causing a crisis, shape the emotions consumers have towards a company. These emotions are said to be part of the customer reaction to a corporate crisis.

Another linking point between crisis management and corporate reputation becomes visible through the admission of guilt of a company concerning a crisis. This represents the strongest form of crisis management tool, since it implies that a company accepts its responsibility in causing a crisis and thus would like to communicate to the customers that a restart is wanted (Weng and Chen, 2017); Lu and Huang, 2018). A similar effect is expected from the separate punishment of a corporate-wrongdoing, where the public assumes that 'justice has been served' and return to a status quo regarding the concerned company (Williams and Barrett, 2000).

To better understand the notion of corporate reputation, it is necessary to define and explain the term. From a business point of view, corporate reputation represents an intangible asset that is able to influence the value of a company (Sarstedt et al., 2013; Weng and Chen, 2017). Rindova et al. (2005) state that intangible assets generally entail more advantages in comparison to aspects related to the product. Research on the influence of corporate reputation supports this claim, as it has been found that a positive reputation can have a positive impact on customer confidence in products, customer loyalty and satisfaction as well as increase the possibility of word-of-mouth marketing for a company (Ainuddin et al. 2007; Walsh and Wiedmann, 2004). Similarly, a negative reputation is found to ensue opposite effects. Eberl and Schwaiger (2005) found that the level of corporate reputation affects future net cash flows of the company, thereby identifying an effect of corporate reputation on corporate financial performance. Given its ability to maintain and enhance competitiveness of a company, corporate reputation can serve as foundation of a competitive advantage (Sarstedt et al., 2013; Fombrun and Shanley, 1990).

Corporate reputation is linked to the cost of equity capital for a company (Weng and Chen, 2017). Weng and Chen (2017) examined the effect of corporate reputation and that of CEO reputation on corporate financial performance and detected the existence of individual effects. Further, it was found that CEO reputation and corporate reputation can be different and are not always correlated with each other.

Gatzert (2015) presents a discussion on the impact of corporate reputation and reputation damaging events on corporate financial performance. It is outlined that the different internal and external stakeholders, such as customers, suppliers, potential and current employees, investors and local communities have differing perceptions of a company's reputation and

thus react differently to reputation damaging events (Fombrun and van Riel, 1997; Ali et al., 2015). Moreover, it is constituted that corporate reputation has multiple dimensions, as it reflects the perceptions of these stakeholders on financial and non-financial aspects of the company (Fombrun, 1995).

Greenwashing is becoming more and more a common practice in marketing and corporate communication. It aims at covering controversial facts that could potentially jeopardise a company's reputation and the perception of corporate sustainability (Delmas and Burbano, 2011). The DS represents such a case, which becomes more visible, when looking at the situation of the VWG before the crisis.

2.3 Volkswagen Before the Scandal

To understand the magnitude of the DS for the Volkswagen Group and the automotive industry, it is important to examine the company's history and strategic orientation before the DS. Founded in 1937 by the Nazi regime in Germany and utilised for propaganda purposes, VW was in a superior position in the market from its inception (Ewing, 2017). After the end of World War II, the company had to start operating as a private company. Emerging successful from the time of rebuilding in West-Germany, VW was soon able to make first acquisitions from direct competitors by buying Auto Union from Daimler-Benz in 1965 and merging it with NSU of Audi in 1966. Buying business units from direct competitors in their domestic market, VW sets out its strong desire to grow early in their existence. This pursuit of growth can be seen in subsequent mergers in acquisitions, during which Spanish carmaker Seat and Czech car manufacturer Skoda were bought in 1986 and 1991 respectively (Ewing, 2017). In line with this, in 2008 then CEO Martin Winterkorn announced that by 2018 the Volkswagen Group would become the leading company in the automotive industry, having the largest overall global market share (Fracarolli Nunes and Lee Park, 2016). Aligning their business procedures to this long-term target, the Volkswagen Group adopted an aggressive growth strategy centred on rapid increase of market share. At the core of this strategy, was the utilisation of the Diesel engine technology, which was presented as a cleaner and cheaper way of driving, to demonstrate the VWG's leading position in engineering and the superior technological standard of their cars (Fracarolli Nunes and Lee Park, 2016; Ewing, 2017). Market leadership of VWG was set to be achieved through a leading role in the technological advancement of

environmentally friendly transportation. Particularly the role of Volkswagen's engineering knowledge with diesel engines was to play a crucial role in developing technologies.

In that context, VW was established as key brand of the VWG, being at the centre of the promotion of cleaner transportation, through lower emission of existing engines and alternative engine types. Aiming at the elimination of wasteful practices in their production lines, starting the research for an electric engine and introducing environmentally friendlier petrol and diesel engines, Volkswagen was able to capture a very positive image concerning social and environmental impact, which led to the company being attributed to be sustainable and to be featured in the top ranks of sustainability ranking lists. However, the VWG's main objective remained the first priority, as can be seen in the monetary incentives given to top-management in the form of profit-shares (Painter and Martins, 2017).

2.4 The Diesel Scandal

2.4.1 The Crisis Event

In 2015, the American Environmental Protection Agency (EPA) conducted emission tests in real driving situations outside the laboratory during which Volkswagen's Diesel engines emitted an up to 40 times higher amount of CO2 than permitted. Tested cars were found to be equipped with a defeat device, in this case a software, which detected emission test situations to cap the emission of the car and to match the required standards. As a consequence, the EPA released a public statement, requesting the VWG to recall over 420.000 vehicles of their VW and Audi brand (EPA, 2015).

2.4.2 The Scandal's Aftermath

The VWG consequently agreed to the request and issued a recall statement. In the same month then-CEO Martin Winterkorn resigned (Painter and Martins, 2017) and the VWG set aside multiple billion euros, which ultimately led to the first losses in over 15 years for the company. Further, numerous recalls in different countries had to be conducted incurring costs adding to the overall loss of the VWG in 2015.

In the first phase after the DS, the VWG strictly denied having actively deceived customers and delegated the responsibility to a few 'rogue' engineers among the employees. This idea was also resembled in the VWG's public communication strategy, in which the VWG did not admit any kind of guilt, yet immediately set a focus on regaining customer trust through a broad

excuse approach (Painter and Martins, 2017; Bowen et al., 2017). The VWG focused on regaining customer trust, by refunding customers in the US and apologising to the public through social as well as traditional media. During that time, the VWG faced a lawsuit in the US, which they ultimately settled for a $4.3 bn fine. After not acknowledging any kind of direct responsibility for over a year, the company admitted being guilty of causing the DS in March of 2017

Fracarolli Nunes and Lee Park (2016) describe the negative effect a corporate scandal has on its parent or partner companies, its industry and supply chain as the inertial effect of a crisis. Considering that Volkswagen is one of numerous car manufacturing company of the Volkswagen Group, the group's companies are likely to be influenced by the inertial effect of the DS. This inertial effect was in fact found in the case of DS, since the VWG stock plummeted, although information on the global magnitude of the recall was scarce. Losing a total of almost 20 percentage points in the weeks following the recall announcement, which can be attributed to the inertial effect of the crisis (Woods et al., 2018)

It becomes apparent that the DS has caused a shift in corporate reputation for the automotive industry, at least partially caused by the negative media coverage on the diesel technology incorporated by the majority of car-manufacturers in specific product lines (Löhr, 2015). The development of new means of mass communication, particularly social media, has strongly increased the potential damaging effect of a corporate wrong-doing (Wilburn and Wilburn, 2015 in Fracarolli Nunes and Lee Park, 2016).

2.5 Hypotheses

Having discussed the role of crisis management and corporate reputation in product recalls and crises and keeping the findings of Bowen et al. (2017) in mind, numerous questions arise. First of all, it is important to know whether the DS had an impact on consumers or not, hence it is of interest to identify if customers perceived the DS as a crisis (Snoeijers and Poels, 2018). As this study aims at finding financial proof of a negative effect of the DS on the customer-side, sales figures are of interest. Thus, the perception of a crisis would implicate that sales figures dropped significantly in both the US and the German market.

Expectation 1: The DS caused a decrease in sales figures in the US and the German market for all companies of the VWG.

Secondly, the literature clearly points out that being punished for a corporate misbehaviour could lead to more positive customer reactions. Since the wrongful behaviour has been punished, one could argue that the general public can treat the crisis as concluded, which in turn would lead to increasing sales volumes in both markets. Since the VWG agreed to settle there is an event that can be analysed.

Expectation 2: The fine settlement of the VWG caused an increase in sales figures in the US and the German market for all companies of the VWG.

Thirdly, since the strongest form of crisis communication is considered to be the admission of guilt and the VWG did admit guilt in the DS, the question arises how that impacted the sales volume of the VWG's companies. It is suggested that admitting guilt has the potential to mitigate negative feelings towards a company, thereby admitting guilt is expected to lead to a regeneration of sales volume. In theory, customers tend to restart buying products of companies concerned by crises if their negative image of the company diminishes and the perceived gain of a purchase surpasses its cost.

Expectation 3: The admission of guilt boosted the sales volume in both the US and the German market.

Additionally, the already identified domestic market effect for the German market is expected to be found as well as the spill over effects caused by the inertial effect of the DS. The domestic effect shall diminish the negative effects of the DS and cause a less strong impact of events related to the DS. The inertial effect is expected to be found in the form of fluctuations inside the VWG.

Expectation 4: The German market is less sensitive to crisis events, as opposed to the US market.

Expectation 5: The sales volumes for each brand of the VWG are affected by the inertial effect of a crisis for both markets.

3. Methodology

Before specifying exact hypotheses for this study, it is indispensable to discuss the different possible methods for such a study in order to understand, how the expectations need to be adjusted. In general, the literature presents several different approaches to quantitatively analysing the impact of a crisis and crisis management on customers and the automotive industry. Simultaneously, it becomes apparent that studies, focusing on this group of stakeholders, lack quantitative research to back up the diverse qualitative findings. Beyond, selecting VWG presents an interesting case for investigation, as the effects of the DS cannot only be pertained to the organisation as a whole, but separate effects can be analysed on VWG's brands collaterally. Looking at the DS through the lens of the TBL several different areas of study for quantitative analysis can be identified.

3.1 Suitable Research Methods

Firstly, as the scandal centres around environmental pollution, the influence on the environment could be examined, as it will also have implications on customers and competitors; e.g. by increasing car prices for environmentally unfriendly cars, an augmented health risk or higher environmental standards for engine emissions. Barrett et al. (2015) estimate the amount of additional environmental pollution caused by the VWG's diesel engines and put the excess emissions in a geographical context, according to the number of vehicles recalled in the US. Further, an analysis on potential health risks, resulting from the increased aerial pollution, is conducted, in which an estimated cost is allocated to the potential health deterioration. Albeit being only focused on the US for putting a price tag on the potential health and environmental damages, the study represents a reasonable estimation that can be transferred to other countries. These results were also confirmed by a study of Holland et al. (2016), in which the potential global environmental damage was pointed out. In addition to this, researchers have also looked into the changes in environmental protection requirements for the automotive industry (Cavico and Mujtaba, 2016). As this kind of study is not only related to consumers, and as it already has been emphasised by researchers, this approach will not be considered in the study at hand.

Secondly, an emphasis can be set on a social aspect namely the change in corporate reputation of VW, the VWG or the automotive industry. Previous crises, caused by fraudulent business

conduct, have shown to strongly deteriorate the corporate reputation of a company and related businesses (Pearson and Mitroff, 1993). Additionally, studies have identified a correlation between corporate reputation and financial performance, making an inference on a crisis' impact on it more valuable (Gatzert, 2015). Corporate reputation is at the centre of interest of crisis management, as it has to be protected and rebuilt to regain customer trust and re-establish customer relationships (Pearson and Clair, 1998). However, directly testing the influence on reputation would require a more frequent measurement of it, as currently available. Further, it is difficult to disentangle the effect of a crisis, in this case the fact of deception on corporate reputation and the effect of social-agents on corporate reputation. Thereby, this approach is rendered inapplicable for this study.

Thirdly, since the VWG is a listed company it could be analysed from a socio-economic point of view, as there is a vast amount of data available for the workforce, stock price and earnings per share dating back to the 1990's. Hence why VWG contains a necessarily large data set to conduct a time series analysis on earnings per share, stock price or employee fluctuation rate. Thus, on the one hand, a time series analysis would be feasible and easily transferrable to related cases in similarly large companies. On the other hand, however, this approach would limit the emphasis of the study to the VWG as a whole and would inhibit an analysis of the changes within every brand of the VWG and the competition. Similarly, using data from stock exchanges excludes the examination of data from not listed companies, that is, it is not possible to transfer this methodology to every other car manufacturing company. In addition, Wood et al. (2018) already conducted a similar study and displayed thereby that it does not identify the customer reactions to the DS. For these reasons, this approach will not be used in the study.

Lastly, the breaking out of a crisis represents a one-time event. Thus, a cross-sectional data analysis could be applicable when a comparison shall be conducted. Though it entails the same restrictions of a time-series analysis, it is possible to identify the impact an event has on market value measures of a firm, such as the company's stock return. Research has shown particular interest in examining the impact certain type of announcements, such as announcing the implementation of a dividend or the announcement of an upcoming merger, have on the market value of a company (Campbell, Lo and MacKinlay, 1997; Corrado, 2011; Greene, 2003). Using data from the stock markets would depict the effect the crisis has had

on the market value, shareholders and potential shareholders of the VWG. This could be done through a so-called event study, however requires some adjustments to be suitable for this study. Shin et al. (2012b) are the first researchers to apply an event study framework to sales levels in the automotive industry. As that approach is also in line with the study's aim to analyse the impact of the DS on stakeholders, such as customers, this method seems applicable for the purposes of this study as well as the hypotheses to be tested. In the following the event study framework will be presented before the necessary adjustments for the purpose of this study will be outlined.

All in all, literature provides a broad overview into the DS and its implications on ecological, economic and social aspects. Nonetheless, hitherto the perspective of and impact on customers and potential customers concerning the DS has been neglected in research. Therefore, this dissertation will conduct multiple event studies to uncover the indirect cost incurred by the DS's breakout, the change in indirect cost caused by the monetary punishment to the company and the change in indirect cost triggered by admitting guilt. That is, finding an answer to the question of how many potential customers Volkswagen lost or gained due to the crisis, punishment and crisis management events.

3.2 Event Study Framework

3.2.1 General Approach

A general overview of the event study approach is given by Campbell, Lo and MacKinlay (1997), who explain that the event study is a tool for measuring the impact of an event on a company's value. It is usually based on financial market data and makes use of the rationality in the marketplace, where an event's impact will be ad-hoc reflected upon stock prices and stock returns to identify an event's effect. It is argued that this method is applicable to ambiguous kinds of event, which is underlined by past research, where it has been widely accepted among scholars, and has been used across different study fields (Campbell et al. 1997, pp. 149-150). At the core of an event study, lies the calculation of the so-called abnormal return, given by the difference between the actual return of a security during an event and the forecasted return during the same period under the assumption that the event did not take place.

As explained by Campbell et al. (1997, pp. 149-180), the event study is flexible in its structure but can be seen as consisting of seven steps. At first, the events to be examined in the study need to be defined. Here it is necessary to select the events that are of interest and to identify a period over which the effect will be examined. There are three different crucial time periods in an event study: the so-called estimation window, the event window and the post-event window, of length $L_1 = t_1 - t_o$, $L_2 = t_2 - t_1$ and $L_3 = t_3 - t_2$ respectively, as depicted in figure 3.2.1.

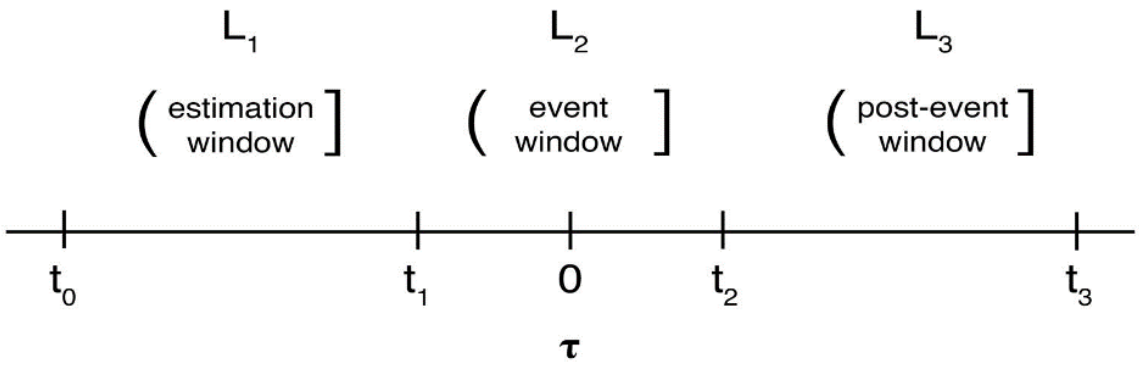

Figure 3.2.1 Timeline of the event study

In an event study time is indexed, here by $\tau = event\ time$. The event date itself in event time is given by $\tau = 0$, the estimation and event windows in event time are represented through $\tau = t_o + 1$ to $\tau = t_1$ and $\tau = t_1 + 1$ to $\tau = t_2$ respectively. Similarly, the post-event window is constituted by $\tau = t_2 + 1$ to $\tau = t_3$ (Campbell et al., 1997).

The event window is most often chosen to be of one or two days for financial market event studies, the day of the event and the day after to account for the timing of the event announcement, which could be after the end of trading. To specify the width of the event window, it is possible to check for significant structural breaks or changes in significance of the abnormal return to identify if and where different impacts between event-days and non-event days can be identified (Sun and Zhang, 2011).

The second step consists of selecting the criteria for firms to be examined in the study. Here it is necessary to set out which data, companies, industries and stock exchanges will be used. Moreover, it is important to consider possible restrictions such as data availability or potential sample-selection-bias. In the third step the way in which normal and abnormal returns are obtained is determined. The abnormal return $\mathrm{R}_{\mathrm{it}}^{*}$ is calculated by (3.2.1) and consists of the difference between actual return R_{it} and the expected return $E[R_{it}|X_t]$, for a company i at a given moment t. The term normal return is used for $E[R_{it}|X_t]$, where X_t is a conditioning information. $E[R_{it}|X_t]$ represents the beforehand mentioned return expectation for any i and t had the event not taken place.

$$\mathrm{R}_{\mathrm{it}}^{*} = \mathrm{R}_{it} - E[R_{it}|X_t] \qquad (3.2.1)$$

For the calculation of the normal return $E[R_{it}|X_t]$ the returns during the estimation window are analysed. For this purpose, there are two applicable approaches; an economic and a statistical approach. The economic approach assumes behavioural schemes among investors, whereas the statistical approach is constituted by statistical assumptions. Anyhow, the economic approach always implies the integration of a statistical component to gain validity, underlining the high importance of the statistical approach to the calculation of normal returns. The statistical approach generally assumes "that asset returns are jointly multivariate normal and independently and identically distributed through time" (Campbell et al., 1997, p. 154). Particularly the assumption of normally distributed returns enables a multitude of options for calculations, of which two are predominantly used in literature (Corrado, 2011). The first possibility is the constant-mean-return model (3.2.2). Here X_t is assumed to be a constant, implying that mean return over time remains constant, represented

by μ_i. Given by

$$\frac{1}{t} \cdot \sum_{t=t_0}^{t_1} R_{it} = \mu_i \qquad (3.2.2)$$

with

$$E[R_{it}|X_t] = \mu_i + \epsilon_{it}$$
$$E[\epsilon_{it}] = 0 \quad Var[\epsilon_{it}] = \sigma_{\epsilon_i}^2 \qquad (3.2.3)$$

where $\mathrm{R_{it}}$ represents the ith element of $\mathrm{R_t}$ and is the return value for stock i at a given period t. Further, ϵ_{it} stands for the noise term and is expected to be zero (3.2.3). Yielding for the expected abnormal return,

$$\widehat{\mathrm{R}}^{*}_{\mathrm{it}} = \mathrm{R_{it}} - \mu_{\mathrm{i}} \qquad (3.2.4)$$

Despite being the simplest model regarding the statistical complexity of other performance models, the constant-mean-return model has been proven to generate similar results when compared to more elaborated models (Brown and Warner, 1980 cited in Campbell et al., 1997).

One example of a more elaborated model can be found in the one factor model given by,

$$\mathrm{R_{it}} = \alpha_i + \beta_i R_{mt} + e_{it} \qquad (3.2.5)$$
$$E[e_{it}] = 0 \quad Var[e_{it}] = \sigma^2_{e_i}$$

where $\mathrm{R_{it}}$ is the return value for stock i at a given period t, similarly R_{mt} is the market portfolio's return at a given period t. Further, e_{it} stands for the zero mean noise term. α_i, β_i and σ_e^2 serve as parameters for the market model and are to be estimated through OLS estimates for the intercept, the slope and the regression's standard error (Corrado, 2011, Greene 2003). Such a more elaborate model[3] is the market model, which assumes that X_t is the market return given by R_{mt}. This means that a linear relation between the return of a security and the market return is assumed[4]. A market model yields the formula (3.2.6) for expected abnormal return.

$$\hat{\mathrm{R}}^{*}_{\mathrm{it}} = \mathrm{R_{it}} - \hat{\alpha}_i - \hat{\beta}_i R_{mt} \qquad (3.2.6)$$

[3] There exist more sophisticated models such as multifactor models, anyhow an explanation of these would exceed the frame of this study. See Sharpe et al. (1995 cited in Campbell et al. 1997) for a discussion and comparison of multifactor models.

[4] „The model's linear specification follows from the assumed joint normality of asset returns" (Campbell et al., 1997, p. 155). In fact, the weighting of assets used to calculate the market return needs to be constant. In financial markets this cannot be given, nevertheless the changes are negligibly small (Campbell et al., 1997).

In order to find the more suitable approach for this study, it is necessary to discuss the main advantages of both approaches. The constant-mean-return is a popular choice among researchers, due to its “clarity and ease of computation” (Shin, Richardson and Soluade, 2012b, p. 74). The more complex

structure of the market model implies a potentially more accurate performance in comparison to the constant-mean-return model, which is confirmed when comparing the variance term of the market model $\sigma_{e_i}^2$ to the variance term of the mean-average model $\sigma_{\epsilon_i}^2$, visualised in (3.2.7) (3.2.8) and (3.2.9).

$$\begin{aligned}\sigma_{e_i}^2 = Var[e_{it}] &= Var[R_{it} - \alpha_i - \beta_i R_{mt}] \\ &= Var[R_{it}] - \beta_i^2 Var[R_{mt}] \\ &= (1 - R_i^2)\, Var(R_{it})\end{aligned} \qquad \textit{(3.2.9)}$$

$$\sigma_{\epsilon_i}^2 = \mathrm{Var}[\epsilon_{\mathrm{it}}] = \mathrm{Var}[\mathrm{R_{it}}] - \mu_{\mathrm{i}} = \mathrm{Var}[\mathrm{R_{it}}] \qquad \textit{(3.2.7)}$$

$$\sigma_{e_i}^2 = (1 - R_i^2)\sigma_{\epsilon_i}^2 \qquad \textit{(3.2.8)}$$

The R_i^2 represents the goodness-of-fit of the market model regression. The goodness-of-fit denotes how much of the variance is explained by the model and has a value of $0 \leq R^2 \leq 1$ (Verbeek, 2000). Thus, the market model is likely to have a smaller variance of the abnormal return when juxtaposed to the constant-mean-return model depending on the goodness of fit of the model. Therefore, an event study utilising a market model regression is chosen for this study.

Having chosen a performance model for the calculation of the abnormal return, the fourth step, consists of calculating the model’s parameters by using the given data and thereby constituting the estimation window, which will be used to calculate the abnormal returns. Therefore, the event window must not be included in the estimation window. After the event window a post-event window can be implemented to analyse the changes in the market after the event has happened.

3.2.2 Hypothesis of Abnormal Returns and Significance Tests

In the following fifth step the abnormal returns are calculated, and a hypothesis is defined to determine the necessary testing procedure. The defined hypothesis depicts the assumption that abnormal results do not exist and is usually given by

$$H_o: R_{it}^* = 0 \qquad (3.2.10)$$
$$H_1: R_{it}^* \neq 0$$

There are two different methods to test for significance: (1) parametric tests, which assume the distribution of data and (2) non-parametric tests, which work without any distributional assumptions. According to Verbeek (2000, pp. 23-29), to be applicable for the basic form of parametric, the t-test, the sample needs to underlie certain assumptions, also referred to as Gauss-Markov Assumptions (GMA). The necessary GMA are given by an expected noise term of zero, the independency of error terms and independent variables, homoscedastic error terms, in other words same-variance noise terms, no correlation among error terms, and the assumption of normally distributed error terms (Verbeek, 2000, pp. 16-23). The common assumptions for event studies include distributional assumptions and thus make the t-test an available option for significance testing.

However, conducting parametric tests limits the results, since the assumptions made are unlikely to depict the real distributive behaviour of a sample. Additionally, t-tests entail drawbacks as it is prone to volatility of stock return shortly before the event, which could lead to incorrect rejections of the null hypothesis (Brown and Warner, 1985 in Campbell et al., 1997). In face of these restrictions research has focused on loosening the assumption of normal distribution and has brought forward more robust parametric and non-parametric testing methods. It is common to conduct a t-test and then an expanded parametric test as well as a non-parametric test, to ensure a wholistic appraisal of significance.

The usual t-test statistic to test for a significant abnormal return and its critical value is given by (3.2.11) and (3.2.12) (Corrado, 2011).

$$t = \frac{R_{it}^*}{\sqrt{Var(R_{it}^*)}} \sim T_{n-2} \qquad (3.2.11)$$

$$P\left(T_{n-2} > t_{\alpha}^{crit}\right) = \alpha$$
$$\frac{R_{it}^{*}}{\sqrt{Var(R_{it}^{*})}} > t_{\alpha}^{crit} \qquad (3.2.12)$$

In research it is also common practice to not only check for the significance of a single abnormal return, but also for the cumulative abnormal return (CAR) over a certain time span given by (3.2.13). By doing so, it can be analysed if an event has had an impact over time on returns.

$$CAR_{iLn} = \sum_{t=t_{n-1}}^{t_n} R_{it}^{*} \qquad (3.2.13)$$

In general, it is necessary to check for the CARs' significance for the interpretation of found values, with H_o: $CAR_{iL_n} = 0$.

$$t_{CAR} = \frac{CAR_{iL_n}}{\sigma_{CAR_{iL_n}}} \qquad (3.2.14)$$

$$\sigma^2_{CAR_{iL_n}} = L_n \sigma^2_{\epsilon_i}$$

The most practicable way to conduct a CAR significance test is by using the CAR t-test (3.2.14), which underlies the same critical values as (3.2.12) (Corrado, 2011; Shin et al., 2012; Sun and Zhang, 2011). As it directly analyses the significance of the different given CARs considering their relation to the event, the discovery and interpretation of the long-term effects of an event is enabled.

The sixth and seventh step respectively deal with the presentation of empirical results and the implications and conclusions that can be drawn from them.

3.3 Modifications to the Event Study

The presented approach focuses on financial markets to analyse the effect of the DS. This approach however, would offer a perspective on the damage of the DS on the company value of the VWG and the damage for shareholders. Yet, this study aims at understanding the effect of the DS on the VWG and its customers. Therefore, it is necessary to identify a measure, which

can only be influenced by customers and which simultaneously allows to disentangle the effects for every brand belonging to the VWG. Such a key financial performance figure available for all companies and company brands could be the sales figures of vehicles. The sales figure is based on a customer's decision-making process and will thus be employed in the analysis, namely as the number of sold vehicles per company and the number of new registrations of vehicles per company for the analysis section.

Having established that financial markets are no longer an appropriate data pool for the study's purposes, it becomes necessary to adjust the event study method in certain aspects.

Shin et al. (2012b) conducted an event study on the effect major recalls, caused by defective car parts, had on sales figures of Toyota, in which they modified some aspects of the method and simultaneously some aspects of the collected data. It is shown that, by adjusting the calculation of abnormal returns and the definition of the estimation window, the event study can be conducted in the usual way with data on the market share of a company. Shin et al. (2012b) utilise the market share data to calculate a variable, which is comparable to the returns used in the classic model. Hereto the market share data is extracted from databases and is modified to mimic stock return. That is, Shin et al. (2012b, p.74) compute a "monthly return of

sales performance (…) defined as"

$$R_{it} = \frac{M_{it} - M_{it-1}}{M_{it-1}} \qquad (3.3.1)$$

with company index i and at a given t. Further, M_{it} represents the market share of company i at time t. The given equation is identical to the calculation method for stock return and thus resembles the original approach of event studies. Thereby, the so called 'Market Share Return' (MSR) is obtained. The MSR will hence also be used in the study at hand. Additionally, as the study conducted by Shin et al. (2012b) is similar in topic and scope, since it tries to uncover the indirect cost of a negative event, represented by sales loss for a car manufacturer, its approach to calculating abnormal returns and estimating time windows will be used and partly expanded in this present study.

Hitherto, only the constant-mean-return model has been applied to the market share variable, thus to expand the framework further, this study will make use of a market model to estimate

the MSR, which is also encouraged for future research by Shin et al. (2012b). As the car market cannot exploit the rationality of the market to the same extent as the stock market, due to a longer delay between acknowledgement of an information and actual impact of an information on sales figures and the fact that there is data on daily development of car sales figures, it becomes apparent that the unit of analysis has to be changed from day to month (Shin et al., 2012b). This also affects the duration of the estimation window, which commonly ends before the event window to prevent the inclusion of event-induced high volatility returns (inter alia Corrado, 2011). Here the estimation window can end immediately before the event window, also without bearing the risks of including event-induced variance of returns, thereby rebutting one of the drawbacks of parametric tests. In this context, the second disadvantage comparing parametric and non-parametric tests is given by the distributive assumptions made for parametric tests. The rather rigid normal distribution assumption of the t-test can be loosened when a sample of events is investigated through the Patell Z test (Patell, 1976), the BMP Test (Boehmer, Musumeci and Poulsen, 1991) or the adjusted versions, which account for cross-sectional correlation, of both (Kolari and Pynnönen, 2010). Yet, this study does not include a cross-sectional study nor investigate a sample of events thus cannot benefit from the application of these tests. Further, as one main disadvantage of parametric tests does not exist in this sample and the other can be mitigated, the study will make use of parametric significance tests. Considering the different parametric significance testing methods, it becomes apparent, that the selection of the ideal test depends strongly on the variable to be tested. Here, the variable of interest is the CAR, since the impact of events over time is to be identified. Therefore, a CAR t-test abiding (3.1.11) and (3.1.12) will be applied in this study.

In crisis management research event studies are rarely used, nonetheless the increasing importance of the topic of corporate crises and particularly the financial crisis of 2008 has led to numerous event studies expanding this research area (inter alia Taylor, 2009; Schnietz and Epstein, 2005; Woods, 2018). The majority of studies stays in the existing framework of the event study methodology and examines financial markets. Still, there are some scientists interested in expanding the scope of the technique. The study at hand aims at providing such an addition to the scope of event studies.

3.4 Data and Calculations

The data used in this study is taken from the online database 'Good Car Bad Car' (GCBC) (GCBC, 2018) for the US and the 'Kraftfahrtbundesamt' (KBA) for Germany (KBA, 2018)[5]. Both represent reliable sources as they are regularly featured in analyses of statistical research institutions such as 'Statista', especially the figures presented by the KBA are highly reliable, as it is a governmental institution. Although both data sets will be used to calculate the market share of certain companies, they depict different data. While GCBC displays the exact sales figures per company per month in the US, the KBA presents data on monthly new vehicle registration in Germany per month. These figures are nevertheless comparable as they both account for privately and commercially used vehicles, except for larger vehicles specifically used for transportation of goods or people, and simultaneously exclude the used-car market. As opposed to figures of GCBC, data from the KBA are likely to contain a time lag, since it takes some time, on average 6-10 weeks in Germany (KBA, 2018), from production to the registration. The data of the KBA and the GCBC are comparable as the relative market share will be calculated.

The calculations and graphic demonstrations in this dissertation were conducted and created on Excel and Gretl. Both programs complement each other as Excel on the one hand offers ease for data collection and basic calculations and Gretl on the other hand enables smooth calculations with regression and cross-sectional regressions.

[5] The exact domains for the GCBC and the KBA data are not given in the references,since the data is ordered by month and company resulting in dozens of sources. Only the main websites from where all the collected data is easily accessible will be given in the reference list.

4. Analysis

Using this explained approach, the collected data will be analysed in the subsequent section, applying an adjusted event study method to identify the indirect cost of the DS on the VWG and its brands in the US and German car markets. In order to do so, this section will abide by the outlined steps of an event study and present the findings of the conducted analyses. These findings will be then discussed, explained and compared in a latter section of this study. Additionally, the expectations drawn from previous studies and the literature will be developed into hypotheses considering the chosen methodology.

4.1 Event Definition

Following the first step of an event study, the events to be examined have to be identified. In addition to this, the expected findings are outlined in accordance to the hypotheses. As the market share of a company is related to the customer reactions, the events to be analysed in this study contain influential events from a crisis management perspective. Therefore, three different types of events are identified.

Firstly, the event that represents the centre of the study, a strongly negative crisis event, namely the DS, will be examined. The publishing of the EPA demanding the recall of over 500.000 vehicles of the VWG in September of 2015, is considered to be the beginning of the DS, and is thus identified as the relevant event here. As the company has never been concerned by a crisis before and the DS additionally represented a special new form of corporate wrongdoing, it can be expected that the revelation of the VWG deceiving its customers will have a strong negative influence on the MSR. Since the DS was uncovered in the US, the effect in the US market is expected to be strongly negative. It can however be expected that the negative effect is temporary and will be followed by an increase in MSR. The underlying idea for this is similar to the idea of Shin et al. (2012b), where it was assumed that a negative event in T will lead sales return to decrease which is identified as the event window. The event window there is followed by the post-event window, which starts when sales return starts to increase again (Shin et al, 2012b). A graph describing this concept can be found in figure 4.1.1. Yet, transferring this framework to the DS might not be appropriate, as the DS regularly featured new revelations, making it highly likely that a turning point might only be momentarily. Volatility is likely to be higher throughout a longer period of time,

possibly inhibiting a distinction between event and post-event windows (Wood et al., 2018). Nevertheless, the DS represents a case of a product recall and can therefore be expected to have MSRs behaving accordingly to the findings fo Shin et al. (2012b).

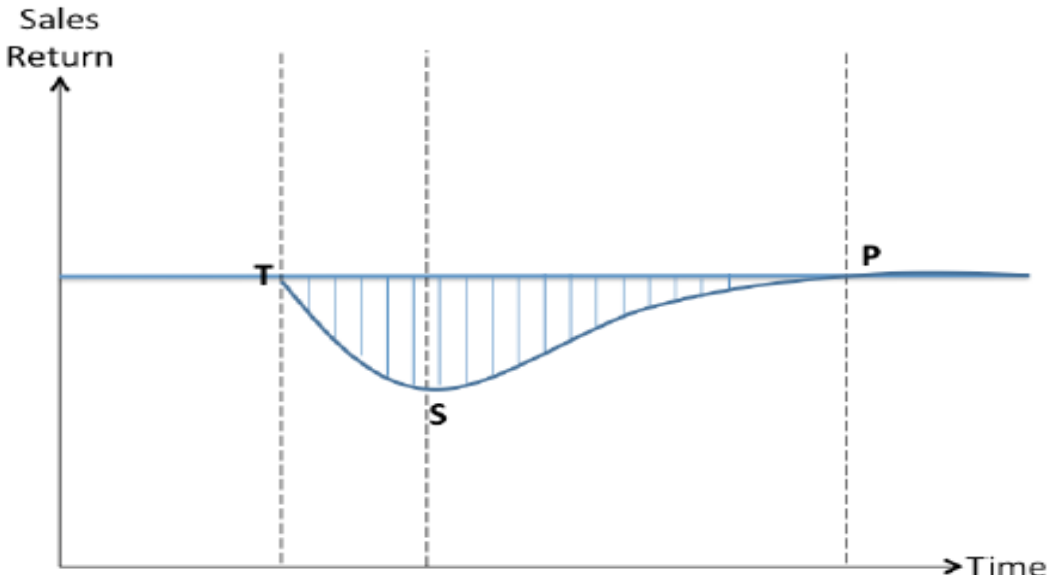

Figure 4.1.1 Event study time windows adopted from Shin et al. (2012b, p. 73)

A similar but less strong negative impact on the German automobile market is anticipated. All in all, it is expected that the announcement of a crisis or recall event will lead to a decrease in MSRs. This decrease will weaken as time passes and eventually reach a turning point. The subsequent increase will lead the MSR to return to its normal pre-event level.

Hypothesis 1a: The start of the DS will have a strong negative impact on the MSRs of the VWG and its companies in the US Market, which will decrease until it reaches a turning point and becomes positive.

Hypothesis 1b: The start of the DS will have a weak negative impact on the MSR of the VWG and its companies in the German Market, which will decrease until it reaches a turning point and becomes positive.

Secondly, the impact of punishments for corporate wrong-doing imposed upon the VWG will be analysed. The VWG was involved in a large lawsuit in the US and in the EU respectively,

each ending with record penalty payment sentences for the VWG. Hence, the announcement of these punishments, in January of 2017 and in June 2018 respectively for the US and the EU, are considered as events. However, the punishment in the EU cannot yet be examined as we are too close to the event to measure its impact. Thus, an emphasis is set on understanding the effect of the VWG's settlement for a $4.3bn penalty payment in the US, for which the VWG settled the US lawsuit against them, on the US car market and if there has been an effect on the German car market as well (Painter and Martiny, 2017). Although it only represents a fraction of total cost incurred by the DS through car repurchases and compensation payments, this sum is not customer-related. In other words, the fine is punishing Volkswagen's deceptive corporate-wrongdoing and is not linked to any customer compensation demands. As shown before, research shows ambiguous results for the impact of such a punishment on a company's corporate reputation. It is assumed that if the public, US or German, perceives the punishment as justice, then the DS could be perceived as concluded and sales figures and market share would increase. Nevertheless, the opposite effect is likely to occur.

Hypothesis 2a: The VWG penalty payment in the US will entail a positive impact on the MSR of the VWG and its companies in the US Market

Hypothesis 2b: The VWG penalty payment in the US will entail a positive impact on the market share of the VWG and its companies in the German Market

Lastly, the VWG also has the possibility to influence corporate reputation through their crisis management approach. As has been pointed out in an earlier section, the strongest impact on corporate reputation has been found in admissions of guilt of a company, which are perceived to be a fundamental step to regain customer trust, which in turn leads to more sales. After avoiding a public admission of guilt in the first year of the DS and neglecting a general responsibility for the misbehaviour of few engineers, the VWG admitted its guilt publicly in March of 2017. Similar to the US punishment, the impact could be ambiguous if the general public assumes that company has taken too long to take responsibility for its corporate misconduct. Yet, as in similar cases other automotive companies, such as Toyota, have taken a considerably longer time to admit guilt, it can be assumed that the VWG guilt admission will have a positive effect on corporate reputation, thus sales figures and market share.

Hypothesis 3a: The VWG guilt admission is positively related to the market share of the VWG and its companies in the US Market

Hypothesis 3b: The VWG guilt admission is positively related to the market share of the VWG and its companies in the German market

An overview of the identified events of interest and the respective event month is shown in figure 4.1.1.

Event	Month/Year
DS Becomes Public	September 2015
VWG US Fine Settlement	January 2017
VWG Guilt Admission	March 2017

Figure 4.1.2 Overview of identified Events

The additional hypotheses drawn from the literature, the possible inertial effect and the domestic market effect for the VWG are accounted for and tested in every application of the chosen methodology.

Moreover, other studies have investigated a-priori if the data contains a significant structural break before conducting an event study. Anyhow, here a Chow Test for structural break, which is an often-used tool in event studies (Sun and Zhang, 2011), is not necessarily advisable as the stock market's immediate implementation of new information cannot be juxtaposed to the car-market, which is influenced by other aspects, such as service and appreciation of market competitors and in addition takes considerably longer to digest information. Albeit this has already been partly accounted for in the unit of analysis, which in a usual event study is a trading day and in this study is a month; and although the aim of the study, to compare effects between the US and the German car-markets facing the DS does not impede the check for structural break, the collectible data does. The data on the US market displays the number of vehicles sold, that is, the number of purchase contracts made in a month, whereas the data on the German car market shows the number of vehicles registered at the vehicle registration office. Thus, the point of measurement in the panel data set is different. Here the impact of the DS on the German market is likely to have an even larger delay or to be weaker than in the US car-market. Therefore, structural break tests are excluded from the study to enable the testing of the same events over the same time frames in both markets.

4.2 Estimating Abnormal Returns

After identifying the events it is necessary to select a model and a variable to calculate the abnormal returns. In a first step, the results for the abnormal returns in a constant-mean-return model are presented, which is complemented in a second step by the results of a market model to calculate abnormal returns. Several different abnormal returns for different event windows are tested for significance, to find a suitable event window and post-event window length. A visualisation of this approach will be given in the first calculation of every event for each calculation model to ensure ease of understanding.

4.3 Constant-Mean-Return Model

Using the approach of Shin et al. (2012b), the MSRs are used to calculate abnormal returns by applying the constant-mean-return model. To calculate the expected return the estimation window needs to be specified. This study makes use of the proposition of Shin et al. (2012b) that a 12-month estimation window will account for an even distribution of seasonal effects avoiding biases. Thus, the estimation window for the events start in September 2014, January 2016 and March 2016 respectively. However, since the second event would then take place in the estimation window of the third event, the third event will be analysed using the estimation window of event number two.

4.3.1 Findings 'DS Becomes Public'

To exemplify the procedure to acknowledge the expected monthly MSRs of a company as given in (3.2.2) in figure 4.3.1 the expected monthly MSRs per company, for the VWG's companies in the US market can be found. For example, the expected MSR over the event window for the VWG US for the first event is 0.00167 or 0.167%[6], when calculated through a constant-mean-return model. By the marginally negative expected return of -0.00473, it becomes apparent, that Volkswagen US was struggling to meet targets increasing its MSR, whereas Audi US had a relatively strong positive expected development of MSR. The returns of the four largest competitors in the American car market, Japanese Toyota Motor Company, American GM and Ford and Italian-American Fiat-Chrysler, during the estimation period can be found in Appendix A.

[6] For the purpose of clarity regarding calculations, the decimal figures will be stated instead of percentages, unless otherwise indicated.

$\tau = 0$	VWG US	VOLKSWAGEN US	AUDI US
SEP 15	0.00165	-0.00473	0.01400
JAN 17	0.00976	0.01880	0.01537
MAR 17	0.00976	0.01880	0.01537

Figure 4.3.1 Expected normal market share returns for the VWG, Volkswagen and Audi in the US market using a constant-mean-return model; μ_i in (3.2.2)

Looking at the impact of these event on the German car market and calculating the expected MSR for the event window, requires considering the higher diversification of the VWG in the German market, which is why every major company of the VWG will be represented in the study. Figure 4.3.2 shows all included companies in the study and presents the expected returns for each company. It can be constituted that crisis struck in a phase of market saturation with VWG car brands, with the only brands experiencing growth on average being Skoda and luxury sports line Porsche. This however is the VWG home market, where they already hold the vast majority of market share, hence marginally negative MSR growth rates are not to be overestimated.

$\tau = 0$	VWG	VOLKSWAGEN	AUDI	SKODA	SEAT	PORSCHE
SEP 15	-0.00555	-0.00881	-0.00061	0.01100	0.00049	0.03299
JAN 17	-0.00429	-0.01555	0.01947	0.02189	0.01761	0.06689
MAR 17	-0.00429	-0.01555.	0.01947	0.02189	0.01761	0.06689

Figure 4.3.2 Expected Normal Return VWG Germany with a constant-mean return model

Having established the expected mean market returns it is now necessary to investigate and analyse the existing abnormal returns in order to identify a statistically significant R_{it}^{*} and subsequently also a significant L_2 and L_3 as window lengths. Hence why, the CAR of the event window will be examined (3.2.13).

Here, a development according to figure 4.2.1 is expected to be found. Simultaneously, the length of the event window is defined by the analysis of CARs, as the duration of an impact

becomes apparent. Additionally, in the US market, where the examined variable is car sales, the event window can start with the event month t_0, as the first publication of the DS is comprised in it and an impact on MSR, caused by potential customers punishing VWG by not buying its products, can be expected.

The calculation is based on the MSRs of all companies of the VWG US, since from beginning of the DS, Audi and Volkswagen cars were concerned by the manipulations and had to be

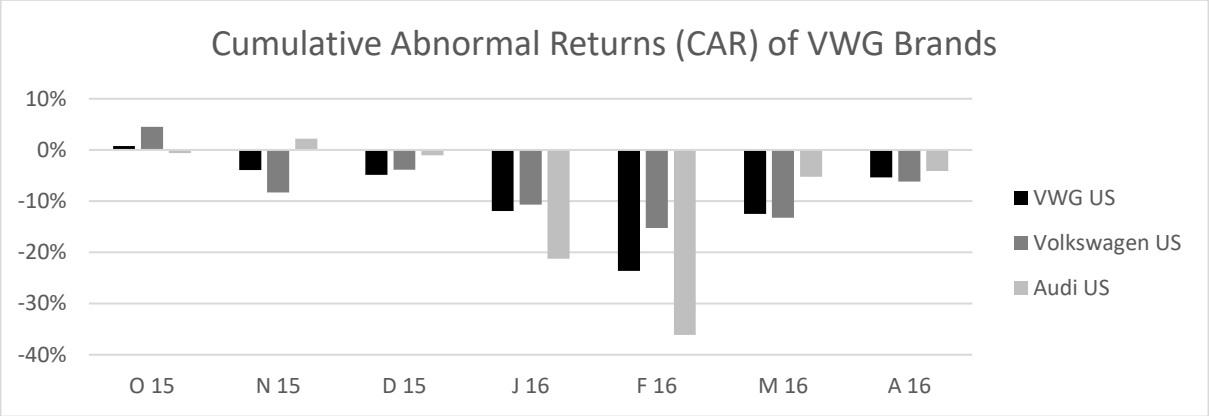

Figure 4.3.3 Cumulative Abnormal Returns US Market Event 1

recalled. Figure 4.2.3 shows the computed CARs for the VWG and its brands in the US market, where the beforehand mentioned turning point outlined by Shin et al. (2012b) can be seen. Here cumulative abnormal returns increase until February of 2016 and decrease afterwards. At its highest point, the CAR amounts up to a decrease of over 20% in MSR for the VWG. Therefore, it is expected that this decrease is likely to be significant due to the large cumulative effect the DS has had on the VWG and its brands. Figure 4.2.4 explains how the event windows and post-event windows are established and shows the findings for the first event of interest in the US market.

Company	t_1/t_{2+1}	t_2/t_3	CAR_{iL_2}/CAR_{iL_3}	$t\ value$
VWG US	0	1	0.00789	0.20391
	0	2	-0.03891	-1.22318
	0	3	-0.04859	-1.71605
	0	4	-0.11944	-2.87860*
	0	5	-0.23632	-3.03411**
	0	6	-0.12504	-1.70080
	0	7	-0.05326	-0.56765
	0	8	-0.03964	-0.58821
	6	14	0.35035	3.80759***
Volkswagen US	0	5	-0.14938	-2.37059*
	6	14	0.36643	3.39305**
Audi US	0	5	-0.36434	-2.54463*
	6	14	0.27566	13.25257***

, ** and * represent significance at a 90%, 95% and 99% level respectively*

Figure 4.3.4 Event 1 US Market: CARs and Significance Values

The results in figure 4.3.4 show that the event window was constituted to reach from September 2015 ($\tau = t_1$) to February 2016 ($\tau = t_2$) as the VWG US, Volkswagen US and Audi US each showed a significantly negative CAR for this period of time. The post-event window was found to be from February 2016 ($\tau = t_2 + 1$) to November 2016 ($\tau = t_3$). It was found that this window, comprising 9 calculation periods, yielded the highest significance[7] for the CARs. Indeed, the event period CARs were all significantly negative for all brands, whereas the after-event period CARs were found to be significantly positive for both brands and the conglomerate. The assumption of figure 4.2.1 was thereby confirmed for the recall event of the DS for Audi US and Volkswagen US thus also the VWG US.

Investigating the impact of the beginning of the DS on the VWG's domestic market, German car market results for this first event are depicted in figure 4.3.5. The first main difference to the US model is that the event month is not included in the event window in the German market due to the expected delay in market reaction. Nevertheless, the event window was set to have the same length as US event window, to match the window length in both markets[8]. Yet, the post-event window was set to be one period longer than in the US event

[7] This method was abstracted from Shin et al. (2012) and is necessary to obtain knowledge about the duration of an effect caused by an event. This is particularly important in the strongly affected US market, where effects are expected to be stronger than elsewhere.

[8] The event window was set to be from October 2015 until March 2016

study, since the delay, caused by the measurement figure for the German market needs to be accounted for. The findings indicate no significant changes in the MSR of the VWG and its companies in the event and post-event windows caused by abnormal returns, except for Audi, whose CAR is marginally significantly negative during the post-event window, and Seat, whose CAR is significantly positive for the post-event window.

Company	t_1/t_{2+1}	t_2/t_3	CAR_{iL_2}/CAR_{iL_3}	$t\ value$
VWG	1	2	0.00496	0.99757
	1	3	-0.06309	-1.82028
	1	4	0.04295	1.10232
	1	5	0.04457	1.13818
	1	6	0.02970	0.81183
	1	7	0.03277	0.94691
	1	8	0.02972	0.90818
	1	9	-0.00625	-0.19700
	7	16	-0.00809	-0.55159
Volkswagen	1	6	-0.01062	-0.37327
	7	16	0.01905	0.56929
Audi	1	6	0.27338	1.51506
	7	16	-0.16283	-2.0535*
Skoda	1	6	-0.02284	-0.20962
	7	16	-0.08812	-1.50873
Seat	1	6	0.03109	0.37736
	7	16	0.52257	4.40271***
Porsche	1	6	0.06719	0.33059
	7	16	-0.19834	-1.28516

, and *** represent significance at a 90%, 95% and 99% level respectively*

Figure 4.3.5 Event 1 German Market: CARs and Significance Values

4.3.2 VWG US Fine Settlement

Shifting the focus to the second event of interest, the penalty payment the VWG had agreed on paying in the beginning of January 2017. Since the second and third event are only separated by a month, the time spans chosen for the windows are shorter than usual to avoid including the effect of the subsequent event in the event period. Figure 4.3.6 shows that during the three-period event window reaching to March 2017, which again included the

event month[9] the VWG US, Volkswagen US and Audi US' MSR diminished strongly yet insignificantly. In the long run, there were marginally and regularly significantly positive impacts of the event on the CARs found on Volkswagen US and the VWG US respectively, for the time span from April 2017 to August 2017. Similarly, the results for Audi US, although not reaching the common significance levels, has significance at the 80% level indicating that also Audi US is likely to have been positively influenced in the long-term by the second event.

Company	t_1/t_{2+1}	t_2/t_3	CAR_{iL_2}/CAR_{iL_3}	$t\ value$
VWG US	0	2	-0.10837	-2.04623
	3	7	0.11972	3.84800**
Volkswagen US	0	2	-0.26437	-3.60427
	3	7	0.11840	2.63951*
Audi US	0	2	-0.14597	-2.21584
	3	7	0.03855	2.08064

, and *** represent significance at a 90%, 95% and 99% level respectively*

Figure 4.3.6 Event 2 US Market: CARs and Significance Values

Analogously to the US market, event and post-event windows are set equally long with a one-month delay for the German market. Similar to the first event of interest, the German market (figure 4.3.7) does not contain any significant short-term CARs. For the post-event window, only Audi and Porsche are found to have both significantly negative CARs in the long-term at the 90% and 95% significance level respectively.

[9] The event month is integrated for the same reason as in event 1. The agreement was made during the month, leaving enough time for consumer reaction. Additionally, in this case the event, which saw the VWG settling, was anticipable, since the lawsuit had been ongoing and a unfavourable verdict for VWG was possible.

Company	t_1/t_{2+1}	t_2/t_3	CAR_{iL_2}/CAR_{iL_3}	$t\ value$
VWG	1	3	-0.00071	-0.02173
	4	8	-0.01292	-0.80275
Volkswagen	1	3	0.00978	0.15660
	4	8	0.03343	0.98874
Audi	1	3	0.00009	0.00106
	4	8	-0.30014	-3.05688*
Skoda	1	3	-0.6515	-1.07735
	4	8	0.20237	1.99740
Seat	1	3	0.04256	0.66038
	4	8	0.04594	0.48963
Porsche	1	3	-0.04577	-1.62085
	4	8	-0.69094	-3.48918**

, ** and * represent significance at a 90%, 95% and 99% level respectively*

Figure 4.3.7 Event 2 German Market: CARs and Significance Values

4.3.3 VWG Guilt Admission

The third and last event, the admission of guilt by the VWG is presented in figure 4.3.8 for the US market and in figure 4.3.9 for the German market. In both markets the event windows have the same lengths, namely six periods. Due to its recency, the post-event window was limited to the availability of data ending in March 2018. Since the US model includes the event month and the German system starts with a delay of one month, the post-event windows are of seven periods for the US and of six periods for Germany.

It can be seen in figure 4.3.8 that Audi US had a strongly significant increase leading to the VWG US also having a significantly positive CAR se over the event window, in turn Volkswagen US witnessed low and insignificant abnormal returns. In the long-term the CARs of the VWG US and Volkswagen US decrease significantly. Opposingly, CARs of Audi do decrease but not significantly over the post-event window.

Company	t_1/t_{2+1}	t_2/t_3	CAR_{iL_2}/CAR_{iL_3}	$t\ value$
VWG US	0	5	0.13582	3.43494**
	6	12	-0.15959	-2.93843**
Volkswagen US	0	5	0.04181	0.92535
	6	12	-0.20605	-3.41034**
Audi US	0	5	0.19022	7.85562***
	6	12	-0.13624	-1.23907

, and *** represent significance at a 90%, 95% and 99% level respectively*

Figure 4.3.8 Event 3 US Market: CARs and Significance Values

Figure 4.3.9 depicts a highly significant positive CAR for Volkswagen in Germany during the event window, which is strong enough to ensure the VWG's CAR to be positive and significant as well during the same time span. Additionally, Porsche faced a significantly negative CAR in the event window. Regarding the post-event window Volkswagen's CAR shows a marginally significant increase. Meanwhile Skoda had a highly significant negative CAR in the same time span.

Company	t_1/t_{2+1}	t_2/t_3	CAR_{iL_2}/CAR_{iL_3}	$t\ value$
VWG	1	6	0.06692	3.58288**
	7	12	0.01971	0.66655
Volkswagen	1	6	0.15203	4.70390***
	7	12	0.10859	2.36527*
Audi	1	6	-0.19352	-1.75811
	7	12	-0.03927	-0.50489
Skoda	1	6	0.17792	1.86704
	7	12	-0.28571	-5.24269***
Seat	1	6	-0.05661	-0.59565
	7	12	0.09308	0.74949
Porsche	1	6	-0.72845	-3.16363**
	7	12	0.00718	0.04773

, and *** represent significance at a 90%, 95% and 99% level respectively*

Figure 4.3.9 Event 3 German Market: CARs and Significance Values

4.4 Market Model

Campbell et al. (1997) state that the statistical factor model for the modelling of the normal return can also compute abnormal returns by "taking the difference between the actual return and a portfolio of firms of similar size, where size is measured by market value of equity." (Campbell et al., 1997, p.155). This implies, that a market model can be constructed of a certain number of securities. Analogous to that, the market model can also be built of non-stock market values, as long as it resembles the characteristic of an average market return calculation. In this case, companies from the US and the German car market can be selected based on their level of sales and can then be used to calculate a market average of, taking the exemplary variable of Shin et al. (2012b), MSRs. The entire statistical construct resembles the classic event study model and thus represents a suitable modelling of the abnormal MSRs.

In order to apply the market model method, the market indices need to be established. For the US market a subset of four companies, which on average held the largest MSRs on the market in the estimation period of the first event, were selected to constitute the market return. These companies are Japanese Toyota Motor Company[10], and US-American GM, Ford MoCo and Fiat-Chrysler, which on average were responsible for 59.6% of the total US MSR during the first estimation window period.

Whereas, the VWG does not represent one of the largest companies according to its MSR in the US market, it is the largest company in the German market. In order to resemble the market model for the US market, where the market return is obtained from companies that are not directly involved with DS, the German market return shall be computed from non-VWG companies. Additionally, an emphasis shall be set on companies with strong ties to the country. However, excluding the VWG completely would yield a market return including less than half the German market's MSR. Consequently, the VWG needs to be included, yet the Volkswagen MSR is excluded to isolate the market return from the MSR of the main company concerned by the DS. Next to the VWG excluding Volkswagen, the market return is chosen to be constructed by companies with similar strong ties to Germany as the VWG. Therefore Daimler[11], the BMW Group[12], Ford MoCo and Opel, which combined were responsible for on

[10] The term 'Motor Company' will be referred to in the following as MoCo. This also applies to the appendix.
[11] Daimler included Mercedes-Benz and Smart.
[12] BMW Group included BMW and Mini.

average 50.1% of the MSR of the German market, were identified as suitable. While Daimler, the BMW Group and Opel are traditional German car manufacturers, Ford is an early incumbent into the German market, which has production sites in the country and therefore gained a significant market share. In figure 4.4.1 the weightings of each company are depicted. As stated by Campbell et al. (1997) the weightings need to remain constant throughout the study. That is, the market indices are calculated using one estimation window and are then applied to three different events. The first estimation window was chosen therefor, since it is the only period in the study where there are no crisis effects involved. In addition to that, the event windows and post-event windows were chosen equally to the mean-market return model to enable comparability of results. Nevertheless, the first event features a detailed example of window duration assessment, using figures for the US and the German VWG.

US MARKET INDEX	**WEIGHTING**	**GERMAN MARKET INDEX**	**WEIGHTING**
Toyota MoCo	0.23953	Daimler	0.19997
GM	0.29686	BMW Group	0.17823
Ford MoCo	0.24918	Ford MoCo	0.13527
Fiat Chrysler	0.21443	Opel	0.14154
		VWG (excl. Volkswagen	0.34500

Figure 4.4.1 Market indices' weightings per company and market

As visualised by (3.2.5) the market returns are used to compute estimates for $\hat{\alpha}_i$ and $\hat{\beta}_i$, which are then used for the calculation of expected returns to obtain abnormal returns. Further, testing for significance in the market model requires to compute the standard errors of the actual firm MSRs and the market MSRs. The estimates and standard errors for each company in the second and third event can be found in Appendix A. Except for those of the first event for the US market.

4.4.1 Findings 'DS Becomes Public'

For the first event in the US the estimated variables for each company can be found as an example below in figure 4.4.2. The linear relationship between the MSR of VWG US and the US market return can be described by a linear relation with an intercept of 0.00448 and a

negative slope of 2.48139. Thus, for every unit increase in the market return, the MSR of VWG US diminishes by 2.48139 unit.

Company	$\hat{\alpha}_i$	$\hat{\beta}_i$	Standard Error
VWG US	0.00448	-2.48139	0.06131
Volkswagen US	-0.00534	0.53349	0.06642
Audi US	0.01605	-1.79533	0.11140

Figure 4.4.2 Computed estimates for the linear relation between a company and the market Event 1 US

The analyses of CARs for the companies of interest visible in figure 4.4.3, yield for the event window a marginally significant negative CAR for Volkswagen US and a significant negative CAR for Audi US, which in sum lead to a significantly negative CAR for the VWG US. Contrarily, the CARs in the post-event window are positive for all three companies. More specifically, a marginally significant CAR for Audi US and a strongly significant CAR for Volkswagen US, lead to the VWG US' CAR during the post-event period to be also strongly significant.

Company	t_1/t_{2+1}	t_2/t_3	CAR_{iL_2}/CAR_{iL_3}	$t\ value$
VWG US	0	1	0.05572	0.90894
	0	2	-0.02978	-0.48569
	0	3	-0.01579	-0.25756
	0	4	-0.07190	-1.17282
	0	5	-0.17980	-2.93274**
	0	6	-0.14731	-2.40282*
	0	7	-0.03051	-0.49762
	0	8	-0.07164	-1.16853
	6	14	0.27296	4.45240***
Volkswagen US	0	5	-0.16007	-2.41019*
	6	14	0.37370	5.62678***
Audi US	0	5	-0.32834	-2.94747**
	6	14	0.25119	2.25488*

, and *** represent significance at a 90%, 95% and 99% level respectively*

Figure 4.4.3 Event 1 Model 2 US Market: CARs and Significance Values

Looking at the computed CARs of the German market in 4.4.4, it becomes apparent that for the event window the CAR of Audi is highly significant and positive, whereas the other brands of the VWG and the VWG itself have no significant CARs. This changes in the post-event window, where Volkswagen, Audi and Porsche incurred strongly significant and negative CARs. So much so that the VWG also had a strongly significant negative CAR for the post-event

window. Seat stands out with its post-event window CAR having the only positive CAR in the time span, which simultaneously is highly significant.

Company	t_1/t_{2+1}	t_2/t_3	CAR_{iL_2}/CAR_{iL_3}	$t\ value$
VWG	1	2	0.00802	0.21514
	1	3	-0.06971	-1.87023
	1	4	0.06915	1.85522
	1	5	0.05048	1.35445
	1	6	0.01494	0.40097
	1	7	0.05094	1.36670
	1	8	0.02989	0.80187
	1	9	-0.05690	-1.52657
	7	15	-0.13369	-3.58676***
Volkswagen	1	6	-0.03912	-0.16672
	7	15	-0.16672	-4.04730***
Audi	1	6	0.26429	6.41575***
	7	15	-0.23915	-5.80538***
Skoda	1	6	-0.00703	-0.17074
	7	15	0.02321	0.56347
Seat	1	6	0.04167	1.01167
	7	15	0.18811	4.56642***
Porsche	1	6	0.00208	0.05060
	7	15	-0.28418	-6.89869***

, and *** represent significance at a 90%, 95% and 99% level respectively*

Figure 4.4.4 Event 1 Model 2 German Market: CARs and Significance Values

4.4.2 Findings 'VWG US Fine'

The market model for the second event in the US given by figure 4.4.5, finds no significant CARs in the event study. There are nonetheless, significant positive CARs found in the post-event window at the 90% significance level for the VWG US and Volkswagen US, and at the 95% significance level for Audi US.

Company	t_1/t_{2+1}	t_2/t_3	CAR_{iL_2}/CAR_{iL_3}	$t\ value$
VWG US	0	2	-0.12604	-1.17177
	3	7	0.26011	2.41823*
Volkswagen US	0	2	-0.28361	-2.59374
	3	7	0.27129	2.48109*
Audi US	0	2	-0.17773	-1.57534
	3	7	0.29094	2.57880**

, and *** represent significance at a 90%, 95% and 99% level respectively*

Figure 4.4.5 Event 2 Model 2 US Market: CARs and Significance Values

Applying the market model to the German market for the second event, here below in figure 4.4.6, fails to identify any significant CAR for the event window. In the post-event window, only Porsche has a marginally significant CAR, which is negative. The computed CARs for the other companies show for example a negative CAR in the event window for Volkswagen and a positive CAR in the post-event window, which however is insignificant.

Company	t_1/t_{2+1}	t_2/t_3	CAR_{iL_2}/CAR_{iL_3}	$t\ value$
VWG	1	3	-0.04831	-1.29600
	4	8	0.01723	0.45299
Volkswagen	1	3	-0.06150	-1.49301
	4	8	0.07858	1.70251
Audi	1	3	-0.09248	-1.06203
	4	8	-0.24150	-1.29386
Skoda	1	3	0.01825	0.30836
	4	8	0.14955	1.30734
Seat	1	3	0.00795	0.04909
	4	8	0.06785	0.41900
Porsche	1	3	-0.16647	-1.36751
	4	8	-0.61449	-2.71666*

, and *** represent significance at a 90%, 95% and 99% level respectively*

Figure 4.4.6 Event 2 Model 2 German Market: CARs and Significance Values

4.4.3 Findings 'VWG Guilt Admission'

Figure 4.4.7 presents the CARs of the VWG in the US for the third event, the admission of guilt by the VWG. During the event window, Audi US' MSR included a significantly positive CAR, whereas Volkswagen and the VWG had no significant CARs. Moreover, in the post-event window there was no significant CAR found for any of the companies.

Company	t_1/t_{2+1}	t_2/t_3	CAR_{iL_2}/CAR_{iL_3}	$t\ value$
VWG US	0	5	0.22116	2.05617
	6	12	-0.15549	-1.44557
Volkswagen US	0	5	0.13475	1.23239
	6	12	-0.20159	-1.84359
Audi US	0	5	0.34365	3.04602**
	6	12	-0.03613	-1.14231

, and *** represent significance at a 90%, 95% and 99% level respectively*

Figure 4.4.7 Event 3 Model 2 US Market: CARs and Significance Values

Looking at figure 4.4.8, which contains data on the German market, it becomes apparent that Volkswagen's MSR during the event window included a significantly positive CAR. At the same time Porsche sustained significantly negative CARs. The post-event windows do not include any significant CARs for the VWG in Germany.

Company	t_1/t_{2+1}	t_2/t_3	CAR_{iL_2}/CAR_{iL_3}	$t\ value$
VWG	1	6	0.05387	1.41650
	7	12	-0.03613	-0.94994
Volkswagen	1	6	0.13249	2.87045**
	7	12	0.02497	0.54096
Audi	1	6	-0.21889	-1.17272
	7	12	-0.14786	-0.79216
Skoda	1	6	0.20078	1.75523
	7	12	-0.18786	-1.64231
Seat	1	6	-0.06610	-0.40815
	7	12	0.05248	0.32407
Porsche	1	6	-0.76154	-3.36679**
	7	12	-0.13442	-0.59428

, and *** represent significance at a 90%, 95% and 99% level respectively*

Figure 4.4.8 Event 3 Model 2 US Market: CARs and Significance Values

5. Discussion

Having presented the results of all the conducted event studies, which can be found summarised in Appendix B, it is now essential to interpret the data found in the analyses. This will be done individually for each event, where findings of both models, the constant-mean return model and the market return model will be compared. Conclusions will be made on the found results, as to what could be a feasible explanation for the results at hand and what the implications for crisis management are. Here the findings are going to be compared to the hypothesised outcomes. The subsequent section will conclude with general remarks on the topic of the DS, its implications on the automotive industry and the chosen event study model.

Since the study used MSR, it is not possible to calculate nor to estimate the monetary value of indirect cost of the DS. This is due to the MSR being composed out of the absolute sales figures instead of the sales revenue of the companies, which is attributed to the nature of the automotive market, where the sales volume is used as unit of measurement, as sales revenue depends on the pricing, which particularly in the automotive industry can differ largely from company to company.

5.1 The DS Begins

For the first event, the beginning of the DS in September 2015, both the constant-mean and the market model identify similar significantly negative CARs over the event windows and similar significantly positive CARs over the post-event windows for the VWG US, Volkswagen US and Audi US. The significance found confirms the chosen first event as suitable and relevant for the study, directly links the identified impacts to the DS and further proves hypothesis 1a to be correct.

Hence, customers in the US market learning from the DS and the entailed recall of vehicles tended to become reluctant to buy VWG vehicles and were likely to postpone a purchase. This reluctance, however, diminished gradually over time to the point where customers expected the problem causing the recall to be fixed and started carrying out previously postponed purchases. An explanation for this could be given by the VWG's crisis management efforts starting shortly after the break-out of the crisis, in which the company tried to regain customer trust and thereby contributed to a more positive overall customer reaction.

Comparing these strong and significant results in both models to the German market results, it becomes obvious that the effect on the German market is weaker than in the US market. Particularly the constant-mean return model shows no significant results for the event window and only a marginally significant negative CAR for Audi and a highly significant CAR for Seat in the post-event period. Further, the results of the market model suggest that the expected delay, caused by the measurement variable in Germany, is likely to be larger than one month. Since, the market model approach in the German market does not offer any identifiable effect during the event window, except for a highly significant positive CAR for Audi, but holds highly significant negative CARs for Volkswagen, Audi, Porsche and the VWG for the post-event window, it can be stated that the delay likely is approximately of the length of the event window[13]. The market model thus displays a negative impact of the DS through negative abnormal returns for the majority of the VWG's German brands during the post-event window.

Additionally, the market model also finds a highly significant positive CAR for Seat in Germany. The positive CAR for Seat can be explained by a shift in preference of German customers, which due to the DS tend to not buy Volkswagen or Audi but substitute these brands by other VWG brands such as Seat. The results for Skoda do not indicate any significance in both windows, which could hint to a balance between loss of market share due to association to the companies affected by the DS and gain of customers turning from Volkswagen or Audi to them.

All in all, hypothesis 1b can also be confirmed, only considering a longer time frame than hypothesis 1a. Thus, despite being detected and publicised by US authorities the DS has an impact on the German market development, which is also due to it being associated to the entire production line. Given this, the need for an international crisis management strategy is highlighted. When applying a strategy of this type, it is particularly important to shape the tools in accordance to the market they will be used in, in order to minimise the damage incurred by a crisis. This can be predominantly seen in the example of the VWG in the German market, where the VWG could benefit from its market leading position to cause a shift in

[13] Additional analyses would be necessary to directly identify the exact start and duration of the correctly adjusted event window. Nevertheless, the same measurement variable would provide a better comparability between the different markets.

customer preference from one VWG brand, namely Volkswagen or Audi to another, namely and most notably Seat, not directly being concerned by the DS.

5.2 VWG US Fine Settlement

The first crisis management related examination in the study is the analysis of the VWG US settlement for a penalty payment. The event window was selected to cover three measurement periods, January 2017 to March 2017, since March 2017 represented the event month of the third event of interest. Here both models fail to identify significant CARs in both markets in the event window. It can be concluded that the short length of the event window impeded the analysis from finding significant impacts on the MSRs of the VWG in the US and Germany. Nonetheless, the found CARs can be used to make an assumption about the impact the fine settlement had, especially since the CARs computed for the US point to a clearly negative CAR for all three examined companies. The German market results however, do not hint to a particular direction.

In contrast to the insignificant event window, the post-event window in the constant-mean return model shows a significant CAR for the VWG US and a marginally significant positive CAR for Volkswagen US. These findings are confirmed through marginal significance in the market model. Additionally, in the market model Audi US is found to have a significant positive CAR. Hence, all US companies show a significant positive CAR for the post-event period that can be linked to the settlement. This implies that the accepting of a fine can lead to an increase of MSR, which simultaneously confirms hypothesis 2a. Anyhow, it has to be mentioned that the post-event window includes the event window of the guilt admission event, which was expected to have boosted MSRs of VWG companies in the US and Germany. In terms of hypothesis 2b this means this means it needs to be rejected as no clear results could be found.

5.3 VWG Guilt Admission

The results on the impact of admitting guilt of the VWG are mixed. While the constant-mean return model identifies significantly and highly significantly positive CARs in the event window for the VWG US, Volkswagen US, Audi US, VWG and Volkswagen, the market return model only confirms the significance for Audi US and Volkswagen in Germany. Similarly, the post-event window in the constant-mean return model is identified to hold significantly negative CARs for the VWG US, Volkswagen in the US and in Germany as well as Skoda, but are not

proven by the market model, which finds no significance in any company for that time span. The findings indicate that customers in the US reacted overall positively to the admission of guilt, visible in the increase in MSR of Audi US and the VWG US. The admission of guilt thus offers the possibility to regain customer trust, however there was no positive effect on Volkswagen US. This may be linked to the strong association of the name Volkswagen to the DS and the underlying customer deception. This in turn would imply that admission of guilt cannot repair every kind of reputational damage, which cannot be confirmed nor rejected by this study.

The lack of significance inhibits a more insightful interpretation of the results for the post-event window. Yet, the insignificance of results can be linked to several other factors. For example, it can be argued that the DS was the first emission-related automotive scandal in a series of numerous cases, which started to be uncovered once the DS had shifted the public interest towards the automotive industry. Simultaneously, this would justify the highly significant effects found for the first event and the lower significance in the subsequent events.

The results indicate mixed results for hypotheses 3a and 3b, as different brands reacted differently to the admission of guilt. Moreover, there was a difference between the effects over time, leading to the hypotheses to be rejected as they need to be more specific for a different result.

5.4 General Remarks

Although there are significant results for both the US and the German market in this study, it is not possible to attribute the entire significance to a single event. The DS regularly brought to light new evidence of corporate wrong-doing and further was object to numerous international investigations and law-suits. Additionally, there were changes in the top-level management of the company. Environmental protection in the automotive industry became a focal point of medial interest, leading to carmakers being at the centre of attention and being under observation, causing uncertainty throughout the automotive industry. Generally, in a phase of political uncertainty company stocks or here MSRs are likely to endure higher volatility (Pastor and Veronesi, 2012). All these factors need to be taken into consideration when explaining a significant CAR. Nevertheless, the found significant CARs display that these

results were due to the breakout of the DS and the way how the VWG ran its crisis management. Assuming that consumers reaction could be driven by the belief that the DS might only be one corporate wrongdoing among numerous in the automotive industry.

The findings of this study indicate that the effects of the DS are internationally noticeable. The results for the German market indicate that there is however a difference in impacts for different target customer groups, as the computed CARs for Porsche, whose luxury sports vehicles and higher price range target a wealthy customer group, do not conform to the general development of CARs of the other VWG companies. This implies that the DS does affect the luxury car segment in a different way than the car market in other price ranges if at all.

6. Conclusion

6.1 Synopsis of Findings and Benefits

This study was designed to expand the existing research on the Volkswagen DS and the financial damage caused by it. Here, the focus was set on uncovering the indirect cost caused by the DS, represented by the sales and market share loss of VWG car brands, to complement the findings of Bowen et al. (2017). The strong link between potential financial damage of a crisis situation and corporate reputation, thus, also corporate crisis management, was highlighted throughout the study and led to the emphases being set on relevant events related to crisis management and corporate reputation. In this context, the example of the Volkswagen DS was chosen to be analysed in a modified event study based on MSR, in other words sales performance.

The study revealed an expected negative effect of the DS on the MSR of the VWG in the US market as well as in the German market as well as a slightly positive long-term effect of the fine settlement of the VWG. The guilt admission was found to have positive short-term impact on Audi US and Volkswagen Germany, thus confirming the idea that admitting guilt can positively influence customer reaction. Nevertheless, for the long-term, no reaction was found. All in all, the findings did confirm the expected domestic market bias, but unveiled that instead of German customers neglecting the impact of the DS, a shift towards a different brand of the VWG was measurable.

The findings could prove helpful for companies in situations where different alternatives of crisis management actions are contemplated and provide information on the probable duration of effects of a crisis event. This links directly to the research area of comparative global crisis management (Coombs and Laufer, 2018). Additionally, due to the study companies could be able to reduce indirect and direct costs, as insights into the product demands and sales volumes are given, lowering overall cost and avoiding drops in prices. Further, the study contributes to the intercultural and international comparison of crisis management, which was identified as a broad field of study increasingly gaining importance, yet still lacking scientific research. Particularly the issues of a corporate crisis' effect on different markets were found to be of high importance for future research.

This study contributes to that by comparing a company's host and domestic market share during a crisis as well as its fluctuations caused by important crisis management events.

6.2 Limitations of the Study

The chosen approach of the study entails several limitations. Although it was intended to identify effects of the DS on the automotive industry, the car-manufacturing industry in this case only contains companies, whose main focus is set on vehicles using fossil fuels. Nowadays however, companies producing vehicles with electric motors, such as Tesla, are on the rise. It can be expected that companies engaging in electric mobility are not concerned by negative aspects of the DS, that is, a company like Tesla does not suffer from the inertial effect of the DS despite being in the same industry as the VWG.

In this study the event window was set on the event month, however it is necessary to consider the date in the event month, on which an event happened. Daily sales data in this particular case, is not available, yet it can be expected that, when looking into sales figures of car dealerships, which can provide more detailed information on sales. Further, in a regular event study, the estimation windows are larger as in this study, due to the unit of measurement being the trading day instead of the sales month. Thereby, the effect of sampling errors in variance calculation diminishes, bringing forward more robust and reliable results (Benninga and Czaczkes, 2008).

Using the figures from the KBA for the German market, although being governmentally controlled, also contain some restraints. As the data represents the monthly new registrations of vehicles in Germany, it does not account for the duration of delivery of the vehicle. There is also the chance to buy a vehicle in advance for example for companies, which could have been bought long before the DS became public. Furthermore, the cases of cars bought in Germany and registered abroad, as well as cars bought abroad, new or used, and brought to Germany for the first time, cannot be excluded from the data set. In addition to this, there is no legislative obligation to register a vehicle, if the car is not to be immediately used, giving the possibility of a delay between the time of purchase and the time of registration, which, though not very likely, needs to be accounted for.

On the one hand, one could argue that the process of identification of suitable event and post-event windows is a form of data mining. On the other hand, however, this process is

indispensable to capture the entire effect of an event. This particularly becomes visible in the first event 'the DS begins', where a differently set event date or post-event date would have had a severe impact on the significance of findings, nevertheless, it is to be mentioned.

6.3 Recommendations for Future Research

Concerning possible future research in this area, it is important to obtain a wholistic perspective. Thus, it is necessary to also consider the MSR of VWG in other markets, but also the MSRs of the automotive industry. Liu et al. (2017) conducted a study on the impact of an unforeseen political event in China on the stock price of a company. The approach used in this study could be a helpful tool to analyse stock price data in the VW case as well.

Crisis management scientists lament the lack of studies on global crisis management in general and particularly the lack of studies in emerging economies. This study could hence be expanded to other countries and companies. Moreover, the integration of an analysis on reputational change during a crisis and its implication on different stakeholders would be of high value for crisis management research as it could depict the interplay of social (non-economic) and economic losses during crises. The approach used here enables a comparison of German and US-American customers in the automobile market, thus presents an applicable method for global crisis management studies. Instead of analysing the data at company and country of origin level, future research could include an examination of the effect of the DS on the customer acceptance of diesel engines compared to other engine types. Thereby, possible crisis management actions can be identified that particularly influence the engine type acceptance on the market. Hence, findings could not only be of value for crisis management and current business case studies literature, but also for marketing and innovation literature.

When constructing the market model to estimate abnormal returns or the expected normal returns, it can be of high value to include more companies to estimate a market return. Further, it is advisable that companies are existent over the entire period of the estimation window, since mergers and acquisitions can lead to biases in sales figures. Additionally, the same study could be used to analyse the effect of the DS on other German car manufacturers in the US. In future research cross sectional analyses could be conducted to unveil the influence of other variables in the abnormal return. This for example, could include the

variables engine type, which could be one or multiple dummy variables inter alia for diesel engines, hybrids and electric cars sold, or also a proxy to measure the level of crisis management conducted by the company. In this context, Wood et al. (2018) conducted an event study and a cross-sectional regression analysis on the stock return of car manufacturers in recalls, which could serve as a guiding paper to select regressors.

It is also advisable to implement non-parametric significance tests, when conducting this kind of study in order to validate findings without distributional assumptions or possible high-volatility return. This implicates that the focus is not set on CARs but rather on abnormal returns per period or a sample of events that are to be examined. Anyhow, this study can serve as a starting point for a study based on car dealerships. Conducting interviews with and receiving financial reports of these dealerships could help to find a more significant break of MSRs due to the DS. This could be picked up on a large scale by scientists in order to identify the most impactful crisis revelation and the most efficient crisis management tool. Thereby, the perfect timing for a crisis management action might become more tangible (Shin et al., 2012b). An additional focus shall be set on proving the link between sales performance and corporate reputation under similar circumstances. This could be done by integrating a proxy for corporate reputation in a cross-sectional analysis of abnormal CARs, or for example by examining the effect of the DS on corporate reputations of automotive companies. In turn, this however requires the research field of corporate reputation to expand enabling its frequent use in quantitative studies. Moreover, based on the expanded theoretic approach, this method could in similar version be used in crisis management studies in order to expand the research are as demanded by Coombs and Laufer (2018).

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Appendices

Appendix A: Additional Tables for the Return Calculations

Event	Toyota MoCo	GM	Ford MoCo	FCA
Sep 15	-0,00595	0,00182	0,00570	0,00282
Jan 17	0,00012	0,00729	-0,00127	-0,01120
Mrz 17	0,00012	0,00729	-0,00127	-0,01120

Figure 0.1 Mean expected returns for US market

Company	$\hat{\alpha}_i$	$\hat{\beta}_i$	Standard Error
VWG	0.00163	-1.09213	0.03727
Volkswagen	0.00507	-2.11006	0.04119
Audi	0.00381	-0.67269	0.08708
Skoda	0.00330	1.17035	0.08757
Seat	-0.00467	0.78408	0.10325
Porsche	0.06469	-4.82059	0.12173

Figure 0.2 Computed estimates for the linear relation between a company and the market Event 1 Germany

Company	$\hat{\alpha}_i$	$\hat{\beta}_i$	Standard Error
VWG US	0.00842	-2.54696	0.10756
Volkswagen US	0.01734	-2.77375	0.10934
Audi US	0.01296	-4.57872	0.11282

Figure 0.3 Computed estimates for the linear relation between a company and the market Event 2 US

Company	$\hat{\alpha}_i$	$\hat{\beta}_i$	Standard Error
VWG	0.00203	-1.22906	0.03803
Volkswagen	-0.00608	-1.84064	0.04616
Audi	0.03176	-2.39036	0.18665
Skoda	0.01081	2.15364	0.11439
Seat	0.02220	-0.89364	0.16194
Porsche	0.08292	-3.11689	0.22619

Figure 0.4 Computed estimates for the linear relation between a company and the market Event 2 Germany

Company	$\hat{\alpha}_i$	$\hat{\beta}_i$	Standard Error
VWG US	0.00842	-2.54696	0.10756
Volkswagen US	0.01734	-2.77375	0.10934
Audi US	0.01296	-4.57872	0.11282

Figure 0.5 Computed estimates for the linear relation between a company and the market Event 3 US

Company	$\hat{\alpha}_i$	$\hat{\beta}_i$	Standard Error
VWG	0.00203	-1.22906	0.03803
Volkswagen	-0.00608	-1.84064	0.04616
Audi	0.03176	-2.39036	0.18665
Skoda	0.01081	2.15364	0.11439
Seat	0.02220	-0.89364	0.16194
Porsche	0.08292	-3.11689	0.22619

Figure 0.6 Computed estimates for the linear relation between a company and the market Event 3 Germany

Appendix B: Summary of Results

Event	Model	Company	Event window CAR attributes	Post-event window CAR attributes
DS Begins	Constant-Mean Return Model	VWG US	Significant, negative	Highly significant, positive
		Volkswagen US	Marginally significant, negative	Significant, positive
		Audi US	Marginally significant, negative	Highly significant, positive
		VWG	No significance, positive	No significance, negative
		Volkswagen	No significance, negative	No significance, positive
		Audi	No significance, positive	Marginally significant, negative
		Skoda	No significance, negative	No significance, negative
		Seat	No significance, positive	Highly significant, positive
		Porsche	No significance, positive	No significance, negative

Figure 6.5.1 Findings Event 1 Constant-Mean Return Model

Event	Model	Company	Event window CAR attributes	Post-event window CAR attributes
DS Begins	Market Model	VWG US	Significant, negative	Highly significant, positive
		Volkswagen US	Marginally significant, negative	Highly significant, positive
		Audi US	Significant, negative	Marginally significant, positive
		VWG	No significance, positive	Highly significant, negative
		Volkswagen	No significance, negative	Highly significant, negative
		Audi	Highly significant, positive	Highly significant, negative
		Skoda	No significance, negative	No significance, positive
		Seat	No significance, positive	Highly significant, positive
		Porsche	No significance, positive	Highly significant, negative

Figure 6.5.2 Findings Event 1 Market Model

Event	Model	Company	Event window CAR attributes	Post-event window CAR attributes
VWG US Fine Settlement	Constant Mean Model	VWG US	No significance, negative	Significant, positive
		Volkswagen US	No significance, negative	Marginally significant, positive
		Audi US	No significance, negative	No significance, positive
		VWG	No significance, negative	No significance, negative
		Volkswagen	No significance, positive	No significance, positive
		Audi	No significance, positive	Marginally significant, negative
		Skoda	No significance, negative	No significance, positive
		Seat	No significance, positive	No significance, positive
		Porsche	No significance, negative	Significant, negative

Figure 6.5.3 Findings Event 2 Constant-Mean Return Model

Event	Model	Company	Event window CAR attributes	Post-event window CAR attributes
VWG US Fine Settlement	Market Model	VWG US	No significance, negative	Marginally significant, positive
		Volkswagen US	No significance, negative	Marginally significant, positive
		Audi US	No significance, negative	Significant, positive
		VWG	No significance, negative	No significance, positive
		Volkswagen	No significance, negative	No significance, positive
		Audi	No significance, negative	No significance, negative
		Skoda	No significance, positive	No significance, positive
		Seat	No significance, positive	No significance, positive
		Porsche	No significance, negative	Marginally significant, negative

Figure 6.5.4 Findings Event 2 Market Model

Event	Model	Company	Event window CAR attributes	Post-event window CAR attributes
VWG Guilt Admission	Constant Mean Model	VWG US	Significant, positive	Significant, negative
		Volkswagen US	No significance, positive	Significant, negative
		Audi US	Highly significant, positive	No significance, negative
		VWG	Significant, positive	No significance, positive
		Volkswagen	Highly significant, positive	Marginally significant, positive
		Audi	No significance, negative	No significance, negative
		Skoda	No significance, positive	Highly significant, negative
		Seat	No significance, negative	No significance, positive
		Porsche	Highly significant, negative	No significance, positive

Figure 6.5.5 Findings Event 3 Constant-Mean Return Model

Event	Model	Company	Event window CAR attributes	Post-event window CAR attributes
VWG Guilt Admission	Market Model	VWG US	No significance, positive	No significance, negative
		Volkswagen US	No significance, positive	No significance, negative
		Audi US	Significant, positive	No significance, negative
		VWG	No significance, positive	No significance, negative
		Volkswagen	Significant, positive	No significance, positive
		Audi	No significance, negative	No significance, negative
		Skoda	No significance, positive	No significance, negative
		Seat	No significance, negative	No significance, positive
		Porsche	Significant, negative	No significance, negative

Figure 6.5.6 Findings Event 3 Market Model

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