

Caught when failing to meet environmental standards: The case of the automotive industry

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Abstract

This research documents that automotive firms' failures to meet environmental standards are associated with a statistically significant negative stock market reaction. The results are based on a sample of 41 environmental standards failure announcements made from 1984 to 2016. On the days of the announcements, there was a mean stock market reaction of -1.02%, with 61% of sample firms experiencing a negative reaction. There is no difference in stock reaction for firms that fail to meet voluntary standards. If the firms offer compensation as a remedy for the failure, this results in a more negative stock market reaction. While the impact of failures has, in general, been associated with a more positive stock market reaction in more recent years, events occurring following the Volkswagen Dieselgate event are associated with a more negative stock market reaction.

1. Introduction

In an era where more consumers are becoming increasingly concerned about the environment, businesses are finding ways to communicate their environmental performance to both consumers and other firms. Commonly, this is achieved through advertising, where a firm makes 'green' claims about their business, but also frequently through the more credible means of gaining environmental certification, such as eco-labels. This has been a popular area of research for many scholars, with topics of interest being whether eco-labels increase demand for products (Sammer & Wüstenhagen, 2006; Testa, Iraldo, Vaccari, & Ferrari, 2015), whether they generate price premiums (Blomquist, Bartolino, & Waldo, 2015; Carlson & Palmer, 2016), the motivations behind adopting voluntary environmental standards (Prajogo, 2011; Prajogo, Tang, & Lai, 2012), and their connection to sustainable supply chain management (Darnall, Jolley, & Handfield, 2008; Iles, 2007).

However, much of this literature focusses around how firms can 'do good', and the benefits they receive from doing so, rather than explicitly discussing how to 'avoid bad' outcomes (Lin-Hi & Müller, 2013) and what influences the magnitude of these undesired outcomes. As such, this study is more interested in investigating the implications of firm's failing to meet the green claims and environmental standards that they set for themselves and communicate to others. Thus, discussions around greenwashing (e.g. Delmas & Burbano, 2011), and the symbolic adoption of eco-certification (Aravind & Christmann, 2011; Christmann & Taylor, 2006), are of relevance. Along with voluntary standards, regulatory environmental standards can also be failed, and in doing so, firms bring attention to their bad environmental performance, as all firms are assumed to be in compliance with such standards. For example, Volkswagen (VW) used illegal means to hide the fact that their vehicles did not meet emission levels required by the Clean Air Act; this September 2015 event has been dubbed 'Dieselgate' (Nunes & Park, 2016). VW gained much negative media coverage over the incident and lost millions of dollars.

This study aims to empirically investigate how the stock market reacts to such publicised failures of environmental standards, like that in Dieselgate. Using an event study methodology,

with a sample of 41 negative environmental events in the automotive industry, we will calculate the abnormal returns of the firms involved on the days the announcements were made. As Laplante and Lanoie (1994) state, it is a common notion that the reductions in stock prices have some deterrence effect on firms. Thus, in the event that there is a negative effect, it would provide a good deterrent to firms to avoid failing such standards and an incentive to ensure that they meet or even exceed the environmental standards required of them, and that they hold themselves to. Few similar studies have tested the effect of negative environmental events on firms stock prices, and of those, the results have been mixed (Jones & Rubin, 2001). This study hopes to provide evidence to support the theory that a firm is financially harmed when it fails environmental standards.

This research is important as while the VW case was significant, it is questionable whether this was a ‘one-off’ or whether firms are able to undertake similar schemes with impunity. The theory is clear that this type of event is undesirable but there is little empirical evidence of this. Therefore, we seek to add empirical evidence to the debate and determine whether such situations are detrimental to shareholder wealth and what circumstances alter or modify that impact. The research therefore supplements existing research that shows that the impact of Dieselgate spread to other U.S. automotive firms (Nunes & Park, 2016).

The rest of this report is structured as follows. Section 2 provides an extensive literature review around eco-labels and voluntary certification programmes and the issues and themes commonly discussed in the literature. With reference to automotive sector specific literature, hypotheses are developed. Section 3 then covers the methodology used, including the collection of our sample, the evaluation of themes and the type of analysis used. The calculation of abnormal returns is discussed in Section 4 and then Section 5 outlines the results of the study, and explains the significance of the results. This is followed by a conclusion and reflection on future research opportunities in Section 6 **Error! Reference source not found.**

2. Literature Summary

In this section, we undertake a literature review of the key concepts and the associated points within the automotive section. As we progress, we develop the key hypotheses that we test in subsequent sections.

2.1. Eco-labels and certification to influence consumers

Eco-labelling is designed to inform or signal consumers about certain characteristics and environmental attributes of their products (Bratt, Hallstedt, Robèrt, Broman, & Oldmark, 2011; de Boer, 2003; Delmas & Grant, 2014). From a firm’s perspective, eco-labels can communicate the superior environmental performance of a product compared to non-labelled products, differentiating the product and creating a competitive advantage (Bratt et al., 2011; Brécard, Hlaimi, Lucas, Perraudou, & Salladarré, 2009; de Boer, 2003). From a consumer’s perspective, eco-labels enable access to information about a product’s environmental pedigree, revealing the more sustainable players in the market (Brécard et al., 2009; de Boer, 2003; Delmas & Grant, 2014; Harbaugh, Maxwell, & Roussillon, 2011).

Due to the increasing consumer awareness about environmental issues, firms adopt eco-labels to capitalise on these trends and benefit from the increased demand for environmentally friendly goods (Brécard et al., 2009; Delmas & Grant, 2014). This assumes that consumers will prefer labelled products to non-labelled. There is evidence that eco-labels do have an influence on consumers’ green consumption, and can guide consumer purchasing decisions (Horne, 2009; Sammer & Wüstenhagen, 2006; Testa et al., 2015). Likewise, Bratt et al. (2011), acknowledged the potential of eco-labels to steer both consumers and producers in a more sustainable direction. As labels make it easier to decipher which products are more sustainable,

consumers have the ability to “buycott”, where they only choose goods that have been produced sustainably or have been certified (Gulbrandsen, 2006). This green demand is determined by intrinsic customer motivation, consumer preferences (i.e., for green products), and customer constraints such as income and available information (Brécard et al., 2009). However, eco-labels only have a significant influence on consumers green purchasing habits if they are fully informed and understand the meaning of the label (Testa et al., 2015). However, as labels get more confusing, consumers are willing to spend less time learning about them and figuring out which are credible, and therefore do not make the effort to engage in green consumption (Madurah, Reiners, & Wood, 2016; Young, Hwang, McDonald, & Oates, 2010). The consumer trust of the label is also crucial, with Darnall, Ji, and Vázquez-Brust (2016) noting that credibility of the label can be boosted through the use of third-party certification. The use of multiple practices to build this credibility and provide assurance to the consumer also builds trust in the governance of the eco-label (Castka & Corbett, 2014). Stronger governance mechanisms are associated with wider adoption, indicating the practical importance for firms and eco-labels to address governance issues (Castka & Corbett, 2016).

The most popular way to address these issues of consumer perception is considered to be increasing customer awareness through more information and education about eco-labels (Harbaugh et al., 2011; Madurah et al., 2016). Although as Grolleau et al. (2016) state, more behavioural approaches should be used, such as making sustainability issues feel closer to the consumer. To decrease customer confusion and fix the attitude-behaviour gap, Young et al. (2010) suggest simple, single-issue labelling that makes it easy for consumers to identify how a product performs on a certain environmental aspect. Horne (2009) criticizes simplicity as a solution and found it does not ease inter-product comparisons and undermines label efficacy. They found, however, that independence and stakeholder involvement are critical and mandatory labels are more successful. Such solutions aim to reignite the role of eco-labels, and ensure they enable consumers to make informed decisions and firms to reap the benefits of sustainable operation.

2.2. Price premium

Despite the theory, the practical question of whether or not eco-labels generate a price premium has been a dominant concern. Because eco-labelling can be quite a costly process, firms want to be assured that investing in certification programmes will offset the costs of certification and pay off for their business (Delmas & Grant, 2014). If price premiums exist for eco-labelled products, it creates an incentive for producers to become certified and adopt sustainable practices, promoting sustainability along the supply chain (Roheim, Asche, & Santos, 2011).

However, the literature has largely been divided on the existence of such premiums; while there is evidence for price premiums (Blomquist et al., 2015; Roheim et al., 2011), others find limited evidence (Carlson & Palmer, 2016). In the case of eco-labelled fish, they were only found to be effective at the retailer level, suggesting that any profit margin made on sustainably sourced fish does not actually make it back to the producer (Blomquist et al., 2015). Likewise, it has been found that at the retailer level, stocking more eco-labelled products leads to the retailer being perceived as more ethical, which in turn increased patronage (Bezençon & Etemad-Sajadi, 2015). This questions the likelihood of price premiums being an incentive to operate sustainably at the production level, as producers themselves may not actually be benefited, as the benefits appear to stop at the retailer level (Blomquist et al., 2015). Carlson and Palmer (2016) however, argue that while price premiums for eco-labelled products may not be guaranteed to producers, there are other less tangible benefits that may justify the costs of certification; such as environmental learning, increased governance, community empowerment, and reputational benefits.

2.3. Stock market reaction to certifications

The relationship between the positive benefits of certification and the stock market reaction has been widely studied. In general, research indicates that the stock market reaction appears to be more positive to ISO 9000 announcements than it is to ISO 14001 announcements, where the results are more mixed.

In general, the relationships seem to indicate that certifications, such as ISO 9000 (quality certification) appears to have a positive impact on operational performance as well as financial performance of the firms (Castka & Corbett, 2016). Corbett et al. (2005) note that U.S. firms experience a strong gain in performance relative to control groups three years following certification. Similar results are reported by Pinar and Ozgur (Pinar & Ozgur, 2007) in the Turkish market, noting that certification leads to higher means and less variance in financial performance. Broadly, N & S report that certification relates to improved financial performance of Spanish firms (Nicolau & Sellers, 2002); a later study by McGuire and Dilts (2008) indicates that the impact is less clear-cut and suggests that the effect is stronger for smaller firms and that firms announcing ISO9001:2000 implementation.

The implementation of ISO14001 has also been shown to improve firm performance. Treacy (2015) found that firms that fully integrate the standard in their operations were able to improve both financial and operational performance. The overall profitability of firms may improve following certification, but Lee et al. (2017) find no evidence of operational performance improvements. However, the findings from Cañón-de-francia and Garcés-ayerbe (2009) and Paulraj and De Jong (2011) indicate that announcements of certification actually decreases the short-term financial performance of the firms. Paulraj and De Jong posit that certification this may be seen as providing parity rather than advantage in a competitive marketplace. Internationalised firms and those that are more polluting have even further negative financial performance on certification (Cañón-de-francia & Garcés-ayerbe, 2009).

2.4. Motivations (internal vs external)

There has often been a lack of consensus as to how and if such standards affect firm-level performance. As identified by Prajogo (2011), a multitude of studies have presented conflicting findings on how the ISO 9000 certification standard impacts a firm's performance, and the same can be said for other standards. Motives (Prajogo et al., 2012) and the quality of the implementation (Aravind & Christmann, 2011) affects performance. Prajogo (2011) puts these two factors together to determine how both motives and implementation of a standard affect performance. A common theme among such studies that comes to light is the importance of internal and external motives in explaining the adoption and implementation of a certification standard and the performance outcomes (Prajogo, Castka, Yiu, Yeung, & Lai, 2016; Prajogo et al., 2012; Prajogo, 2011).

Internal motives tend to revolve around establishing internal capabilities and resources through the use of the certification standards (Prajogo et al., 2012). Firms who are internally motivated often are interested in meeting the triple bottom line, and are looking to use certification programmes such as ISO 14001 as a strategic tool in improving their environmental performance, their operational efficiency, and synergising their management systems (Prajogo et al., 2012). The goal of such firms is to achieve high quality outcomes, rather than attaining the certification itself (Prajogo, 2011). Firms may also experience positive benefits from green production (Ergün, Uludağ-Demirer, & Kasap, 2013).

Externally motivated firms however take a different approach. External motives are the social and environmental forces that a firm responds to by becoming certified; these can be coercive (stakeholder pressure), mimetic (imitating competitors), or normative (certification as necessary in a market) (Prajogo, 2011; Prajogo et al., 2012). Although external pressures force

compliance with certification standards, they do not always ensure that they are fully implemented and integrated within the business (Aravind & Christmann, 2011; Castka & Prajogo, 2013; Prajogo et al., 2016), as the goal of such firms is merely to receive the certification itself in response to stakeholder demand (Prajogo, 2011). This is evident in the many firms that become certified but do not improve their environmental performance (Froese & Proelss, 2012; Hadjimichael & Hegland, 2016; Prajogo et al., 2016).

Only firms with internal motives for certification gain all environmental, social and economic benefits, and are satisfied with the certification (Prajogo et al., 2016; Prajogo, 2011, 2011). In contrast, externally motivated firms are likely to be unsatisfied with the certification, and gain less benefit. Aravind and Christmann (2011) found evidence that firms that implement their certification standards to a low quality had no more environmental benefits than uncertified firms. This suggests that to gain the full benefits from certification, an internally focused approach is required, rather than simply trying to satisfy external stakeholder demand.

2.5. Fuel economy standards in the automotive sector

Little research has been done in regard to how firms are affected if they fail to meet the environmental standards that they claim to have, or that are required by law. In this respect, little research has been undertaken on ‘avoiding bad’ in corporate social responsibility and surrounding areas, with most research focusing on ‘doing good’ and the associated benefits (Lin-Hi & Müller, 2013). However, Downing and Kimball (1982) noted that it was rare for violations of pollution control laws, such as emissions standards, to result in court action. Many violations are resolved non-judicially, which is evident in the number of voluntary or forced recalls undertaken when auto manufacturers fail to meet emission standards, as the EPA have the authority to require a manufacturer to issue a recall of vehicles that do not conform to regulations (US EPA, 2016b). Many firms undertake voluntary recalls at the request of the EPA however, as the negative publicity that occurs from refusing such a request is substantial enough to ensure compliance (Jackson & Morgan, 1988). In support of this, Levy and Levenson reported that at least 75% of vehicles repaired under EPA guidance are recalled voluntarily, and only 25% of recalls were EPA-ordered (as cited in Jackson & Morgan, 1988). Some research has been done on the effect of product recalls in the automotive industry (Rhee & Haunschild, 2006; Rupp, 2001); with Rhee and Haunschild (2006) finding that more reputable firms suffer from more market penalties, and Barber and Darrough (1996) finding that recalls negatively affect a firm’s shareholder value. However, such studies do not focus solely on sustainability or environmental issues or recalls due exclusively to emission faults. Hence, there is a gap in the literature around such matters.

A deterioration in reputation is not the only challenge facing a firm from failing to fulfil the claims on an eco-label. Some of the firms identified to be performing below certification standards, were subsequently de-certified or had their certifications suspended until they improved their performance (Christian et al., 2013; Froese & Proelss, 2012; Gutierrez et al., 2012). Loss of certification has further disadvantages and can cause firms to be excluded from vital markets that only trade with certified firms (Lallemand, Bergh, Hansen, & Purves, 2016); retaining certification is therefore critical for holding market position. As access to markets is a main motivator for getting certified (Hadjimichael & Hegland, 2016), this should provide incentives to firms to avoid failing to meet standards.

2.6. Hypotheses

We develop the hypotheses, based on the review of the literature.

2.6.1. The stock market reaction to a failure announcement

The automotive industry has one of the largest impacts on the environment and therefore plays an important role in the sustainable development of society and the reducing of emissions (Günther, Kannegiesser, & Autenrieb, 2015; Koplin, Seuring, & Mesterharm, 2007). Much of the literature around sustainability and the automobile industry looks at the effects of regulation and manufacturers' ability to meet them. Gerard and Lave (2005) examine how government regulations and policies, such as the 1977 Clean Air Act (CAA), can force car manufacturers to conduct sustainable innovation and adopt more sustainable technologies. They found that these technology driving policies and institutions like the Environmental Protection Agency (EPA), were pressures that indisputably lead to significant technological advances and environmental improvements. This supports the argument that regulatory pressures are among those external forces that influence firms' adoption of more sustainable practices (Hall, 2000; Seuring & Müller, 2008).

As a part of the CAA emissions certification programme, every passenger car or light truck sold in the U.S. has a government fuel economy rating sticker aimed at providing consumers with reliable information they can use to compare vehicles (Greene et al., 2017). However, these ratings can differ greatly from the estimated amount and in reality cars have a much lower fuel economy (Greene, Goeltz, Hopson, & Tworek, 2006; Greene et al., 2017; Mintz, Vyas, & Conley, 1993), with Schipper and Tax (1994) saying that automobile fuel economy tests understate fuel use by 15-25%. Greene et al. (2006; 2017) find this estimation gap particularly large for hybrid vehicles, which is concerning considering the advertising for hybrids is built around them being more sustainable and economical. Wernle and Nelson (2014), iterate this in regards to Ford having to lower their fuel economy ratings for a number of their hybrid vehicles and how such actions undercut their advertising, which revolves around fuel economy. Similarly to the way the collective reputation of an eco-label or certification body can be harmed when a single firm fails it (Hamilton & Zilberman, 2006), the variation in estimates, "reduces the value of fuel economy information by diminishing confidence in the accuracy of the fuel economy ratings" (Greene et al., 2017, p. 158). As such, it is acknowledged that although fuel economy tests are useful for indicating the relative difference in efficiency of new cars, the tests themselves are a poor measure of actual fuel usage (Schipper & Tax, 1994). This is due to a number of factors such as driver behavior, the testing formulae underrepresenting real life driving situations, and test values not actually representing the cars sold, i.e., through optimisation of the tested vehicle (Schipper & Tax, 1994). The last point raises a matter of interest; do car manufacturers knowingly manipulate emissions tests to get favourable ratings? Or are the variations purely down to reasons beyond the manufacturers' control, such as how people drive the car? Shiau, Michalek, and Hendrickson (2009) identified that when fuel economy standards, namely Corporate Average Fuel Economy (CAFE) standards, get too high, automakers no longer adhere to the standards when designing vehicles, but violate them and pass the costs of the CAFE penalty along to the consumer. They found that the likelihood of violation depends on the penalty for the violation, thus to prevent these from occurring, the penalties need to increase along with the environmental standards. This can be explained by Wu who states, "environmental violations can be well explained by standard economic theory: a firm will choose to violate an environmental standard if the expected penalty for the violation is smaller than the expected cost of compliance" (2009, p. 3364).

However, not only can automakers violate economy estimates, but it is often found that they have also misreported their emission levels. The most significant example has been dubbed Dieselgate, where VW was publicly vilified when it was discovered their vehicles were not only emitting far more toxic fumes than legally allowed, but that they were aware of it and covering it up (Nunes & Park, 2016; Siano, Vollero, Conte, & Amabile, 2017). Earlier, both

Honda and Ford were also involved in a similar implication when they were fined by the U.S. government for tampering with emission control devices that caused emissions to increase beyond regulated levels (Mokhiber, 1998). Their actions, and the failure to report them, led to a violation of the CAA, and resulted in million dollar civil penalties. The issue of fraudulent emission reporting is thus evident in the automotive industry. Journalists Hakim and Bradsher (2015) also noted this after Dieselgate, highlighting that automakers in the U.S. conduct their own emissions tests, and in Europe automakers hire private companies to conduct them; questioning the wisdom of allowing automakers such sway in how air pollution standards are enforced. They also bring to light that these private testing companies can find ways to obtain the lowest possible emissions levels, and may do so to secure contracts with the carmaker.

Given the economic consequences of this type of event, plus existing studies showing that there is a ‘spillover’ from Dieselgate, we hypothesise that:

HYPOTHESIS 1. *The announcements of failures to meet environmental standards will have a negative stock market reaction.*

2.6.2. Failing to meet voluntary standards

Firms have been publicly recognised for failing to meet voluntarily self-imposed standards or having their actual environmental performance be below that of the certification standard. Two main groups stood out. These groupings are not specific to the automotive industry.

The first group is firms that are environmentally certified such as with an eco-label, and/or claim that their environmental performance is superior to other firms. This could be defined by what Kirchhoff (2000) explains as voluntary over-compliance; firms that voluntarily operate at a level above the legal environmental standards (or at least claim they do). These firms are then held to higher environmental standards than other industry operators. As such, when it is found that their actual performance is below these standards, they are displayed and vilified in the media. Included in this category are ‘greenwashers’, those firms that may or may not be eco-labelled, but promote themselves as sustainable or green when their performance or products are not as environmental as they say they are (Delmas & Burbano, 2011). They have therefore also made the claim that they are operating at a higher environmental standard than regular firms, and as such when their actual operations do not reflect these claims, they are publicly sanctioned. An example of a case from this category, is the event in which a consumer report found that two Ford hybrid vehicles fell short of their fuel economy claims (Harlin, 2012). As such, the company had miss-reported the efficiency of their vehicles and in reality they were not as environmentally friendly as they were claiming.

The second group are firms that do not claim to be environmentally superior, through certification or other means, but are found to have failed environmental standards that they are assumed to have been meeting i.e. legal environmental requirements. Such firms are held to a higher standard than their actions actually are. In trying to explain why some firms violated environmental standards when others over comply, Wu (2009), found that costs and risks of implementing sustainable practices, along with market forces, facility characteristics, and managerial values all contributed to why a firm would decide to violate environmental regulations. When a firm’s environmental performance is below that of even the legal minimum requirements, they’re likely to be held accountable in the media, and are subject to more legal repercussions. For instance, in America (and similarly in many other countries) all vehicle and engine emissions are required by the CAA to meet certain pollution standards, and all new vehicles are required by CAFE to meet certain fuel economy standards. These standards are enforced by either the EPA or the National Highway Traffic Safety Administration (NHTSA) (Shiau et al., 2009). All new vehicles and engines are also required to have EPA-

issued certificates of conformity and emissions labels (US EPA, 2017). The EPA may seek civil penalties for violations of the CAA, which can be taken through the courts, and violators can be subject to fines of up to US\$37,500 per noncompliant vehicle or per day for violations in reporting, as well as fines of up to US\$3,750 per tampering event or per sale of a defect device (US EPA, 2016a). The NHTSA also issues fines for violations of CAFE standards, which have been set at US\$55 per mpg per vehicle (Shiau et al., 2009). One example in this group is DaimlerChrysler who were fined US\$1m and ordered to spend a further US\$95m on improving their emission controls after the EPA and the California Air Resources Board (CARB) found them to have violated the CAA through excess emissions. In this case, consumers purchasing Chrysler vehicles would assume that the car met all necessary conditions for it to be legal and road-worthy, where in reality the vehicles were emitting illegal levels of toxic emissions. This is an illustration of how a company can be heavily punished for having such disconnect between their assumed and their actual environmental performance, and the extent of these fines shows the potential for financial harm to firms who fail legal environmental requirements, and therefore why investors may have interest in such events.

The failure of a firm to reach a self-imposed standard, higher than the minimum, government mandated level, can therefore be perceived as a loss of competitive advantage in the marketplace. We hypothesise that failure to meet a stringent and self-imposed standard will be treated more negatively by investors than the failure to meet required standards, and therefore:

***HYPOTHESIS 2:** The stock market reaction to announcements of failures to meet voluntary fuel standards will be more negative than failure to meet mandated standards.*

2.6.3. The impact of a refund as remedy to the problem

However, a similar question as before must be asked. Are all car manufacturers purposely trying to cheat the system, or is failure of environmental standards in some cases merely due to an inadvertent oversight of the company? Just as cases like Mitsubishi and VW illustrate the unethical practices of automotive firms when it comes to emission standards, other firms can also fail these standards and face the same repercussions, yet do so with no wrongful intent. For instance, Kia Motors Corp. were ordered by the CARB to recall over six thousand vehicles and make an estimated US\$451,000 in repairs due to the firm falling short of state emission standards (DJNS, 1999). Kia then voluntarily extended the recall to over 32 thousand vehicles to repair the defective part in the emissions system that was leading to excessive pollution; a move that cost them an estimated US\$1.7 million. In such cases where the failure occurred due to mechanical defect rather than any deliberate intent, firms have the ability to protect their corporate reputation with voluntary recalls and by being proactive to avoid negative publicity (Jackson & Morgan, 1988). Thus, how firms respond to accusations that they have failed environmental standards, whether deliberately or not, is also of interest. In the likes of Mitsubishi and VW, some firms admit that they have violated regulations and settle any accusations or lawsuits without argument. Others deny the allegations but still settle, as in the case of Nissan who was accused of manipulating emission tests by the Korean government and ordered to recall certain vehicles and pay a US\$280,000 fine (DJIN, 2016). Nissan denied the accusation but in the wake of Dieselgate, agreed to recall the vehicles (although later sued the government and won). Yet other firms deny accusations and fight any legal action against them until a conclusion, positive or negative is reached. In this category is the likes of SsangYong Motor Company, who refrained from taking any action to compensate customers after overstating fuel efficiency until after the court verdict (Nam, 2014). Although a firm's reaction to such allegations does not prove their ethical or unethical behavior, it gives an indication of their defensive nature or sensitivity to such issues. Past research has indicated that

compensation, as a remedy, is treated as a more expensive option than other remedies, and leads to a more negative stock market reaction (Ni, Flynn, & Jacobs, 2014). Therefore, we hypothesise:

HYPOTHESIS 3: The stock market reaction to offers of compensation will be more negative than for other remedies.

2.6.4. The changing perception of the importance of meeting standards

Some automotive firms do take measures to internalise sustainability into their practices and there are examples of implementation of sustainable strategies in the automotive industry. Sukitsch et al. (2015) evaluates the implementation of sustainable strategies and practices in automobile companies through looking at their sustainability reports. They note that the automotive industry is aware of the significance of corporate sustainability activities, yet the majority of implementation appears to be defensive rather than proactive. As such, it is argued that some firms like Ford have successfully overcome allegations of greenwashing and become celebrated for their green practices (Mitchell & Harrison, 2012). This trend has been increasing over time and influences firms' internal practices.

Furthermore, firms can demand suppliers adopt more environmentally friendly practices, pushing environmental concern up the supply chain in the automotive sector (González, Sarkis, & Adenso-Díaz, 2008; Vanalle, Lucato, & Santos, 2011) and in other sectors (Rogers, 2016; Wang, Petkova, & Wood, 2014; Wang & Wood, 2016). Gunther et al. (2015) highlight the importance of looking at the end-to-end supply chain process as well as reverse supply chain activities, and Koplín et al. (2007) emphasise the importance of adding environmental standards into purchasing processes. They also acknowledge that the consumer facing firm can often get blamed for environmental failures at any point along the supply chain, which "represents a significant risk to a company's public reputation and its attractiveness on the sales market, because it has to take the responsibility for its suppliers in front of the media and critical non-governmental organisations (NGOs)" (Koplín et al., 2007, p. 1053). This point alludes to the fiscal and other risks of failing environmental standards, and provides some reasoning as to why firms have invested in greening their entire supply chain.

Given the significant growth in firms' awareness coupled with the strong consumer awareness of environmental issues, firms have increasingly worked to capitalise on the trend (Brécard et al., 2009; Delmas & Grant, 2014). Therefore, with the passage of time, we hypothesise that:

HYPOTHESIS 4: The stock market reaction to recent announcements of failures to meet environmental standards will be less negative than for older announcements.

2.6.5. The change in reaction following Dieselgate

The influence of a large and recognised event, such as the Dieselgate, can have wider ramifications on the business community. Mansouri (2016) identified the reasons behind Dieselgate, examined the impact on VW stakeholders and how such an event should be dealt with, and how it can be prevented from happening again. Klier and Linn (2016) state that Dieselgate illustrates the tradeoff between controlling vehicle emissions under regulation and improving vehicle performance to meet consumer demand. Cârstea (2016) faults the consumer for wanting high performance cars despite the environmental impact these types of vehicles have through excessive pollutants. This is possibly one of the reasons why VW may have acted in such an unethical way in manipulating their vehicles emissions, as they made the decision

to do so when the EPA released even tougher emission standards in 2005; engineers facing pressures from upper management to meet the new standards, and working in such an autocratic, performance based culture, may have perceived rigging the emissions system as the only feasible solution (Mansouri, 2016). One of the largest consequences of the scandal was the loss of consumer confidence in car manufacturers that affected not only VW, but the entire automotive industry (Cârstea, 2016).

Lack of consumer faith in VW caused loyal customers to switch brands and sales fell dramatically (Mansouri, 2016). However, consumers were not the only stakeholders to drop VW, shareholders also lost confidence and VW's shares plunged, wiping billions of dollars in value from the company (Mansouri, 2016). This illustrates how cheating environmental standards can damage firms, and in an attempt to prevent such events from happening again, discussions were sparked as to how to improve the gap between emissions testing and real world observations, and both the U.S. and the E.U. regulators adjusted their approaches to fuel economy (Klier & Linn, 2016). Following Dieselpgate, further attention will likely be given to firms that fail to meet standards, and we can expect a stronger stock market reaction. Therefore, we hypothesise that:

HYPOTHESIS 5: *The stock market reaction to announcements of failures to meet environmental standards after Dieselpgate will be more negative than other announcements.*

3. Methodology

3.1. Sample Selection and Description

The sample in this study consists of announcements made about firms in the automotive industry who have failed to meet their environmental commitments. Often these announcements are made when the government, or some other party such as the EPA in the U.S., discovers certain vehicles violate environmental standards, i.e., with excess emissions, when a recall is announced due to emissions flaws, or when a firm has been found to have overstated the efficiency/economy claims of their vehicles.

To generate our sample, we first undertook an initial search with preliminary keywords. As we identified announcements, we developed a more comprehensive set of keywords. Through an iterative process of identifying, evaluating, and adding commonly used keywords in such announcements, a final set of keywords was created. The search terms used related to a sequence of synonyms for "certification" for automotive firms (e.g., *ecolabel** or *certif** or *Clean Air Act*) within five words of a synonym for misrepresentation (e.g., *fals** or *mislead** or *greenwash** or *fraud** or *unsustainab** or *misrepresent**) were used to identify relevant events, along with verbs located near the keywords to ensure the events were of interest to the study; the broad set of keywords limits the possibility of missing any important announcements. These keywords were then used to search for and download the full text of announcements from the *Dow Jones Institutional News*, *Global Newswire (U.S.)* and *The Wall Street Journal (All sources)* for the period 1980-01-01 to 2016-12-15.

This search resulted in over 17,000 articles. The articles were scanned for relevance to the failure of environmental standards. Of those deemed relevant, the full text was scanned. All articles not concerning environmental performance of automobile manufacturers were excluded, along with multi-event announcements. For example, a firm announcing two separate recalls, one due to an environmental failure and the other a safety issue, would be excluded as the effect of the environmental failure could not be isolated. This process yielded approximately 50 events. To ensure that the first announcement and therefore the true date of the event was identified, more targeted searches were undertaken on each event, and only the earliest announcement was retained in the database (Park, Park, & Zhang, 2003).

The final event sample of 53 was gathered. In these additional specific searches, any subsequent developments relating to the main event were also recorded as sub-events, as often the ramifications and coverage of these events extended over months and even years, with each development and subsequent article published having the potential to cause further damage to the firm's stock prices. The event and sub-event sample thus totals 136 with approximately 25 different automotive firms (although some belong to the same parent group).

Two additional checks were undertaken to determine whether there were other confounding events and to ensure there were sufficient stock returns data, enabling the event to be considered in further analysis. First, a confounding event check was undertaken on the event sample of 53 cases to ensure the event had an isolated effect on the firm's stock price. The impact of an event under study cannot be determined if any other financially relevant events have also occurred during the event window (McWilliams & Siegel, 1997). Thus, a three day event window (the date before and after the initial announcement) was analysed for each firm, and confounding events, if any, were recorded and thus excluded. This process also accounted for the time-zone differences. Second, the stock returns data available were checked and collected using *Datastream*. In some instances, a firm was not yet publicly listed and so had to be excluded from the analysis. After checking for and removing cases where there were confounding events or no stock returns data, the final sample size was 41 events.

4. Estimating abnormal returns

To determine the stock market reaction to the failure of firms to meet environmental standards, we used the event study methodology to calculate abnormal returns. This is a process for evaluating the difference between the return on a given stock (related to the events in our sample) relative to an appropriate benchmark. Careful selection of the benchmark enables a control for several other factors that might explain changes in the stock returns. Therefore, after controlling for these factors, the remaining unexplained variation is considered to be the abnormal return that is then connected to other influences – in this case, the influence of the events under study.

4.1. Estimation windows and time period when measuring abnormal returns

The normal return parameters were estimated through an ordinary least squares approach with an estimation window of 200 trading days, separated from the event day by a 10-day isolation period. This provided an estimation window of (-211, -11), and is similar to previous event study research (Hendricks, Singhal, & Zhang, 2009).

4.2. Model for estimating abnormal returns

While there are many methods that may be used to calculate the abnormal returns, we opted to use the commonly used market model. This is generally accepted to provide an effective estimate of abnormal returns by relating the normal returns to the returns of market portfolio (Brown & Warner, 1985; MacKinlay, 1997). Using the market model, the abnormal return AR_{it} for firm i on day t was estimated as:

$$AR_{it} = R_{it} - (\hat{\alpha}_i + \hat{\beta}_i R_{mt}) + \varepsilon_{it} \quad (1)$$

where R_{it} is the return on the stock of firm i on day t . R_{mt} is the normal return calculated with reference to the market portfolio of stocks on day t . $\hat{\alpha}_i$ and $\hat{\beta}_i$ are market model parameters, estimated using ordinary least squares.

Since the final sample firms are listed in different indices from six countries, local indices are applied to estimate market movement for individual stocks, as suggested in the finance literature for multi-country event studies (Campbell, Cowan, & Salotti, 2010; Corrado &

Truong, 2008; Meric, Ratner, & Meric, 2008; Samitas, Kenourgios, & Zounis, 2008). The selected local indices are presented in Table 1.

Table 1.
Local Market Index and proportion of each sample coming from each country

Country	Local Index	Sample	% of sample
Germany	CDAX_GERMANY	6	14.63%
France	SBF_120_FRANCE	1	2.44%
Japan	NIKKEI_225_JAPAN	9	21.95%
U. S.	S&P_500	19	46.34%
Korea	KOREA_SE	5	12.20%
U. K.	FTSE_UK	1	2.44%

4.3. Hypothesis testing and cross-sectional analysis

We used cross-sectional regression to determine how the impact of the announcement was related to the firm and characteristics of the failures in question (Kothari & Warner, 2007). We used the following regression model:

$$AbRet_i = \beta_0 + \beta_1 Recall_i + \beta_2 FirmSize_i + \beta_3 Voluntary_i + \beta_4 Compensation_i + \beta_5 Recency_i + \beta_6 PostDieselgate_i + \varepsilon_i \quad (2)$$

, where AR_i is the abnormal return for firm i in the given event period.

4.3.1. Variables to represent hypotheses

Whether the failure related to voluntarily high levels of performance was addressed with the variable *Voluntary*. This was evaluated by examining the announcements to determine how the event was described. The predicted sign of the coefficient was negative.

What compensation method, if any, was used by the firm (*Compensation*). This was evaluated by classifying the remedy outlined by the firm. While there were several types, the primary focus here was a classification of compensation offered vs other remedies. The predicted sign of the coefficient was negative.

Whether the effects of more recent events were milder than older events (*Recency*). This was evaluated by calculating the number of years from the start of the sample (1984) to the year of the current event. Therefore, more recent events have a higher value. The predicted sign of the coefficient was positive.

Events occurring following Dieselgate (*PostDieselgate*). This variable was calculated by taking the date for Dieselgate and classifying whether the event occurred before or after the date. The predicted sign of the coefficient was negative.

4.3.2. Control variables

Our first control variable relates to the size of the firm (*FirmSize*). We used the logarithm transformation of the net sales or revenues of the firms involved in the event at the time the announcement was made. This determines whether the size of the firm, as indicated by revenues, has any effect on the abnormal returns. Larger firms have a greater ability to cover costs associated with an adverse event (Jones & Rubin, 2001), and thus the size of the returns may be influenced by the firm size.

Our second control variable relates to whether or not a recall was announced (*Recall*), which tests if the involvement of a recall in an announcement affects the observed returns as there is strong evidence that recalls have a negative impact on abnormal returns.

4.4. Model diagnostics for influential observations and homoscedasticity

An analysis of the influence of each observation indicated that no observation was greater than three times the average hat-value, which is the point in a smaller sample where there would be a concern that the observation was unduly influential (Fox, 2002). We also tested for skewness in the data. In general, the departure from a normal distribution is generally accepted to have minimal impact on results when using the market model to estimate daily stock returns (Brown & Warner, 1985). Due to the small sample size, we used studentized Breusch-Pagan test (Breusch & Pagan, 1979) and the results indicated a level of heteroscedasticity (12.186, df = 6, p-value = 0.05795). Therefore, we used robust standard errors in our analysis (White, 1982). We used the Heteroscedasticity consistent (HC) estimator recommended by Cribari-Neto (2004), as it provides robust performance with small samples and influential observations (Kleiber, 2008).

5. Results and discussion

We found that on the day of an announcement about a failure to meet environmental standards (Day 0), there is a mean negative abnormal return of -1.02%, which is statistically different from zero at the 5% level with a two-tailed test (using the Boehmer et al. adjusted test statistic (Boehmer, Masumeci, & Poulsen, 1991), the Corrado Rank test (Corrado & Zivney, 1992), and the Patell Z test (Patell, 1976)). 61% of the firms experienced a negative return.

These results indicate that an announcement of an environmental failure does have a negative financial impact on the firm involved, and firms that fail to meet their advertised or assumed environmental performance have adverse stock market reactions. To further understand what contributes to the abnormal returns found, explanatory variables were regressed against the abnormal returns as the dependent variable. The results of this cross-sectional regression analysis are presented in Table 2.

Table 2.

Results of hierarchical regression analysis (n=40; 1 case excluded due to missing data)

Independent Variable	Model 1		Model 2		
	Coefficient	Robust std Error	Coefficient	Robust std Error	VIF
Intercept	0.0597*	0.0367	0.0207	0.0434	
Recall	0.0076	0.0079	0.0062	0.0141	2.54
FirmSize	-0.0037**	0.0020	-0.0018	0.0019	1.51
Voluntary			-0.0218	0.0248	2.99
Compensation			-0.0548***	0.0221	1.35
Recency			0.0014*	0.0011	4.21
PostDieselgate			-0.0564**	0.0314	2.22
F	2.6		9.306		
Significance	.08775		.000		
R ²	.1232		.6285		

Significant levels (one-tailed tests): * 10% level, ** 5% level, *** 1% level

The variance inflation factors (VIF) are all below 10.0, providing evidence of low multicollinearity (Hair, Black, Babin, & Anderson, 2014). Model 1 includes the two control variables (presence of a recall and the firm size). The variables used to test the hypotheses of interest were added to generate model 2, which can be used to investigate whether they added significantly to the abnormal returns. With an R² of 12.32% in model 1, on their own, recalls and firm size (revenues) were unable to explain any variance in the abnormal returns. However, by adding further explanatory variables in Model 2, the R² increased substantially to 62.85%,

indicating this model is accurate in explaining the variation in the abnormal returns observed on Day 0 of an environmental failure announcement.

Model 2 provides some support for our hypothesised relationships. The hypothesis relating to the voluntary standards is not significant. The remaining hypotheses are significant with compensation statistically significant at the 1% level, the recency of the events is significant at the 10% level, and the occurrence following Dieselgate is statistically significant at the 5% level.

While we had predicted that failure to reach a voluntary standard would be more negative, there is no evidence to support this. As predicted, the estimated coefficient relating to the breach of a voluntary standards is negative but the robust standard error is large and therefore we cannot say conclusively whether a difference exists when the standard breached has been voluntarily set.

The estimated coefficient for the indicator variable that compensation was used as a remedy is negative and statistically significant at the 1% level in a one-tailed test. This indicates that there is an additional penalty on the firm if they elect to use compensation of customers. A key implication of our results is that firms will pay a higher price if they use compensation. The negative economic impact should encourage the firms to examine other options that may rectify the situation without the adverse impacts.

While we predicted that the coefficient relating to the recency of the event would be positive, the estimated coefficient was only marginally positive and significantly different from zero at the 10% level in a one-tailed test. This indicates a very weak pattern whereby more recently occurring events are less economically damaging to the firms. The coefficient is also of a smaller magnitude than the others, indicating a weak and small effect.

In contrast, the estimated coefficient relating to events occurring post-Dieselgate was negative, as predicted, and significantly different to zero at the 5% level in a one-tailed test. This indicates that the added scrutiny on firms, their behaviours, and failures in the post-Dieselgate economy has led to a sharper stock market reaction to failures. A key implication is that managers should increasingly pay attention to the implications of failing to meet the environmental standards in the contemporary era.

In the case of the control variables, the coefficients for firm size and the presence of recalls are insignificantly different to zero. While the coefficient relating to recalls is insignificantly different from zero, it is positive. This may indicate that a recall in conjunction with the announced environmental failures is perceived as being marginally positive, perhaps indicating that the firm is prepared to take more substantive action to remedy the problem.

The results (Table 3) indicate that while Dieselgate has ‘grabbed headlines’, this category of failure is consistently considered ‘negative’ by the stock market. Therefore, while Dieselgate resulted in a loss of stockholder wealth for VW (Mansouri, 2016), this category of event is also negative for other automotive firms. Our results are broadly consistent with the findings of Nunes and Park (2016), which documented that the impact of the Dieselgate was contagious to other U.S. automotive sector firms (the competitors). Similarly, we find a temporal effect, insofar as while Dieselgate increased immediate suspicion of the other firms, the negative abnormal returns post-Dieselgate also increased in magnitude.

Table 3. Results of the hypothesis testing

Hypothesis	Predicted direction	Result
<i>HYPOTHESIS 1: The announcements of failures to meet environmental standards will have a negative stock market reaction.</i>	-	-1.02% ^a
<i>HYPOTHESIS 2:</i>	-	Not significant
<i>HYPOTHESIS 3: The stock market reaction to offers of compensation will be more negative than for other remedies.</i>	-	-0.0548***
<i>HYPOTHESIS 4: The stock market reaction to recent announcements of failures to meet environmental standards will be less negative than for older announcements.</i>	+	0.0014*
<i>HYPOTHESIS 5: The stock market reaction to announcements of failures to meet environmental standards after Dieselgate will be more negative than other announcements.</i>	-	-0.0564**

Significant levels (one-tailed tests): * 10% level, ** 5% level, *** 1% level
 Significant levels (two-tailed test for the abnormal return): a 5% level

Our finding relating to the fuel standards is that identified breaches of fuel standards leads to more negative abnormal returns. In some ways, this contrasts with the theoretical perspective where we might expect substantive efforts made by the firms to reach voluntary targets to be more significant. However, that theory relates to the underlying operational performance. When we consider ‘fuel standards’ as an ‘order qualifier’ instead, the failure to attain this standard is clearly strategically problematic for the companies involved as it may lead to direct penalties or ‘removal from the market’; in contrast, failure to hit a voluntary target leaves them ‘in the market’.

4.1 Implications

Our results are firstly explained by the finding that when the firm is told to compensate consumers for the failure in the announcement, the abnormal returns are more negative. This suggests that when compensation is involved, investors perceive that the costs of the failure will be greater to the firm. This finding is important for businesses to note, as it highlights the fact that providing compensation may not be the best way to remedy an environmental failure (financially, in any case). We recommend that perhaps other forms of compensation such as extended warranties or free repairs may be a more viable option. However, if monetary compensation is most practical, another suggestion could be to avoid mention of compensation in the initial failure announcement, and instead notify consumers privately so as to not concern shareholders.

Secondly, the significance of abnormal returns being more negative after the VW scandal suggests that public scrutiny of automotive firms failing environmental standards have largely increased after this event. Due to the large losses VW faced in the wake of cheating their emissions tests (Mansouri, 2016), subsequent environmental violations saw shareholders react with increased alarm at potentially similar disastrous losses. In a post-Dieselgate world, automotive firms should therefore be increasingly concerned with maintaining their environmental standards, and ensuring that they are meeting the required environmental regulations. This increasingly negative impact of adverse events occurring post-Dieselgate could be transferrable to other industries, and the negative impact on abnormal returns could exist for other types of failures. Thus, after an industry experiences a major shock event, like Dieselgate, investors could become increasingly sensitive to any similar reoccurrences, even if they are not on the same scale. However, this phenomenon would require further research to ascertain its existence.

Our findings overall suggest that firms are punished by the market when they are publicly announced to have failed certain environmental standards. We hope that these findings serve as a deterrent to those firms who try to get away with minimal compliance, those which benefit from inflated environmental performance claims that differ from reality, and those who try to evade the legal environmental requirements completely, as in the case of VW.

While these results are derived from the automotive sector, this is merely a context for the study. Similar early studies in product harm literature also focused on automotive recalls (Haunschild & Rhee, 2004; Rupp, 2001), and yet the results have been broadly similar for other product recalls. As a result, we assume that the results would be generalizable to other sectors as well. Some of the key results indicate that managers should take care following major events and monitor to ensure that their own firms will not ‘fall foul’; our results indicate that investors have become increasingly risk averse following the Dieselgate scandal in our sample, with following cases experiencing a more severe stock market reaction. Similarly, if there is a major event in another sector, the competitors should monitor their own performance following the event as the implications will be treated more severely afterwards.

6. Conclusions

Based on our analysis of 41 announcements made by publicly traded automotive firms from 1984-2016, we have documented that the announcements are associated with a statistically significant negative stock market reaction. Using a single-day event window, the mean stock market reaction is -1.02% and the percent of cases experiencing a negative reaction is 61%. We find that more recent announcements resulted in a less negative stock market reaction than early announcements; however, a failure to meet fuel standards, the announcement occurring after Dieselgate, and the offering of compensation as a remedy, are all associated with a more negative stock market reaction.

These findings are important as they indicate that announcements about firms failing environmental standards in the automotive industry, do have a negative impact on stock returns on the day the announcements were made. This finding also warns firms of the risks of advertising or marketing the environmental performance of their products without the commitment to meet their claimed sustainability; while our results were not statistically significant there is an indication that this may lead to a negative stock market reaction. Shareholders thus appear to have an adverse reaction to such announcements, possibly in the expectation that firms will subsequently incur large costs in remedying the publicised failure. These results provide evidence that these failures are more closely monitored and can be more significant following a bellwether event, such as VW’s Dieselgate scandal. Our results also indicate that while the Dieselgate episode was a major event, this category of event is also important and can result in a meaningful adverse stock market reaction.

We have identified five directions for future research. First, it could be valuable to examine in more detail whether there are different drivers for the failures and examine whether the abnormal return varies by these different drivers. Second, it would be useful to broaden the research to other industry sectors and examine whether organisational or operational characteristics of the announcing firms have an impact on the abnormal returns. Third, not all firms in the sample experienced a negative stock market reaction to the announcement – the development and testing of a range of hypotheses to explain this result may shed more light on the market reaction. Fourth, the interaction between recalls and failures may require additional exploration as our estimated coefficient for the use of recalls was positive although not significantly different to zero. Fifth, our research examined the financial performance of the firm in relation to failures to reach standards and therefore leaves aside the question of whether a firm striving to reach more stringent voluntary standards will gain operational performance

benefits. Further analysis on similar samples might indicate whether these failures to maintain voluntarily set standards have any impact on the operational characteristics of the firms involved.

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