Do Prior Investor Perceptions Mitigate the Adverse Impact of Natural Disasters on Utility Share Prices? The Case of Fukushima.

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ABSTRACT

This paper investigates whether favourable investor perceptions prior to an environmentally-related accident may have a moderating effect on resulting negative share price reactions. Share prices are regarded as the outcome of investor perceptions on the basis of financial performance evaluation. Prior research on environmental accidents has found significantly negative market reactions for companies affected by such events (Blacconiere & Patten, 1994; Bansal & Clelland, 2004; Capelle-Blancard & Laguna, 2010). The study focuses on the share price reactions on utility stocks worldwide following the disaster at the Fukushima Daiichi nuclear power plant on 10 March 2011. Due to the severity and magnitude of the accident, the event represents an interesting research context to investigate the resulting market reaction and to examine whether prior investor perceptions about utility companies may have a mitigating effect. The paper analyses in particular whether firms with a higher organisational reputation prior to the accident may experience a more moderate negative share price reaction compared to companies with a lower organisational reputation.

Based on a sample of 459 utility companies worldwide, the study applies an event day methodology to calculate post-Fukushima share price reactions. The abnormal returns are then regressed on three reputational measures (environmental reputation, CSR reputation and investment reputation) in order to examine whether prior organisational reputation had an impact on market prices. The study finds that a favourable environmental reputation (i.e., being listed in the Newsweek 'greenest' companies ranking) and investment reputation (i.e., credit ratings) prior to the Fukushima disaster had a mitigating effect on the negative share price movements of nuclear companies. However, CSR reputation (i.e., being listed in the Dow Jones Sustainability Index) is found to have no impact on investor perceptions. This suggests that establishing and maintaining a favourable environmental reputation and investment reputation may benefit utility companies during environmental crises.

1. INTRODUCTION

This paper investigates whether favourable investor perceptions (positive organisational image) prior to an environmentally-related accident may have a moderating effect on the resulting negative share price reaction. Share prices are generally regarded as being the outcome of investor perceptions on the basis of financial performance evaluation (e.g., Bowen et al., 1983). Prior research on environmentally-related accidents has found significantly negative market reactions for companies related to these events (Blacconiere & Patten, 1994; Bansal & Clelland, 2004; Capelle-Blancard & Laguna, 2010). These negative market reactions are the result of investors re-assessing companies' future financial performance in terms of expected future cash flows and risk (Hill & Schneeweis, 1983). On the one hand, environmentally-related accidents generally result in higher costs for companies due to stricter imminent regulation, costs stemming directly from the accident, or from compensation claims. On the other hand, these accidents make investors perceive respective companies and/or industries as more risky to invest in. As future cash flows are expected to decrease and future risk to increase, share prices, being the outcome of aggregate investor evaluations, decrease.

The present study focuses on the negative share price reaction on utility stocks worldwide, which resulted from the disaster at the Fukushima Daiichi nuclear power plant that had been struck by an earthquake and its resulting tsunami on 10 March 2011. Prior to the Fukushima disaster, only two other nuclear accidents had occurred that resulted in extensive news coverage and negative market reactions, namely the Three Mile Island accident and the disaster at Chernobyl. The Three Mile Island accident occurred on 28 March 1979 in the U.S. as a consequence of a partial meltdown. The event was classed as a level 5 event on the International Nuclear and Radiological Event Scale (INES) (accident with wider consequences). The Chernobyl disaster happened on 26 April 1988 as the result of an explosion at the Chernobyl nuclear power plant in Ukraine. Up until the Fukushima disaster, this event was the most severe nuclear accident as it had far-reaching consequences for most of Europe and the former Soviet Union due to spreading radioactivity. It was classed as a level 7 event on the INES (major accident), which is the highest level on the scale. Prior studies have already investigated the impact of these two accidents on utility share prices in the U.S. and find a significantly negative effect (Bowen *et al.*, 1983; Hill & Schneeweis, 1983; Fields & Janjigian, 1989; Kalra *et al.*, 1993). The Fukushima disaster in 2011 is the only other level 7 event to date and is therefore the most severe nuclear accident in the history since Chernobyl in 1988. Not only did the resulting radioactive releases and outages have fatal consequences for the Japanese society and economy, but also for economies worldwide due to the increasing globalisation and Japan being an important export nation. Due to the severity and magnitude of the accident, it represents an interesting research context to investigate the resulting market reaction on a global scale and to then examine whether prior investor perceptions about utility companies may have a moderating effect.

The prior literature discusses a variety of constructs relating to audience perceptions of organisations, including organisational legitimacy, reputation, and image. This study views image as an overarching concept encompassing legitimacy and reputation. Suchman (1995, p.547) defines organisational legitimacy as "*a generalized perception or assumption that the actions of an entity are desirable, proper, or appropriate within some socially constructed system of norms, values, beliefs, and definitions*". This widely used definition recognises that legitimacy is a construct based on organisational outsiders' perceptions and formed along the lines of social norms and values. Organisational reputation, on the other hand, is defined by Deephouse and Carter (2005, p. 331) as "*a comparison of organizations to determine their relative standing*". Organisational reputation is thus based on stakeholder perceptions based on a comparison of a specific organisational aspect and subsequent ranking amongst industry peers. By contrast, evaluations of organisational legitimacy are based on a binary judgement: an organisation is either perceived as being a legitimate entity within its social system or not.

As organisational reputation is assessed along different organisational aspects, an organisation can have different types of reputation. A very recent study by Cho et al. (2012), for example, investigates organisational reputation with respect to environmental performance. They examine the relationship between environmental reputation and environmental performance and the role that environmental disclosure may play in this relationship. They question, in particular, whether environmental reputation is the outcome of organisational environmental performance. Cho et al. (2012) find a discrepancy between environmental reputation and performance. Organisations with a high environmental reputation are likely to be poor environmental performers. They further find environmental disclosure to be a tool to improve environmental reputation, while disguising actual environmental performance.

1.1 Contribution

This study combines two strands of literature, namely event studies on environmentally-related accidents and studies on stakeholder perceptions. This paper investigates whether firms with a higher organisational reputation prior to an environmental accident may experience a more moderate negative share price reaction compared to companies with a lower organisational reputation. Specifically, it examines whether utility companies with a favourable environmental reputation, CSR reputation and investment reputation prior to the disaster at the Fukushima Daiichi nuclear power plant may have experienced a less severe negative share price reaction. The paper contributes to the literature in two ways. First, it is the first study to investigate the impact of prior investor perceptions on negative market reactions following an environmentally-related accident. Second, it is the first study, to our knowledge, to investigate the share price reaction to a nuclear accident within the utility sector on a worldwide scale.

1.2 Main Findings

Based on a sample of 459 utility companies worldwide, the study applies an event day methodology to calculate the post-Fukushima share price reaction. The abnormal returns are then regressed on three reputational measures, in order to investigate whether prior organisational reputation amongst investors had an impact on the market reaction. The study finds that a favourable environmental reputation (as measured by being listed in the Newsweek 'greenest' companies ranking) and investment reputation (as measured by being credit ratings) prior to the Fukushima disaster had a mitigating effect on the negative share price reaction of nuclear companies over the short event period. This, however, does not hold over the longer event period. In the long run, utility companies with a medium credit rating experienced a more moderate negative share price reaction. CSR reputation is found to have no impact on the post-Fukushima market reaction. The study thus finds evidence that a favourable environmental reputation and investment reputation may benefit companies operating in the utility sector during environmental crises.

1.3 Structure of paper

The next section of the paper provides the theoretical foundation of the study by elaborating on audience perceptions of organisations. Section three discusses prior event studies on incidents with negative environmental impacts and prior literature on investor perceptions. These form the basis for hypothesis development. Section four discusses the sample, data and research methods used. In section six the results of the analysis are presented and discussed. Section seven concludes with a summary, highlights the limitations of the study and provides suggestions for future research.

2. OUTSIDER PERCEPTIONS OF ORGANISATIONS

Perceptions of organisations manifest themselves in the concepts of organisational legitimacy, reputation and image. The three notions are variously defined in the literature. With respect to organisational image, definitions vary between perceptions of organisational insiders and outsiders. Hooghiemstra's (2000, p. 58) definition of the concept of image exemplifies the strand of the literature that bases the notion of image on insiders' perceptions as he defines it as "*the way organisational members believe others see the organisation*". Dutton and Dukerich (1991, p. 548) share this view on image by defining it as "*attributes members believe people outside the organization use to distinguish it*". Gray and Balmer (1998, p. 697), on the other hand, represent the strand of researcher that bases image on outsiders perceptions by defining it as an "*immediate mental picture that audiences have of an organization*". After having reviewed different interpretations of image, Gioia et al. (2000, p. 66) conclude that it "*is a wide-ranging concept connoting perceptions that are both internal and external to the organization*". We take this as the basis of our definition of image which we regard as an overarching concept encompassing the notions of organisational legitimacy and reputation. In the context of this study, image is viewed as the outcome of organisational audiences' perceptions of the organisation.

Definitions of reputation and legitimacy are equally "*diverse, ambiguous, and contested*" concepts (Deephouse & Suchman, 2008, p. 59). In the context of this study we regard reputation and legitimacy as sub-component of image. Reputation entails the evaluation of the quality of the organisation or organisational activities in comparison with its competitors. By contrast, legitimacy is based on the judgement of the organisation's normative appropriateness.

Organisational legitimacy and reputation can be viewed from two different perspectives, namely the strategic and the institutional perspective. From the strategic perspective, organisational legitimacy is achieved when an organisation's value system appears to be congruent to the wider society's value system. This approaches views management as having an active role in the construction of legitimacy as they can control and manipulated organisational outsiders' perceptions. From the institutional perspective, organisational legitimacy is defined as a "*perception or assumption that the actions of an entity are desirable, proper, or appropriate within some socially constructed system of norms, values, beliefs, and definitions*" (Suchman, 1995, p. 574). This approaches views management as having a passive role as legitimacy is controlled by organisational outsiders as is it reflects their perceptions about the organisation. In this study, we adopt the strategic perspective on legitimacy. We assume that the Fukushima disaster results in a legitimacy gap (Sethi, 1975), as outsiders' norms and expectations change in the course of the accident in the sense that they expect higher safety regulations for nuclear operations. Form the strategic perspective, management "*will seek to eliminate or minimise a legitimacy gap*" by realigning the organisation's value system with that of society (Islam & Deegan, 2010, p. 133), thereby restoring their organisational legitimacy. This may, for example, be done by reinforcing safety systems and procedures.

Bebbington et al. (2008) note the existence of two perspectives on reputation, namely an economic/strategic informed management perspective and a sociologically informed perspective. The former perspective understands reputation as an intangible and strategic asset which results in a competitive advantage for the organisation. The latter perspective "*sees reputation as the outcome of shared socially constructed impressions of a firm*" as the result of outsiders reflecting on '*sense making*' processes inside the organisation (Bebbington *et al.*, 2008, p. 339). We adopt the economic/strategic informed management perspective on organisational reputation, which is aligned with the strategic perspective on organisational legitimacy. This perspective on organisational reputation sits within the evaluative school of thought identified by Chun (2005). From this approach, reputation is based on evaluating the financial performance of organisations by investors or managers. Being evaluated as having a high reputation in terms of financial performance is said to result in a competitive advantage for the organisation. Management is therefore assumed to have an interest in achieving a relatively high reputation.

The notions of organisational legitimacy and reputation differ along various dimensions. They can, for example, be distinguished by the type of evaluation involved. Deephouse and Carter (2005, p. 331) note that legitimacy is assessed on the basis of whether an organisation "*meet[s] and adher[s] to the expectations of a social system's norms, values, rules and meanings*". Thus, in the case of legitimacy, organisational outsiders judge an organisation in terms of its normative appropriateness, i.e. whether an organisation's actions are "*desirable, proper or appropriate*" (Suchman, 1995, p. 574) with respect to the society's value system in which it operates. Only if the organisation is perceived to be acting according to the norms and rules of the society it will be seen as legitimate.

An organisation's reputation, on the other hand, is based on "*a comparison of organizations to determine their relative standing*" (Deephouse & Carter, 2005, p. 331). Thus, organisational reputation is the result of an evaluative ranking of an organisation relative to its competitors. While organisational legitimacy is assessed on the basis of norms and rules by its respective society, reputation is the outcome of stakeholders' evaluation of the organisation in terms of quality. Quality issues a firm can be assessed by may, for example, include: financial performance, acumen and expertise of management, social and environmental responsibility, employee training and education, and the standards or goods and services (Bebbington et al., 2008). Based on these quality issues, there are different aspects of organisational reputation, including environmental reputation, CSR reputation, employee reputation and investment reputation. Thus, an organisation's overall reputation can be broken down into reputations relating to individual organisational aspects, which are then "*used by individuals when they evaluate reputation*" (Bebbington et al., 2008, p. 340). Organisational reputation is thus an evaluation of an entire organisation relative to its competitors based on the different reputations stakeholders hold of specific aspects of the organisation.

As reputation is based on a relative comparison amongst companies, its specification is scalar. That means that companies competing against each other are ranked on a scale from companies with the worst reputation to the companies with the best reputation. An organisation's legitimacy, on the other hand, is either given or not. Therefore, organisational legitimacy is *dichotomous* in its specification (Deephouse & Suchman, 2008, p. 60).

Being perceived as legitimate or as having a comparatively favourable reputation is beneficial for an organisation. The benefits are related to the type of evaluation involved and the type of audience involved in the evaluation. Organisational legitimacy which involves an assessment of normative appropriateness by the respective society has economic, social and political value for the organisation, because a legitimate state means that the company is an accepted entity within society. This in turn "*helps [the organisation] attract resources and the* *continued support of constituents*" (Ashforth & Gibbs, 1990, p. 177). Therefore, organisational legitimacy facilitates an organisation's survival.

Organisational reputation, on the other hand, has economic, social and political value for an organisation as well. In the case that an organisation and/or specific organisational aspects are evaluated positively, the organisation acquires a higher relative standing compared to its competitors. A positive reputation thus indicates a firm's uniqueness, which in turn gives it a competitive advantage over its industry peers. A competitive advantage may manifest itself in "*premium prices for products, lower costs for capital and labour, improved loyalty from employees, greater latitude in decision making, and a cushion of goodwill when crises hit*" (Fombrun, 1995, p. 57). The social value of organisational reputation, on the other hand, may manifest itself in being seen as reputable company resulting in customer loyalty. Political implications of a favourable organisational reputation may, for example, be lower levels of regulation and/or taxes.

In terms of time dimension, both organisational legitimacy and reputation involve relatively stable evaluations about an organisation. In comparison to organisational legitimacy organisational reputation has a relatively shorter time horizon. That means that audience's reassess reputation on a more frequent basis. An example would be sustainability rankings. These reflect an organisation's environmental reputation and are usually reassessed on a yearly basis. Organisational legitimacy, on the other hand, is – once acquired – a long-term, stable evaluation that can only be threatened by extraordinary events like environmental disasters or scandals affecting an organisation. Table 1 summarises the different aspects of organisational legitimacy and reputation.

Table 1: Distinguishing the concepts of organisational legitimacy and reputation

	Organisational legitimacy	*Organisational reputation*
Type of evaluation	Normative appropriateness	Evaluative ranking
Based on	Norms and rules	Quality
Judge	Respective society	Stakeholders
Specification	Dichotomous	Scalar
Organisational dimension	Whole organisation or industry	Whole organisation or aspects of it
Organisational aim	Social acceptance	Uniqueness
Value for the organisation	Social/political	Economical
Benefit	Organisational survival	Competitive advantage
Time dimension	Stable & long-term	Stable & short term

Adapted from Deephouse & Suchman (2008) and Brennan & Merkl-Davies (forthcoming, Table 1).

3. LITERATURE REVIEW AND HYPOTHESES DEVELOPMENT

There is extensive prior literature on environmentally related accidents and their impact on the share prices of companies affected by the events. Evidence suggests that such events result in negative market reactions. Capelle-Blancard and Laguna (2010), for example, conduct an event study on 64 sample accidents and 38 sample companies in 12 countries worldwide. The events under investigation are chemical disasters that occurred between 1990 and 2005. The authors analyse the reaction for several countries, as they assume country-specific varying levels of regulatory changes following chemical incidents. Like other prior research, they also assume that negative market reactions following chemical disasters are to be expected because investors will anticipate an increase in governmental regulations in the wake of these accidents, reducing future cash flows. They examine the market reactions to their sample incidents over a longer and a shorter time horizon (120 and 20 days respectively).

Capelle-Blancard and Laguna (2010) employ an event study methodology to compute the market reactions to their sample incidents. They define abnormal returns "*as an unbiased estimate of the total financial consequences of an accident (all expected uninsured future costs)*" (p. 197). To obtain abnormal returns, they employ the market model to estimate the parameters using daily share price data over a 181-day pre-event window. They then compute average as well as cumulative abnormal returns for the post-event window. They also

calculate the average abnormal shareholder loss which is the multiple of the cumulative abnormal return over a certain post-event window and the market value of the company prior to the event. The authors further attempt to explain cumulative abnormal returns and average abnormal shareholder losses for each of the affected companies using multivariate regressions. The explanatory variables used for the regressions are the number of casualties or people injured as a result of the accident and resulting toxic releases causing pollution.
Capelle-Blancard and Laguna (2010) find that the average negative market reaction to a chemical disaster is 1.3 percent for a two-day window following the event. Furthermore, they find that all disasters cause negative market reactions, but not all of them are statistically significant (only for twenty-five percent of the accidents). Having investigated the determinants of the share price reactions for each company over a short time horizon after an accident, they find that both the number of casualties or injured people and any environmental pollution resulting from an accident have a significant effect on market reactions. The authors conclude that the market reaction to chemical accidents is strongly related to the resulting social costs. This study provides strong evidence that environmentally-related incidents lead to strong negative market reactions for affected companies.

Based on these findings, and given that the earthquake and tsunami causing the Fukushima disaster were unanticipated events, we expect that negative equity value changes will occur for the Japanese utilities sector as well as for utility companies worldwide after 11 March 2011. Therefore, the first hypothesis of the study, stated in its alternative form, is:

> H_A^1: The Fukushima disaster and resulting events has a negative impact on the share prices of public utility companies worldwide.

3.1 Prior event studies on nuclear accidents

Within the literature investigating the market reactions to environmental accidents, there is a number of event studies focusing on nuclear disasters, namely the Three Mile Island accident in the U.S. in 1979 (Bowen *et al.*, 1983; Hill & Schneeweis, 1983) and the Chernobyl disaster in 1986 (Fields & Janjigian, 1989; Kalra *et al.*, 1993).

Bowen *et al.* (1983) investigate the share price reaction within the U.S. public utility sector to the nuclear incident at the Three Mile Island nuclear power plant on 28 March 1979. The authors explicitly acknowledge that "*changes in the attitude of the public and of industry regulators*" may result in investors re-assessing a company's future cash flows which will be reflected in a change in share prices (p. 87). Bowen *et al.* (1983) investigate whether such a negative share price reaction occurred in the U.S. utility sector after the Three Mile Island accident They exclude the company operating the nuclear power plant from their analysis, as they expect a certain drop in the share price of this company.

Bowen *et al.* (1983) test the market reaction using a sample of 83 U.S. public utility companies. They further sub-divide the sample. Twenty one firms are grouped into a 'large nuclear' sub-sample using the criterion of having a nuclear capacity of at least 20 percent. Another sub-sample comprises 11 firms which are connected to the nuclear power plant builder BW who built the Three Mile Island plant. The third sub-sample contains the remaining 51 firms. By sub-dividing their sample, they argue that they are able to detect whether the effects of the incident differ for firms involved in nuclear power generation and firms that are not. The study uses daily share price data over a 459 day pre-event window and a 196 days post-event period and the market model to compute abnormal returns during the event period for the entire sample and the sub-samples. They find that the 'large nuclear' sub-sample and the BW sub-sample faced a more severe share price drop than the sample comprising all public utility firms. Thus, their finding shows that firms involved in nuclear operations were affected worse than firms that are not. It should, however, be noted that the entire utility sector experienced a negative share price reaction which indicated that the entire industry's legitimacy was threatened by the Three Mile Island nuclear accident.

Hill and Schneeweis (1983) also investigate the effect of the Three Mile Island nuclear accident on the U.S. public utility sector. The authors also explicitly acknowledge that share prices reflect investors' perceptions. They state that "*a nuclear accident may directly affect investors' perceptions of both the expected cash flows of utilities and their risk*" which is captured by the share price (p. 1285). Thus, a nuclear accident may result in the loss of a company's legitimate state and a share price drop based on stakeholders' and shareholders' perceptions respectively.

Hill and Schneeweis (1983) investigate the effects of the accident on three different samples: a general sample of all public utility companies listed on the New York Stock Exchange, a

nuclear and a non-nuclear sample. The company operating the Three Mile Island nuclear power plant was excluded and analysed separately.
To obtain cumulative abnormal returns Hill and Schneeweis (1983) use monthly data over a 15 month pre-event window and a 15 month post-event window. Furthermore, they use a single index as well as a two index market model to estimate their parameters with the S&P 500 representing the market index, the S&P AAA long term industrial bond index representing the second index.

Like Bowen *et al.* (1983), Hill and Schneeweis (1983) find that whilst both nuclear and non-nuclear utility firms were affected by the Three Mile Island, the share price reaction was more negative for nuclear companies than for non-nuclear companies.

Fields and Janjigian (1989) investigate investor reactions to the major nuclear accident in Chernobyl which occurred on the 26 April 1986. Although, the accident happened in Eastern Europe, Fields and Janjigian (1989) examine the share price reaction for a sample of 89 U.S. public utility firms using a pre-event window of 75 trading days and a post-event window of 60 days. They also examine a general sample comprising all utility firms, and sub-samples of nuclear and a non-nuclear firms. Like Hill and Schneeweis (1983), they use daily share price data.

Fields and Janjigian (1989) also use the market model to estimate the parameters needed to obtain abnormal returns. In contrast to Hill and Schneeweis (1983) and Bowen *et al.* (1983), however, they run a generalised least squares regression instead of an ordinary least squares regression to estimate the parameters to account for issues of heteroskedasticity and cross-sectional autocorrelation that may arise as a result of the sample comprising one industry and one time period.

Fields and Janjigian (1989) also investigate whether the Chernobyl accident had an impact on market-wide risk, which they test by analysing whether a shift in the β parameter occurred after the accident. They find a negative β shift for all three samples, but, as the shift is not statistically significant, they conclude that the incident did not significantly affect market-wide risk. Fields and Janjigian (1989) find that the accident had a negative effect on share prices all three samples, with nuclear firms suffering the highest share price drops.

Kalra *et al.* (1993) also examine the share price reaction to the Chernobyl accident, and, like Fields and Janjigian (1989), they also restrict their sample to U.S. utility companies. As mentioned before, the study offers an interesting context, as the Chernobyl accident was not financially linked to the U.S. utility industry. This suggests that the incident not only posed a legitimacy threat to local utility firms, but also to the nuclear industry worldwide.

For the purpose of their study Kalra *et al.* (1993) divide their sample of 71 U.S. utility companies into sub-samples, namely: nuclear utilities, mixed utilities, and a conventional utilities sample. They use daily share price data commencing 250 trading days prior to the accident and a post-event period comprising 30 trading days and the market model to compute abnormal returns. In addition, they employ an event parameter model to account for cross-sectional dependence and correlation, which is the result of industry and event clustering. The authors also test for α and β beta shifts. These shifts are then included in the event parameter model regression by means of a dummy variable.

Kalra *et al.* (1993) find that all U.S. utility companies experienced a negative market reaction following the Chernobyl accident. However, they find that the share price drops were not statistically significant for the nuclear and the conventional sub-samples. The effect on the mixed utilities sub-sample, however, was higher. They explain this by the involvement of many mixed utilities in newer and riskier nuclear operations. Table 2 summarises prior event studies on nuclear accidents.

The literature on prior nuclear disasters thus finds clear evidence that such accidents result in significantly negative abnormal returns and that this effect is strongest for nuclear companies. This is not only true for companies directly involved in the events, but for the entire utility industry. What is more, the studies on the impact of the Chernobyl disaster on the US utility industry highlight that negative market reactions are not limited to utility companies headquartered in the country where the event happened, but impact on the entire industry worldwide. This indicates that nuclear accidents not only threaten the legitimacy of certain companies, but the entire utility sector. This suggests that the impact of the Fukushima disaster needs to be investigated on utility share prices on an industry-wide and thus worldwide scale.

Table 2: Event studies investigating share price movements after nuclear incidents

Study	***Nuclear incident***	***Sample***	***Data***	***Model***	***Findings***
Bowen et al. (1983)	28 March 1979, U.S. Three Mile Island plant (run by General Public Utilities)	83 U.S. public electricity utilities (large nuclear sub-set/sub-set where plant built by same contractor than TMI)	Daily share prices	Market model	Significantly negative effect on share prices; effect larger for nuclear firms than non-nuclear firms; increase in systematic risk
Hill & Schneeweis (1983)	28 March 1979, U.S. Three Mile Island plant (run by General Public Utilities)	64 U.S. public electricity utilities (30 nuclear/34 non-nuclear)	Monthly share prices	Market model	Significantly negative effect on share prices of nuclear sub-set; no significant negative effect on share prices of neither non-nuclear sub-set, nor whole sample; effect larger for nuclear firms than non-nuclear firms
Fields & Janjigian (1989)	26 April 1986, Soviet Chernobyl plant (run by Soviet government)	89 U.S. public electricity utilities (57 nuclear/32 non-nuclear)	Daily share prices, dividend information	Market model	Significantly negative effect on share prices; effect larger for nuclear firms than non-nuclear firms; no significant effect on systematic risk
Kalra et al. (1993)	26 April 1986, Soviet Chernobyl plant (run by Soviet government)	69 U.S. public electricity utilities(nuclear, mixed and non-nuclear sub-samples)	Daily share prices	Event parameter model	Significantly negative effect on share prices; effect larger for mixed sub-set than for non-nuclear and nuclear

3.2 Prior event studies on the Fukushima disaster

Several studies investigate the market reaction following the Fukushima disaster. These studies investigate the share price movements for different geographic contexts and for different utility sub-sectors (Betzer et al. 2011; Lopatta & Kaspereit, 2011; Ferstl *et al*., 2012; Kawashima and Takeda, 2012).

Betzer *et al*. (2011) investigate how regulatory changes as a result of the Fukushima disaster may impact on shareholder wealth. They focus in particular on environmental policy changes in the German context. They regard the German setting as being particularly distinct from other countries, as the German government decided on immediate nuclear phase out strategies in the aftermath of the Fukushima disaster. Because of these rapid regulatory changes and because of the recent trend of energy companies to increase their investment in renewable energy operations, the authors expect a shareholder wealth shift from the nuclear sector to the 'green' energy sector. After investigating the wealth transfer in the German utility sector, Betzer *et al*. (2011) also compare their results to those from the wider European energy sector.

In order to examine shareholder wealth shifts, the Betzer *et al*. (2011) employs an event study methodology. The market model is applied to compute α and β parameters over a 200 day pre-event window using an OLS regression. The authors calculate the impact on shareholder wealth for a nuclear and conventional sub-sample comprising three German energy firms and for a 'green' sub-sample comprising 35 energy companies that engage in renewable energy operations. Furthermore, they create a sub-sample consisting of 13 European energy companies that are comparable to the German nuclear and conventional sub-sample, as well as a European 'renewable' energy sub-sample comprising 25 companies.

Betzer *et al*. (2011) find that on the day of the Fukushima disaster the German nuclear and conventional firms suffered a significantly negative abnormal return of -3.27%, while the German 'green' energy companies experienced a significantly positive abnormal return of 11.62%. Looking at cumulative abnormal returns over the post-event period, the German nuclear and conventional companies still faced negative cumulative abnormal returns of over 3% after event day 20. Within this time period the 'green' energy sector, however, benefitted from positive cumulative abnormal returns of over 17%. In monetary terms, the German nuclear and conventional energy sector lost over 2 billion Euros, while the 'green' energy sector gained almost 1.9 billion Euros.

Betzer et al. (2011) find that European nuclear and conventional utility firms suffered a significantly negative market reaction amounting to over 5.5 billion Euros. The 'green' energy sector, on the other hand, gained almost 0.7 million Euros. This positive market reaction is, however, insignificant. Looking at cumulative abnormal returns, the European nuclear and conventional utility firms lost almost 6 billion Euros over the 20 days post-event period, while the European renewable energy firms gained over 1 billion Euros. Both results are, however, insignificant. In summary, the authors conclude that a shareholder wealth shift took place, namely from the German nuclear and conventional utility firms to their European counterparts as well as to the German 'green' energy companies.

Lopatta and Kaspereit (2011) also conduct an event study on the effect of the Fukushima disaster on utility companies. In contrast to prior event studies, they measure the engagement of a company in nuclear and renewable power generation through the percentages of revenues that these particular operations contribute to a firm's total revenues. On the basis of these measures, they examine three particular issues. First, they investigate whether a firm's engagement in renewable power generation may mitigate the effects of the firm's engagement in nuclear power production. Second, they analyse whether environmental sustainability investments may mitigate the effect on share prices. And third, they consider the effect of the political system in which a company is headquartered on its share prices, focussing in particular on whether a nuclear phase out has been announced or not.

The sample Lopatta and Kaspereit (2011) select for their event study is based on the International Atomic Energy Agency's Power Reactor Information System which lists companies operating or owning nuclear power plants. They also included 3 reactor building companies and an uranium mining company, resulting in a final sample of 56 publicly listed utility companies. To calculate the abnormal returns, the authors choose Fama et al.'s (1969) model. The model parameters are estimated over an estimation period of 250 trading day. Abnormal returns are computed for an event period spanning from day -10 to day +20, with 11 March 2011 being denoted as event day 0.

Lopatta and Kaspereit (2011) find the highest negative abnormal returns to have occurred on event days 2 and 3. This is true for the full sample as well as for the sample excluding directly affected firms. Conducting a regression analysis for the cumulative abnormal returns over those two days, they find that the higher a firm's engagement in nuclear power operations, the more negative the share price reaction following the Fukushima disaster. Furthermore, a company's engagement in renewable power generation does not have a mitigating effect on the share price reaction. This is explained by a shift towards conventional energy instead of towards renewable energy, as the former is cheaper to produce. In respect to a company being headquartered within a political system committed to a nuclear phase out, the abnormal returns for those companies are significantly higher. The authors also find that firms investing in environmental sustainability experienced less negative share price movements.

Ferstl *et al*. (2012) also investigate the share price reaction following the Fukushima disaster. They particularly focus on the reactions in France, Germany, Japan and the US and contrast the impacts on the nuclear and alternative energy sectors. To do so they apply an event study methodology. They use the three-factor model developed by Fama-French to compute abnormal returns. The estimation period to obtain the model parameters is three years. The authors compute abnormal returns for a shorter event window starting on 14 March 2011 and comprising 5 trading days, and for a longer event period starting 21 March and comprising 20 trading days. As for the nuclear samples, Ferstl *et al*. (2012) select all nuclear operators with at least 1,000 megawatt of installed nuclear capacity for each of the four country settings. To identify their alternative sample they use Thomson Reuters Datastream classification 'Alternative Energy'.

The authors find that French, German and Japanese nuclear energy companies suffer significantly negative abnormal returns over the shorter event window, while abnormal returns for US firms are insignificant. Furthermore, the cumulative abnormal returns of the former three nuclear samples stay significantly negative over the shorter event period. The French, German and Japanese alternative energy samples, on the other hand, experience positive share price movements in the short run. This is again not the case for the US alternative energy sample.

Over the longer event window, significantly positive cumulative abnormal returns are found for the German alternative sample and significantly negative abnormal returns for Japanese nuclear company stocks. Most other significant results over the longer event window are found to be the result of confounding events. Ferstl *et al*. (2012) conclude that investors in Japanese nuclear companies appear to be uncertain about future regulatory changes, while investors in French and German nuclear firms appear to anticipate shift towards the use of alternative energy production. In the US, however, no regulatory changes of energy policies are expected.

Kawashima and Takeda (2012) also investigate share price reactions following the Fukushima disaster. The authors are in particularly interested in investigating the impact of the disaster on Japanese utility companies other than TEPCO, as this would be a clear indication of changing investor perceptions about the risks and returns of nuclear operations in the Japanese context. For this purpose, they analyse the market reactions for 11 Japanese utility companies. They employ the market model to estimate the alpha and beta parameter over an estimation period of 250 trading days. They then calculate the abnormal returns for three event windows. The authors find that Japanese utility companies that were also directly struck by the earthquake and the following tsunami and those that operate nuclear power plants suffered more negative abnormal returns. Kawashima and Takeda (2012) also test for changes in systematic and total risk of Japanese utility companies and find that both increase as a result of the disaster, suggesting that systematic changes such as those concerning energy regulations are recognised by investors as potentially driving up the cost of generating power in the future.

Given the findings of prior event studies on the Fukushima disaster, as summarised in Table 3, it is expected that companies that are involved in the nuclear power generation would suffer a more severe impact on their share prices than utilities companies that are involved in different power generation operations, such as, for example, hydro or coal. Thus, a more negative market reaction might be expected for nuclear companies. Therefore, the second hypothesis stated in its alternative form is:

> H_A^2: The effect of the Fukushima disaster and resulting events on the share prices of nuclear utility companies are more negative than those for non-nuclear utility companies.

Table 3: Event studies investigating share price movements after the Fukushima disaster

Study	***Nuclear incident***	***Sample***	***Data***	***Model***	***Findings***
Ferstl et al. (2012)	11 March 2011, Japanese Fukushima Daiichi plant (run by TEPCO)	2 French,10 German,10 Japanese,13 U.S. utility companies (nuclear and alternative sub-samples)	Daily share prices	Fama-French model	Significantly negative abnormal returns for French, German and Japanese nuclear utilities over the short run; Significantly positive abnormal returns for French, German and Japanese alternative energy utilities over short run
Betzer et al. (2012)	11 March 2011, Japanese Fukushima Daiichi plant (run by TEPCO)	38 German utilities (3 nuclear and conventional/35 renewable); 38 European utilities (13 nuclear and conventional/25 renewable)	Daily share prices	Market model	Significantly negative abnormal return for German nuclear and conventional utilities; significantly positive abnormal returns for renewable energy utilities
Lopatta & Kaspereit (2012)	11 March 2011, Japanese Fukushima Daiichi plant (run by TEPCO)	48 publicly listed utility companies, listed in International Atomic Energy Agency's Power Reactor Information System and 4 nuclear reactor construction companies	Daily share prices	Market model	Significantly negative abnormal return over short run (event days [1:2]); effect stronger the higher the nuclear involvement; no moderating effect for companies with renewable energy operations
Kawashima & Takeda (2012)	11 March 2011, Japanese Fukushima Daiichi plant (run by TEPCO)	11 Japanese utility companies (directly affected /non-victim/nuclear/non-nuclear/large nuclear)	Daily share prices	Market model	Significantly negative abnormal return Japanese conventional utilities; effect stronger for directly affected and nuclear sub-samples

3.3 Prior studies on investor perceptions

The previous literature on the post-Fukushima market reaction predominantly investigates differences between countries and sub-sectors. The present study differs from the prior literature in that it investigates the share price reaction resulting from the Fukushima disaster not only for a specific number of countries, but for a sample of utility companies worldwide. Furthermore, while most prior studies recognise market reactions to be a consequence of changing investor perceptions, none has yet directly investigated the effect of prior investor perceptions about utility companies on the post-Fukushima share price reaction.

There has, however, already been one study examining the effect of prior investor perceptions on the market reaction following the Bhopal disaster in 1984 in India. Blacconiere and Patten (1994) investigate how prior investor perceptions may have a mitigating effect on the share price reaction following the disaster. The authors examine in particular how investors' assessments of regulatory costs may have an effect on the market reaction. For this purpose, they use corporate disclosure to measure how investors may anticipate regulatory costs to change. Thus, the study investigates whether corporate environmental disclosures released before the Bhopal disaster may have a moderating effect on the resulting share price reaction. The central assumption underlying the study is that the more a company is involved in chemical operations, the higher is the impact of the incident on the company's market value. The question is whether pre-event disclosure may mitigate this effect as it may have a positive effect on how investors' assess a company's regulatory risk, and thus on investors' prior perceptions about companies.

For the purpose of their study, Blacconiere and Patten (1994) created an intra-industry sample of US firms operating in similar chemical sectors, with readily available share prices, readily available ex-ante 10K reports and without any other firm-relating events around the Bhopal disaster. The final sample comprises 47 U.S. chemical firms. To test the market reaction to the Bhopal accident, Blacconiere and Patten (1994) use the market model to estimate the parameters over a pre-event window that comprises two years. The overall market reaction is calculated by cumulating abnormal returns over a 5-day window following the event.

In order to assess whether environmental disclosure moderates the market reaction, Blacconiere and Patten (1994) conduct a multiple regression to investigate whether the cumulative abnormal returns can be explained by the extent to which a company is involved in chemical operations and by the extent of environmental disclosures prior to the incident. The former explanatory variable is obtained by the proportion of revenue generated by chemical operations relative to total revenue. The latter explanatory variable is generated using content analysis of 10K reports in order to find the proportion of environmentally-related disclosure.

Blacconiere and Patten (1994) find that the chemical industry suffered a significantly negative share price reaction following the Bhopal accident. Furthermore, this effect is more pronounced in companies involved in chemical operations. They find that environmental disclosure may have a moderating effect on the post-event share price reaction. That means that companies with a higher extent of ex-ante environmental disclosure suffered a more moderate change in their market value. The significance for this effect, however, does not hold when control variables, such as firms' revenues, are included which means that the extent of environmental disclosure may not entirely explain moderating effects on the market reaction. This result gives way to examining other potentially mitigating effects on share price reactions following environmental disasters. The study also highlights that negative share price reactions are not limited to companies directly related and/or in close proximity to an environmentally-related event, but affect companies belonging to the same sector worldwide.

Cho *et al*. (2012) investigate the relationship between an organisation's environmental performance and its environmental reputation with respect to investor perceptions. Environmental reputation is regarded as others' perceptions of the organisation. The authors question whether environmental performance has an impact on these perceptions, i.e., whether environmental reputation reflects the actual environmental performance of a firm. In this respect, they also examine the effect that environmental disclosure may have on the relationship between environmental performance and reputation. Apart from the relationships between environmental performance, reputation and disclosure, they also analyse the impact of an organisation's membership in the Dow Jones Sustainability Index (DJSI), which, on the one hand, is regarded as being influenced by environmental disclosure and, on the other hand, as influencing environmental reputation.

In order to investigate the relations between those four factors, Cho *et al*. (2012) use path analysis for a sample of 92 US firms operating in environmentally sensitive industries. As a proxy for environmental reputation, they employ the scores published in the Newsweek 'greenest' companies ranking from 2009. As a measure for environmental performance, they use the "Environmental Impact Score" from the same ranking. They use the amount of disclosure published in recent annual reports and CSR reports as a proxy for environmental disclosure. They employ a dummy variable (which is 1 if the case that a firm is listed in the DJSI and 0 otherwise) to capture an organisation's membership in the DJSI, The authors note that the DJSI listing is regarded as a proxy for a company's CSR reputation.

Cho *et al*. (2012) find that the relation between environmental performance and reputation is negative, while environmental disclosure and reputation are positively related. Furthermore, the relation between membership in the DJSI and environmental reputation is positive. Environmental disclosure is also positively related to a DJSI listing. Environmental performance, however, is negatively related to a DJSI listing. The relation between environmental performance and disclosure is also negative.

The results imply that poor environmental performers have a better environmental reputation and are also more likely to be listed on the DJSI. This can be explained by the positive relation between environmental disclosure and reputation as well as membership in the DJSI, which implies that poor performers can increase their environmental reputation and ensure a DJSI listing through increased levels of environmental disclosures. These findings are in line with prior studies that find that companies that perform poorly increase their levels of environmental disclosures (see, e.g., Patten, 2002). On the basis their results, Cho *et al*. (2012, p. 10) conclude that "*voluntary environmental disclosure appears to be an effective tool for reputation risk management*". Furthermore, companies appear to be included in the DJSI on the basis of environmental disclosure, rather than based on their actual environmental performance. Thus, environmental disclosure and being listed in the DJSI may keep companies from trying to improve their environmental performance in the future.

It becomes obvious that investor perceptions about organisations may be influenced by several factors, such as corporate disclosures or company rankings. What is more, as investor perceptions may be subject to such factors, share prices may not necessarily reflect actual performance. This gives way for the present study to analyse whether favourable investor perceptions prior to the Fukushima disaster may have a mitigating impact of the resulting share price reaction.

As discussed above, organisational reputation comprises a multitude of quality assessments of different organisational aspects, such as financial performance, product quality or social and environmental performance. In the context of this study we focus on three aspects of organisational reputation, namely environmental reputation, CSR reputation and investment reputation. The first two are regarded as crucial factors in influencing utility companies' overall reputation, as many of them engage in environmentally sensitive operations, such as nuclear power generation, resulting in a higher awareness of environmental and CSR issues by stakeholders. Capturing the investment reputation of utility firms is crucial insofar, as the aim of a share price reaction study is to capture the assessment of future financial performances of firms by investors.

In order to measure environmental reputation, we adopt the proxy used by Cho *et al*. (2012). They investigate the relationship between an organisation's environmental performance and its environmental reputation. They employ the scores published in the Newsweek 'greenest' companies ranking as a measure of environmental reputation. As organisational reputation is the result of evaluative assessments, the use of such a ranking as proxies is an intuitively appealing approach. For the purpose of this event study environmental reputation is not measured in terms of the scores given in the ranking, but in terms of whether a utility company is listed in the ranking or not, as a listing is assumed to reflect positively on a company's environmental reputation. With respect to environmental reputation, we thus expect that companies listed in the Newsweek 'greenest' companies ranking will experience more positive abnormal returns. This leads to the following hypothesis:

> H_A^3: Cumulative abnormal returns are more positive for companies listed in the Newsweek 'greenest' companies ranking.

Another measure that Cho *et al*. (2012) use is the Dow Jones Sustainability Index (DJSI). The authors note that a "*[m]embership in the DJSI has been lauded as a signal of leadership in terms of corporate sustainability (Makipere & Yip, 2008) and has even been used as a proxy for CSR reputation*" (p. 3). Therefore, this study adopts the DJSI as a measure for CSR reputation. As is the case with environmental reputation above, CSR reputation is also seen as being favourable once a utility company is listed in the DJSI. Hence, we expect that membership in the DJSI will result in more positive abnormal returns for the respective utility companies and state this hypothesis as:

H_A^4: Cumulative abnormal returns were more positive for companies listed in the DJSI.

With respect to measuring investment reputation, we propose a proxy that has, to our knowledge, not been used before in this context, namely credit ratings. Fombrun (1995, p. 118) states that "*[r]ating agencies like Moody's Investor Services and Standard & Poor's help us to assess the merits of companies as investments*" and that "*ratings are judgements about a company's financial and business prospects*". He goes on to quote Harold Goldberg, chairman of the rating committee at Moody's: "*A rating indicates the degree of comfort we have in a company's ability to deliver expected levels of performance. … It's heavily influenced by three factors: the fundamentals of the business, how the company is managed financially, and the credibility of the company's management*" (Fombrun, 1995, p. 119). This highlights that credit ratings provide investors and interested parties with valuable information about a company's financial standing, financial strength and creditworthiness. Therefore, they constitute a good measure of organisational investment reputation. An advantage of using credit ratings is also that they provide companies' relative standing with respect to financial performance and as such provide a reputational ranking. For the purpose of this study, we expect that the higher a company's credit rating, the more positive its post-Fukushima abnormal returns. This leads to the following hypothesis:

H_A^5: Cumulative abnormal returns are more positive for companies with a higher investment reputation.

Similarly, we expect companies with lower credit ratings, to have suffered a more negative share price reaction and state this hypothesis as:

H_A^6: Cumulative abnormal returns are more negative for companies with a lower investment reputation.

Aside from reputational aspect, we also expect other factors to have an impact on the market reaction following the Fukushima disaster, namely the extent of utility companies' nuclear involvement and their location. Given that prior studies have found nuclear companies to suffer significantly more negative abnormal returns the higher their involvement in nuclear power generation operations (Bowen et al., 1983; Hill & Schneeweis, 1983; Fields &

Janjigian, 1989; Lopatta & Kaspereit, 2012), we expect the same to be valid for our sample. We state this hypothesis as:

> H_A^7: Cumulative abnormal returns are more negative for companies with a higher involvement in nuclear operations.

Geographical location is expected to have a significant impact on abnormal returns as well, as it is assumed to account for a number of factors. It captures, for example, the regulations with respect to nuclear power generation within different geographical contexts. Lopatta and Kaspereit (2012) find that regulation has a significant impact on the post-Fukushima share price reaction, as countries which committed themselves to phase out nuclear power generation suffered significantly more negative abnormal returns. Capturing the regulatory regimes by a location variable is thus essential. Also, including geographical location into the regression model accounts for the distance of countries to Japan, where the Fukushima disaster happened, but also to other regions where nuclear incidents have happened or are likely to happen. This may have an impact on investors' assessing the riskiness of nuclear utilities, as they may take into account the possibility and likelihood of such a disaster happening. This discussion results in the following hypothesis:

> H_A^8: Cumulative abnormal returns are different for companies headquartered in countries other than Japan.

4. METHODOLOGY

Following prior research on market reactions to environmental disasters, this study adopts an event study methodology to estimate abnormal returns following the Fukushima disaster for a sample of publicly listed utility companies worldwide. The calculated abnormal returns are subsequently analysed more closely by conducting a regression analysis. The main focus of this analysis is to examine whether favourable prior investor perceptions, with respect to organisational reputation and legitimacy, may have had a moderating effect on the post-Fukushima share price reaction.

4.1 The Fukushima disaster

The Fukushima disaster happened on 11 March 2011. It was caused by an earthquake at North Japan's coast at approximately 2:46 (JST), causing the Fukushima Daiichi nuclear power plant to shut down. The tsunami that resulted from the earthquake struck the plant about an hour later. This caused a failure in the cooling system on the same day and a series of fires and explosions in the ensuing days. What is more, radiation levels around the site and in bordering sea water rose above the norm, causing the evacuation or local residents in a radius of up to 30 kilometres. Soon after the incident news broke of a possible partial meltdown in the plant. This was later confirmed by the Japanese government, as well as by the operator of the Fukushima Daiichi nuclear power plant Tokyo Electric Power Company (TEPCO). A timeline of events can be found in Table 4.

Table 4: Timeline of events following the earthquake and tsunami on 10 March 2011

Date	***Events***
11 March 2011 t = 0	Earthquake in front of North Japan's coast at 2:46 pm (JST), Fukushima nuclear power plant shuts down. Tsunami approximately an hour afterwards, Fukushima nuclear power plant swept by tsunami. Failure of cooling system. Radiation levels 1,000 times normal. Japanese government declares state of emergency at a reactor of Fukushima nuclear power plant because of the possibility of radiation leak. Evacuation of 2,800 residents.
12March 2011	TEPCO reports failure of cooling system in a second reactor. Japanese government declares state of emergency at a second reactor of Fukushima nuclear power plant Comparison to Three Mile Island and Chernobyl incidents. Explosion at Fukushima. 20km evacuation radius.
13 March 2011	Attempt to cool down reactors in Fukushima 1 using seawater. Evacuation of over 200,000 residents.
14 March 2011 t = 1	Second explosion at Fukushima. Drop in water levels in all three reactors in Fukushima 1. Danger of meltdown.
15March 2011 t = 2	Third explosion at Fukushima. TEPCO admits to possibility of partial meltdown. Fire breaks out at Fukushima. Staff evacuated from plant; only 50-70 workers left. Evacuation radius extended to 30km.
16 March 2011 t = 3	Second fire breaks out at Fukushima.
17 March 2011 t = 4	Water cannons to cool down fuel rods.
20 March	Japanese government announces to permanently shut down the plant.
23 March 2011 t = 8	High radiation levels found in Tokyo's tap water. Black smokes over Fukushima.

25 March 2011 t = 10	Three workers injured after stepping into radioactive water on 24 March 2011.
29 March 2011 t = 12	Government confirms partial meltdown of fuel rods on 11 March 2011.
5 April 2011 t = 17	Discharge of radioactive water into the Pacific Ocean.
7 April 2011 t = 19	New earthquake of a magnitude of 7.1. Evacuation of workers from the plant.
12 April 2011 t = 22	TEPCO confirms partial meltdowns in reactor 1 on 11 March 2011. Nuclear incident classified as level 7 on the International Nuclear Event Scale (highest level; same as Chernobyl).
23 May 2011 t = 51	TEPCO confirms partial meltdowns in two more reactors on 11 March 2011.

4.2 Sample selection

4.2.1 Sample

The study focuses on electric utilities worldwide. In order to be included in the sample, companies must be listed on any stock market worldwide and daily share prices must be readily available. A search on Thomson Banker was conducted to identify sample companies. Sample companies are members of the ‘utilities’ sector (ICB code = 7000) and members of one of the following sub-sectors: ‘electric, gas, and sanitary services’, ‘electric services’, or ‘combination utility services’ (SIC codes 490, 491 and 493, respectively). This search yields a sample of 511 companies. Thomson One Banker was used to download daily share prices for those 511 firms in order to calculate daily returns. For 37 companies daily share prices were not continuously available. For this reason they were dropped from the sample. Another 13 companies had zero returns throughout the time period around the Fukushima disaster. These firms were also dropped. This yields a population of 461 publicly listed utility companies.

From the population further utilities are excluded when no information about whether they were engaging in nuclear power generation was found during the manual search on company websites and/or reports. This is typically the case when no website can be found, no English language website exists or when websites and/or reports do not contain any information about the company’s power generation capacities. In total, no information about nuclear involvement was found for 135 companies. Two more companies were identified to have had confounding events around the day of the Fukushima disaster which resulted in positive abnormal returns. Sky Harvest Windpower Corporation was found to have announced the issue of employee stock options on 10 March 2011[i]. Unit Energy Europe AG was undergoing insolvency proceedings and its shares were traded highly speculatively during the time of the disaster. Both companies are excluded which yields a total sample of 324 publicly listed utility companies.

4.2.2 Sub-samples

For the purpose of the study, the sample is divided into sub-samples. During the sample selection process, a manual search on companies' websites, 2010 annual reports and CSR reports (or the latest published reports at the time of the Fukushima disaster) was conducted in order to identify utility companies that operate nuclear power plants. The companies that are identified to be involved in nuclear power generation are assigned to the nuclear sample and their percentages of installed generating capacity of nuclear power generation are collected. Companies found to have no involvement in nuclear power generation are assigned to the non-nuclear sample. 59 companies are identified to be involved in nuclear operations, and 265 were identified as having no involvement at all. Another sub-sample for which the market reaction is investigated comprises nuclear companies, but excludes all Japanese utilities and all utilities with a nuclear generating capacity below 10 percent. Table 5 summarises the sample and sub-sample selection process.

Table 5: Sample and sub-sample selection

		N
Population		**461**
	Reasons for exclusion from sample	
	1) No information about nuclear involvement available was found - No website - No English language website - No information on website/in corporate reports	(135)
	2) Companies that had confounding events around 11 March 2011	(2)
Sample		**324**
Sub-samples		
	Non-nuclear sub-sample	265
	Nuclear sub-sample	59
	Nuclear sub-sample excluding Japanese companies and companies with a nuclear generating capacity < 10%	32

4.3 Event study methodology

The earthquake and resulting tsunami that caused the disaster at the Fukushima Daiichi nuclear power plant were unanticipated events. As a consequence, share price movements are expected to occur on the day of the accident and thereafter. Therefore, 11 March 2011 is designated to be the event day 0, as no news could have broken before that day. Abnormal returns will be tested for a shorter as well as a longer event window. The shorter event period ranges over 3 trading days between event day 0 and event day 2 (Tuesday, 15 March 2011) and the longer event period ranges over 26 trading days, between event day 0 and event day 25 (Friday, 15 March 2011). The shorter event window will test the short-term impact on utility share prices. The advantage of a short event window is that it "*enables us to attribute any abnormal return to the event of interest as it minimizes the potential for confounding events during the same window that may affect firm performance*" (Hillman *et al.*, 1999, p. 73). The longer event window will analyse the impact on share prices over a 5 week period spanning the event. The latter investigation may, however, be contaminated by confounding events relating to sample companies, countries and/or sub-sectors.

The event methodology adopted in the study uses the market model to estimate α and β parameters. To do so, an estimation period of 100 days prior to the disaster is chosen, comprising -110 to -11 trading days prior to the designated event day 0. On the basis of the share prices P_t collected over the estimation period, the ex-ante stock returns $R_{j,t}$ are calculated as:

(1) $$R_{j,t} = \frac{P_t - P_{t-1}}{P_{t-1}}.$$

Using the pre-event stock returns and the market model as the equilibrium model, the parameters $\alpha_{j,t}$ and $\beta_{j,t}$ are estimated for each sample company using an ordinary least square regression:

(2) $$R_{j,t} = \alpha_{j,t} + \beta_{j,t} R_{m_t},$$

where R_{m_t} represents the stock index on which the companies' shares are primarily listed. Having estimated the parameters $\alpha_{j,t}$ and $\beta_{j,t}$, the expected returns $E(R_{j,t})$ for the event period are then computed:

(3) $$E(R_{j,t}) = \alpha_{j,t} + \beta_{j,t} R_{m_t}.$$

$E(R_{j,t})$ represents the returns a specific stock would have generated in the event that the incident – in this particular case the Fukushima disaster – had not occurred. Abnormal returns for the event period are then calculated by:

(4) $$AR_{j,t} = R_{j,t} - E(R_{j,t}).$$

The average abnormal returns the market reaction are then calculated for each event day by:

(5) $$AAR_t = \frac{1}{n} \sum_1^n AR_{j,t}.$$

The AARs will be computed for the full sample, as well as for the nuclear and non-nuclear sub-samples. The nuclear sample is reduced for the purpose of calculating AARs over the event days, as companies with negligible involvements in nuclear operations (below 10 percent of the company's total installed energy generating capacity) are excluded from the sample. This approach follows prior event studies on nuclear accidents. Bowen *et al.* (1983), for example, only include companies of 10 percent installed nuclear capacity and higher in their nuclear sample. Fields and Janjigian (1989), on the other hand, only include nuclear companies with 20 percent installed capacity or more. This reduces the nuclear sub-sample to 42 utility companies.

Once the AARs are computed, the study goes on to test whether they are significantly different from zero. To do so, the study applies a t-statistic using the crude-dependence-adjustment suggested by Brown and Warner (1980):

(6) $$t - stat = \frac{AAR_t}{SD},$$

where the standard deviation is calculated over the estimation period:

(7) $$SD = \sqrt{\frac{1}{99}\left(\sum_{-109}^{-10}\left[\left(\frac{1}{N}\sum_{i=1}^{N} AR_{it}\right) - A^*\right]^2\right)},$$

where

(8) $$A^* = [\sum_{-109}^{-10} \sum_{i=1}^{N} AR_{it}] * \frac{1}{100N}.$$

This particular t-statistic suggested by Brown and Warner (1980) is used, as it accounts for event-day clustering as well as for industry clustering in the sample which may result in cross-sectional correlation (Edwards & Shevlin, 2011). This is problematic insofar as it would result in abnormal returns being correlated and thus not independent.

Following Lopatta and Kaspereit (2012), cumulating abnormal returns are tested for statistical significance as follows:

(9) $$t - stat = \frac{CAR_t}{\sqrt{L} * SD},$$

where L denotes the length of the time period over which abnormal returns are cumulated.

4.3.1 Thin trading

The existence of thinly-traded stocks in the sample has to be taken into consideration, as it results in econometric problems (Scholes and Williams, 1977). When estimating $\alpha_{j,t}$ and $\beta_{j,t}$ for infrequently traded stocks using the market model and an ordinary least squares regression, the parameters will be biased and inconsistent. That is because for single thinly traded stocks, variances may be overestimated and their returns may be leptokurticly distributed and serially correlated. As a result, thinly traded stocks "*have ordinary least squares estimators asymptotically biased upward for alphas and downward for betas*" (p. 310). Scholes and Williams (1977) develop a procedure to construct consistent estimates of $\alpha_{j,t}$ and $\beta_{j,t}$. The present study applies this approach. At first, adjusted β coefficients are computed as follows:

(10) $$\beta_n^{s-} = \frac{cov(R_{j,t}^s, R_{m,t-1}^s)}{var(R_{m,t-1}^s)},$$

(11) $$\beta_n^{s+} = \frac{cov(R_{j,t}^s, R_{m,t+1}^s)}{var(R_{m,t+1}^s)}.$$

Then, an autocorrelation coefficient is defined as:

(12) $$\rho_M^s = \frac{cov(R_{m_t}^s, R_{m,t-1}^s)}{std(R_{m,t}^s)std(R_{m,t-1}^s)}.$$

New α_n^s and β_n^s estimates are then calculated as:

(13) $$\alpha_n^s = \alpha_n + (\beta_n \ \beta_n^s)\mu_M,$$

(14) $$\beta_n^s = \beta_n - (\beta_n^{s-} + \beta_n^{s+} - 2\beta_n\rho_M^s),$$

where β_n and α_n represent the parameters obtained from the previous OLS regression, and μ_M represents the mean market returns for the particular indices. α_n^s and β_n^s are then used to obtain the new Scholes-Williams adjusted expected return and consequently, abnormal returns.

4.4 Reputation measures

4.4.1 Environmental reputation

Following Cho et al. (2012), environmental reputation is measured using the Newsweek green rankings. The Newsweek green rankings are prepared by MSCI ESG Research, Trucost, CorporateRegister.com and ASAP Media. The overall aim of the rankings is "*to assess each company's actual environmental footprint and management of that footprint (including policies and strategies), along with its reputation among environmental experts*" (The Daily Beast, 2010). The overall assessment is captured with the green score. The score is composed of an environmental impact score, a green policies score and a reputation survey score. The environmental impact score evaluates the impacts of companies' operations on the environment and corporate environmental disclosure related to the impacts. The green policies score evaluates how companies manage their environmental impacts by means of policies, strategies, disclosure and initiatives. The reputation survey score is established conducting a survey with CSR specialists including CSR professionals and academics as well as CEOs of companies assessed by the index.

The ranking assesses the environmental performance of companies on a US and a global scale. Both rankings consider the largest publicly listed companies only. In the 2010 Newsweek green rankings, the US ranking lists the 500 biggest US companies from 15 industries, while the global ranking lists the 100 biggest global companies from 13 industries. For the purpose of the study, a company is regarded to have had a favourable environmental reputation prior to the disaster, if it was listed in one of the 2010 rankings (either US or global). It is assumed that being a member in this ranking has a positive impact on investor perceptions when evaluating companies' environmental performance. Out of 600 publicly listed companies listed in the 2010 US and global Newsweek green rankings, 44 are included in our sample and regarded as having a favourable environmental reputation.

4.4.2 CSR reputation

CSR reputation is measured using the Dow Jones Sustainability Index (DJSI). As the name suggests, the index is concerned with corporate sustainability. The concept of corporate sustainability is understood as "*an approach to creating long-term shareholder value by embracing opportunities and managing risks deriving from economic, environmental and social trends and challenges*" (SAM Sustainable Asset Management AG, 2012). The index is compiled by the Swiss-based SAM Sustainable Asset Management AG and assesses the corporate sustainability of the largest companies listed in the Dow Jones Global Total Stock Market Index. SAM focuses in particular on how companies adapt to continuously changing industry environments which respect to economic, environmental and social challenges and opportunities. The better a company can adapt to its changing environment, the more sustainable it is, resulting in better shareholder value. The DJSI is established through SAM's Corporate Sustainability Assessment (CSA). The assessment computes a total sustainability score for each company within its industry group by means of questionnaires. The questionnaires contain questions covering economic, environmental and social. Answers given in the questionnaires are checked against corporate documents and other information given by stakeholders and the media. Once the total sustainability score for a company is computed, it is ranked against its industry group and only the highest scorers are included in the index.

The DJSI comprises 19 supersectors, one of which is utilities. The supersector includes the sectors electricity, gas distribution and water. For the purpose of the study, a company is regarded to have had a favourable CSR reputation prior to the disaster, if it was listed in the 2010 DJSI. As mentioned earlier, being listed in the DJSI is said to be perceived as "*a signal of leadership in terms of corporate sustainability*" and as such a good measure for CSR reputation (Cho et al., 2012, p. 16). The 2010 DJSI comprises 323 companies across the 19 supersectors. The utility supersector included 20 utilities, 15 of which are included in our sample. These are headquartered in Australia, Finland, Germany, Italy, Portugal, Spain and the US. It is worth noting here that 9 sample companies are included in both the Newsweek greenest company ranking and the DJSI.

4.4.3 Investment reputation

In terms of investment reputation, this study is the first, to our knowledge, to include a measure using credit ratings. Credit ratings are a good indication of a company's financial viability and creditworthiness. A manual search on Moody's and Standard & Poor's websites was conducted to collect credit rating for all sample companies. Standard & Poor's provide corporate credit ratings for 19 industry sectors and 4 utility sectors. The latter are classified into electric, gas, multi and water utilities and comprise 578, 220, 124 and 50 companies, respectively. Moody's provides credit ratings for 92,188 companies in 22 industry sectors. The utility sector comprises 2,877 companies.

Out of the 324 sample companies, 95 companies had obtained a credit rating from both Moody's and Standard and Poor's. 16 companies had obtained a credit rating from Moody's only and 35 from Standard and Poor's only. This results in a total of 146 sample companies with a credit rating and 178 companies without a rating. Where companies had obtained a rating from both agencies, the average of both was taken with respect to a 20-point numerical scale. Rating agencies employ different symbols when rating companies or countries, but "*any agency's symbol has its counterpart in the other agencies' rating scales*", enabling the transformation of any scale into a 20-point numerical scale (Al-Sakka & Ap Gwilym, 2009, p. 156). Out study adopts this scale to measure investment reputation (Table 6).

Investment reputation was classed into high, medium or low. A high investment reputation was given to companies rated as 14 or higher with respect to the numerical scale. A medium investment reputation was assigned to companies whose credit rating range between 5 and 13. A low investment reputation was given to corporate credit rating below 5. More than the majority of sample companies, however, were not rated by either of the credit rating agencies. The group of unrated sample companies functions as the base case in the regression analysis to avoid multicollinearity.

Table 7: Investment reputation measured using Moody's and Standard & Poor's credit ratings

Investment reputation	*Numerical scale*	*N*	*Moody's*	*N*	*Standard & Poor's*	*N*
	20	-	Aaa	-	AAA	-
	19	-	Aa1	-	AA+	-
	18	5	Aa2	9	AA	-
High	17	7	Aa3	1	AA-	8
	16	4	A1	5	A+	3
	15	9	A2	9	A	7
	14	14	A3	10	A-	23
	13	26	Baa1	17	BBB+	19
	12	23	Baa2	19	BBB	27
	11	29	Baa3	22	BBB-	21
	10	10	Ba1	6	BB+	5
Medium	9	7	Ba2	5	BB	7
	8	6	Ba3	3	BB-	4
	7	1	B1	1	B+	1
	6	1	B2	3	B	1
	5	2	B3	1	B-	1
	4	1	Caa1	-	CCC+	1
Low	3	1	Caa2	-	CCC	2
	2	-	Caa3	-	CCC-	-
	1	-	Ca-C	-	CC/R/SD/S	-
Ratings		146		111		130
No ratings		178		213		194
Total		**324**		**324**		**324**

4.5. Nuclear involvement

Apart from reputation variables, the regression also includes a variable for sample companies' involvement in nuclear power generation to test whether nuclear companies were experiencing a more negative market reaction than non-nuclear companies. This is crucial, as prior event studies have found that nuclear companies suffer significantly more negative abnormal returns following a nuclear accident than non-nuclear utility companies (see, e.g., Lopatta & Kaspereit, 2012). Two variables are used to test this. The nuclear dummy variable (NuclY/N) takes on the value of 1 for companies engaging in nuclear energy generating and 0 otherwise. The other nuclear variable (Nucl%) ranges between 1 and 0, denoting the percentage of a company's nuclear involvement. This measure was obtained by a manual search on corporate websites and in corporate reports to establish the nuclear and non-nuclear sub-samples.

4.6. Control variable

4.6.1 Firm size

In addition, control variables are included for companies' size and geographical location. Company size is computed by the log of market capitalisation which was obtained from Thomson One Banker for the day of the Fukushima disaster (11 March 2011). Table 8 lists the descriptive statistics of continuous variables.

Table 8: Descriptive statistics of continuous control variables

N=324	***Smallest***	***Largest***	***Mean***	***Median***
Size	-1.22	4.89	3.06	3.26
Nucl%	0%	95.9%	3.6%	0%

4.6.2 Geographical location

With respect to geographical location, the study adopts the country classification adopted by Thomson One Banker. Sample countries were grouped into seven locations, due to the high number of countries in the sample (45). When including the location variables in the regression, Japan is used as the base case to avoid multicollinearity. Table 9 summarises all variables included in the regression analysis.

Table 9: Independent variables and control variables

	Variable	*Measured by*	*Data source*	*Type*	*Range*	*N=324*
(1)	Environmental reputation (EnvR)	Company's membership	Newsweek Green Ranking	Dummy	1 if listed 0 otherwise	44 280
(2)	Corporate Social Responsibility reputation (CSRR)	Company's membership in	Dow Jones Sustainability Index	Dummy	1 if listed 0 otherwise	15 309
(3)	Investment reputation (InvRH; InvRM; InvRL)	Company's credit rating translated into 20-point scale	Moody's; Standard & Poor's	Dummy	High (20-14) Medium (13-5) Low for (4-1) No rating	39 105 2 178
(4a)	Nuclear involvement (NuclY/N)	Whether a company is engaged in nuclear energy generation	Company's corporate report(s) and/or website	Dummy	1 if yes 0 otherwise	59 265
(4b)	Nuclear involvement (Nucl%)	Percentage of installed capacity for nuclear energy generation	Company's corporate report(s) and/or website	Continuous	[0.8% - 95.9%] 0%	59 265
(5)	Firm size (Size)	Log of market capitalisation in $ as of 11 March 2011 (event day 0)	Thomson ONE Banker	Continuous	-	324
(6)	Geographical location (WE; EE; NA; SA; AP; J; AMECA)	Country classification	Thomson ONE Banker	Dummy	Western Europe Eastern Europe North America South America Asia-Pacific Japan Africa/Middle East/Central Asia	75 42 96 30 64 11 6

5. RESULTS

5.1 Share price reaction

Abnormal returns were computed for the full sample (N=324), the non-nuclear sample (N=265) and the nuclear sub-sample (N=59), as well as for the nuclear sub-sample that excludes all Japanese utilities and all utilities with a nuclear generating capacity below 10 percent (N= 32). The results of the share price reaction study can be found in Tables 10, 11 and 12 below.

The results show significantly abnormal AARs and CARs for utility companies worldwide on event days 0 and 2. The full sample was also found to have experienced significantly positive AARs on event day 7. Further significantly negative AARs were experiences on event days 12 and 19.

Table 10: AARs and CARs for sample companies (n=324)

Day	***AAR_t***	***t-stat***	***CAR_t***	***t-stat***
0	*-0.0037	-2.2176	*-0.0037	-2.2176
1	0.0013	0.7661	-0.0024	-1.0264
2	*-0.0040	-2.4083	*-0.0065	-2.2285
3	0.0017	1.0256	-0.0048	-1.4172
4	-0.0002	-0.1153	-0.0050	-1.3191
5	0.0024	1.4200	-0.0026	-0.6245
6	0.0004	0.2428	-0.0022	-0.4864
7	**0.0050	2.9667	0.0017	0.3615
8	-0.0015	-0.8798	-0.0009	-0.1795
9	-0.0008	-0.4921	-0.0011	-0.2130
10	0.0005	0.2788	0.0030	0.5310
11	0.0016	0.9800	0.0036	0.6119
12	*-0.0029	-1.7232	0.0022	0.3607
13	0.0016	0.9661	0.0019	0.3060
14	0.0014	0.8622	0.0023	0.3499
15	0.0020	1.2038	0.0064	0.9474
16	0.0001	0.0559	0.0058	0.8385
17	0.0007	0.4040	0.0069	0.9694
18	-0.0003	-0.1528	0.0064	0.8722
19	*-0.0032	-1.9062	0.0049	0.6579
20	0.0027	1.6012	0.0069	0.8948
21	0.0013	0.7865	0.0070	0.8862
22	-0.0027	-1.6014	0.0062	0.7650
23	0.0014	0.8484	0.0070	0.8463
24	0.0003	0.1783	0.0071	0.8488
25	0.0004	0.2369	0.0081	0.9448

* significant at 5% level; ** significant at 1% level; *** significant al 0.1% level.

Comparing AARs for the non-nuclear and nuclear sub-samples (Table 11), we find that non-nuclear utility companies suffered significantly negative AARs on the day of the Fukushima disaster, while the nuclear sub-samples experienced positive, but insignificant AARs on the same day. This reverses on event day 1, when non-nuclear companies experienced significantly positive AARs, while nuclear companies suffered significantly negative AARs over event days 1 and 2. Thereafter, the results vary greatly between significantly abnormal positive and negative AARs for all three sub-samples.

Table 11: AARs for nuclear and non-nuclear sub-samples

	Non-nuclear (n=265)		**Nuclear (n=59)**		**Nuclear (excl. Japanese firms and Nucl% < 10%) (n=32)**	
Day	***AAR_t***	***t-stat***	***AAR_t***	***t-stat***	***AAR_t***	***t-stat***
0	**-0.0046	-2.4298	0.0004	0.1420	0.0011	0.3793
1	*0.0043	2.2667	***-0.0124	-4.5156	***-0.0138	-4.5863
2	-0.0002	-0.0853	***-0.0215	-7.8359	***-0.0098	-3.2557
3	0.0020	1.0577	0.0004	0.1409	-0.0008	-0.2732
4	-0.0006	-0.3054	0.0016	0.5680	-0.0046	-1.5205
5	0.0023	1.2189	0.0026	0.9634	-0.0005	-0.1612
6	-0.0005	-0.2723	*0.0046	1.6690	*0.0052	1.7365
7	**0.0047	2.4768	*0.0061	2.2313	0.0036	1.2051
8	-0.0013	-0.6951	-0.0022	-0.7853	-0.0029	-0.9688
9	0.0000	0.0060	*-0.0046	-1.6742	0.0004	0.1245
10	0.0009	0.4704	-0.0015	-0.5338	-0.0005	-0.1720
11	0.0031	1.5952	*-0.0046	-1.6943	-0.0019	-0.6388
12	-0.0030	-1.5578	-0.0025	-0.9231	0.0033	1.1108
13	0.0018	0.9187	0.0010	0.3757	**0.0078	2.6074
14	0.0025	1.3036	-0.0032	-1.1783	-0.0004	-0.1173
15	0.0030	1.5487	-0.0022	-0.7960	0.0014	0.4684
16	0.0002	0.1012	-0.0004	-0.1286	0.0017	0.5813
17	0.0021	1.1080	*-0.0058	-2.1078	-0.0024	-0.7905
18	-0.0002	-0.1009	-0.0005	-0.1984	0.0018	0.6156
19	**-0.0045	-2.3581	0.0026	0.9653	*-0.0045	-1.4838
20	0.0022	1.1534	*0.0049	1.7783	0.0012	0.4117
21	0.0009	0.4601	0.0033	1.2063	*-0.0039	-1.2948
22	-0.0031	-1.6317	-0.0008	-0.2823	0.0016	0.5467
23	0.0016	0.8121	0.0009	0.3132	*0.0047	1.5669
24	-0.0001	-0.0516	0.0021	0.7614	*0.0039	1.3108
25	-0.0001	-0.0491	0.0026	0.9509	*0.0048	1.5941

* significant at 5% level; ** significant at 1% level; *** significant al 0.1% level.

Comparing CARs for the non-nuclear and nuclear sub-samples (Table 12), paints a more revealing picture. Following the significantly negative AAR on event day 1, the non-nuclear sub-sample experiences only significantly positive CARs between event days 15 and 18 and on event day 21. Following the positive but insignificant AARs on event day 0, nuclear companies suffered significantly negative CARs throughout event days 1 and 25. The nuclear sub-sample that excludes Japanese companies and companies with a nuclear generating capacity below 10 percent, also experiences significantly negative CARs between event days 1 and 12. This evidences that the Fukushima disaster resulted in significantly negative market reactions for nuclear companies worldwide. The results also show that this negative reaction lasted longer for Japanese nuclear companies, suggesting that non-Japanese nuclear companies' share prices may have recovered soon.

Table 12: CARs for nuclear and non-nuclear sub-samples

	Non-nuclear (n=265)		**Nuclear (n=59)**		**Nuclear (excl. Japanese firms and Nucl% < 10%) (n=32)**	
Day	***CAR_t***	***t-stat***	***CAR_t***	***t-stat***	***CAR_t***	***t-stat***
0	**-0.0046	-2.4298	0.0004	0.1420	0.0011	0.3793
1	-0.0003	-0.1153	***-0.0120	-3.0926	**-0.0126	-2.9748
2	-0.0005	-0.1434	***-0.0335	-7.0492	***-0.0224	-4.3086
3	0.0015	0.4046	***-0.0331	-6.0343	***-0.0232	-3.8679
4	0.0010	0.2253	***-0.0316	-5.1432	***-0.0278	-4.1396
5	0.0033	0.7033	***-0.0289	-4.3018	***-0.0283	-3.8447
6	0.0028	0.5482	***-0.0243	-3.3519	**-0.0230	-2.9032
7	0.0075	1.3885	**-0.0182	-2.3465	*-0.0194	-2.2897
8	0.0062	1.0774	**-0.0204	-2.4741	**-0.0223	-2.4816
9	0.0062	1.0240	**-0.0250	-2.8765	*-0.0220	-2.3149
10	0.0071	1.1181	**-0.0264	-2.9036	*-0.0225	-2.2590
11	0.0101	1.5310	***-0.0311	-3.2691	**-0.0244	-2.3473
12	0.0072	1.0389	***-0.0336	-3.3969	*-0.0211	-1.9471
13	0.0089	1.2467	***-0.0326	-3.1729	-0.0132	-1.1794
14	0.0114	1.5410	***-0.0358	-3.3696	-0.0136	-1.1697
15	*0.0144	1.8792	***-0.0380	-3.4616	-0.0122	-1.0155
16	*0.0146	1.8477	***-0.0384	-3.3894	-0.0104	-0.8442
17	*0.0167	2.0568	***-0.0441	-3.7907	-0.0128	-1.0067
18	*0.0165	1.9788	***-0.0447	-3.7351	-0.0110	-0.8386
19	0.0120	1.4014	***-0.0420	-3.4247	-0.0154	-1.1492
20	0.0142	1.6193	**-0.0372	-2.9541	-0.0142	-1.0317
21	*0.0151	1.6802	**-0.0338	-2.6290	-0.0181	-1.2840
22	0.0119	1.3030	**-0.0346	-2.6301	-0.0164	-1.1418
23	0.0135	1.4413	**-0.0338	-2.5108	-0.0117	-0.7979
24	0.0134	1.4019	*-0.0317	-2.3078	-0.0078	-0.5196
25	0.0133	1.3650	*-0.0291	-2.0765	-0.0030	-0.1969

* significant at 5% level; ** significant at 1% level; *** significant al 0.1% level.

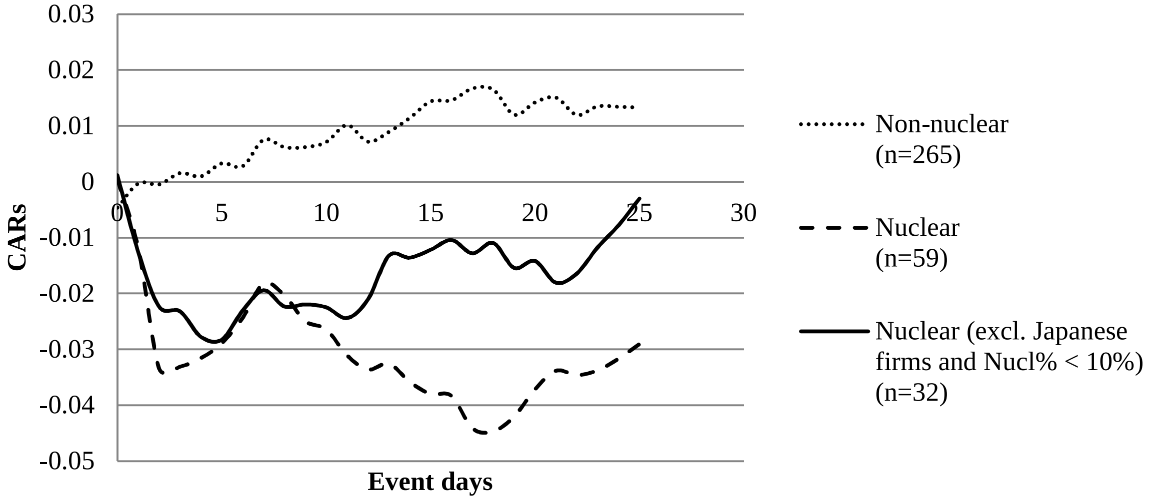
Looking at the CARs in Figure 1, illustrates our findings. We can see that non-nuclear companies, after an initial negative share price reaction on event day 0, experience positive

CARs throughout. Looking at the full sample, we find that utility companies worldwide suffered an initial negative market reaction, but that reversed on event day 14. As expected, nuclear utility companies suffered a strong negative market reaction following the Fukushima disaster. The sample that excludes Japanese nuclear companies and companies with a minor stake in nuclear power generation appears to recover from this negative market reaction on event day 25. The nuclear sample that includes Japanese nuclear companies suffers a far stronger, negative market reaction far beyond event day 25. With respect to our first hypothesis, our results show that the Fukushima disaster had a significantly negative impact on utility share prices worldwide on event days 0 and 2. We thus reject our first null hypothesis (H_A^1). Our results also support our second hypothesis (H_A^2), as we find that the market reaction was significantly more negative for nuclear utility companies than for non-nuclear utility companies. Our results are thus consistent with prior studies that found utility companies in general and nuclear companies in particular appear to suffer significantly negative market reaction following the Fukushima disaster (Betzer *et al*. 2011; Lopatta & Kaspereit, 2011; Ferstl *et al*., 2012).

Our results concerning non-nuclear companies experiencing a positive share price reaction are also consistent with findings of Betzer *et al*. (2011) and Ferstl *et al*. (2012). They found that utility companies that are engaged in alternative (or 'green') forms of energy production actually gained from the Fukushima disaster, as they increased their market share. Betzer *et al*. (2011) find that alternative energy companies in Germany and Europe in general gained a considerable stake in the utility market, while conventional and nuclear utility companies lost their market share. Ferstl *et al*. (2012) find the same results when comparing nuclear and alternative energy companies in the French, German and Japanese context over the short run.

Looking at CARs for our worldwide full, nuclear and non-nuclear samples, the results suggest that the market value of nuclear companies worldwide decreased, while non-nuclear companies gained from the Fukushima disaster. This suggests that investors pulled out their funds from nuclear investments and redistributed them to what they perceived to be safer and less risky investments in alternative energy companies.

Figure 1: CARs [0:25]



5.2 Regression analysis

Table 13 displays the correlation coefficients of independent variables used in the regression analysis. The matrix shows a relatively high correlation between company size and the nuclear dummy and the nuclear percentage variables. This indicates that larger companies tend to be engaged in nuclear operations and that the larger the company, the higher the involvement in nuclear operations. Furthermore, environmental reputation is relatively highly correlated to company size and the nuclear dummy variable, which indicates that larger, nuclear companies tend to be listed in the Newsweek 'greenest' companies ranking.

With the highest correlation being 0.6839, none of the correlation coefficients exceeds 0.7, which is far below the cut-off point of 0.9 mentioned by Terziovski et al. (2003). Therefore, multicollinearity between explanatory variables is unlikely and novariables were excluded from the regression models.

Table 13: Correlation matrix

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
(1) Size	1													
(2) Nucl Y/N	**0.5772**	1												
(3) Nucl %	**0.5024**	**0.6839**	1											
(4) InvRepH	0.4691	0.3493	0.2658	1										
(5) InvRepA	0.142	0.2014	0.1328	-0.2544	1									
(6) InvRep	-0.0082	-0.0264	-0.0181	-0.0204	-0.0388	1								
(7) EnvRep	**0.604**	**0.6062**	0.4319	0.1908	0.3212	-0.0222	1							
(8) CSRRep	0.4845	0.3524	0.267	0.2389	0.0977	-0.0123	0.2982	1						
(9) WE	0.1302	-0.0141	0.0116	0.0945	-0.2423	0.1013	-0.0267	0.192	1					
(10) EE	-0.1011	-0.1358	-0.1014	-0.1131	-0.2104	-0.0216	-0.1272	-0.0856	-0.2134	1				
(11) NA	0.0048	0.2079	0.1653	-0.0655	0.5151	-0.0358	0.3213	0.0201	-0.3538	-0.2487	1			
(12) SA	-0.0505	-0.0966	-0.0937	-0.1172	0.1645	-0.0179	-0.0964	-0.0709	-0.1766	-0.1241	-0.2058	1		
(13) AP	-0.0782	-0.1554	-0.1372	-0.0616	-0.1804	-0.0278	-0.1528	-0.0732	-0.2744	-0.1929	-0.3198	-0.1596	1	
(14) AMECA	-0.0316	-0.0653	-0.0446	0.0208	-0.0959	-0.0077	-0.0548	-0.0305	-0.0759	-0.0534	-0.0885	-0.0442	-0.0686	1

In order to explain abnormal returns, we conducted separate regressions for the nuclear dummy variable and the nuclear percentage variable. Table 14 shows the regression results using the nuclear dummy variable over event days 0 to 2. We find that the constants in this Models 1 and 2 are not significantly different from zero, which shows that utility companies worldwide experienced, on average, no significant abnormal returns over the shorter event period. In Model 3, however, we find that Japanese utility companies suffered, on average, significantly negative abnormal returns as observed by the significantly negative constant. In comparison, Western European, South American and Asian-Pacific utilities companies, as well as Eastern European and South American nuclear companies experience significantly more positive abnormal returns as evidenced by significantly positive location coefficients. The results also show that company size has a significantly negative effect on abnormal returns across all models. Larger utility companies thus suffered significantly more negative abnormal returns following the Fukushima disaster. This is also true for nuclear companies, who experienced significantly more negative abnormal returns over the short term across all models. With respect to investor reputation, however, the results in Model 3 show that nuclear companies with a high and medium credit rating experienced significantly more positive abnormal returns than nuclear companies with no credit rating. This suggests that a favourable investment reputation prior to the Fukushima disaster did have a moderating effect on the resulting share price reaction. Concerning environmental reputation, we find some evidence that nuclear companies that are listed in the Newsweek ‘greenest’ companies ranking experienced significantly more positive abnormal returns over the short term as evidenced by a significantly positive coefficients in Model 2. This, however, does not hold for Model 3.

Table 14: Regression results over days [0;2] using nuclear dummy variable

	Model 1 (N=324)		Model 2 (N=324)		Model 3 (N=324)	
CAR [0;2]	***Coef***	***SE***	***Coef***	***SE***	***Coef***	***SE***
NuclY/N	*-0.0173	0.0110	***-0.0676	0.0242	**-0.1256	0.0545
EnvR			-0.0032	0.0213	-0.0021	0.0200
CSRR			0.0058	0.0369	-0.0001	0.0340
InvRH			0.0040	0.0159	0.0121	0.0159
InvRM			-0.0048	0.0092	-0.0006	0.0099
InvRL			0.0047	0.0442	-0.0157	0.0410
NuclxEnvR			*0.0392	0.0281	0.0236	0.0264
NuclxCSRR			0.0166	0.0423	-0.0133	0.0412
NuclxInvRH			0.0254	0.0329	***0.0965	0.0355
NuclxInvRM			*0.0450	0.0299	**0.0956	0.0443
WE					***0.1106	0.0434
EE					0.0489	0.0442
NA					0.0698	0.0433
SA					**0.0890	0.0445
AP					*0.0722	0.0436
AMECA					0.0646	0.0484
NuclxWE					0.0365	0.0526
NuclxEE					**0.1062	0.0644
NuclxNA					0.0319	0.0571
NuclxSA					*0.1112	0.0698
NuclxAP					0.0664	0.0564
Size	***-1.12E-06	4.52e-07	***-1.66E-06	6.15e-07	***-2.20E-06	6.08e-07
Constant	0.0025	0.0040	0.0050	0.0048	**-0.0732	0.0433
Adjusted R^2		0.0517		0.0593		.02094

*,**,*** denote statistically significant at 10%, 5% and 1% level , respectively.

The regression results using the nuclear dummy variable over the 26-day period are displayed in Table 15. We find that utility companies worldwide experience, on average, significantly positive abnormal returns following the Fukushima disaster as evidences by significantly positive constants in Models 1 and 2. This result, however, does not hold in Model 3. Furthermore, over the longer window, CARs of utility companies worldwide are not significantly different from Japanese utility companies. Company size is again found to have a significantly negative effect on abnormal returns across all models over the longer event period. The results thus show that larger companies suffered significantly more negative abnormal returns over both the shorter and the longer event period. Nuclear companies, however, only experience significantly more negative abnormal returns than non-nuclear companies over the shorter window. With respect to investment reputation, utility companies with a medium credit rating were found to have experienced significantly more positive abnormal returns over the longer term. Environmental reputation, on the other hand, did not appear to have any significant effect over the long term.

Table 15: Regression results over days [0;25] using nuclear dummy variable

	Model 1 (N=324)		Model 2 (N=324)		Model 3 (N=324)	
CAR [0;25]	***Coef***	***SE***	***Coef***	***SE***	***Coef***	***SE***
NuclY/N	-0.0179	0.0277	-0.0351	0.0608	-0.1070	0.1452
EnvR			0.0218	0.0535	0.0455	0.0533
CSRR			0.0230	0.0927	0.0061	0.0905
InvRH			0.0113	0.0400	0.0443	0.0422
InvRM			0.0116	0.0230	**0.0457	0.0265
InvRL			0.0009	0.1113	-0.0080	0.1092
NuclxEnvR			0.0794	0.0707	0.0549	0.0703
NuclxCSRR			0.0492	0.1064	0.0059	0.1096
NuclxInvRH			-0.0898	0.0828	-0.0297	0.0946
NuclxInvRM			-0.0263	0.0752	-0.0365	0.1179
WE					0.1580	0.1156
EE					0.0904	0.1176
NA					0.0676	0.1152
SA					0.1128	0.1184
AP					0.1504	0.1160
AMECA					0.0680	0.1289
NuclxWE					0.1234	0.1400
NuclxEE					0.1676	0.1714
NuclxNA					0.1311	0.1521
NuclxSA					0.0499	0.1859
NuclxAP					0.1379	0.1502
Size	*-1.74E-06	1.14E-06	**-2.81E-06	1.55E-06	***-4.72E-06	1.62E-06
Constant	**0.0179	0.0101	*0.0156	0.0121	-0.1069	0.1152
Adjusted R^2		0.0118		0.0198		0.0773

*,**,*** denote statistically significant at 10%, 5% and 1% level , respectively.

We conducted the same regression using the nuclear percentage variable, instead of the nuclear dummy variable, to test whether being classed as a nuclear utility company *per se* or whether the extent of a company's engagement in nuclear operations had an effect on utility companies' share prices following the Fukushima disaster. Table 16 below shows the results for the shorter event window. Consistent with the results using the nuclear dummy variable, utility companies worldwide experience, on average, no significant abnormal returns. Japanese utilities suffered significantly negative abnormal returns, as shown in Model 3. Utilities in all other locations experiences significantly more positive abnormal returns, as did Western European and North American nuclear companies. Market capitalisation is again found to have a significantly negative effect on abnormal returns across all models over the shorter period. Nuclear involvement, however, does not appear to have a significant impact on abnormal returns. Considering our results from the regression using the nuclear dummy variable, we observe that being classed as a nuclear company does have a negative effect on the post-Fukushima share prices, but not the extent of operations attributable to nuclear power generation. Consistent to our results from the regression using the nuclear dummy variable, nuclear companies with a high and medium credit rating, i.e., those with a favourable investment reputation, experienced significantly more positive abnormal returns as shown in Model 3. In contrast to the results from the regression using the nuclear dummy variable, nuclear companies that are listed in the Newsweek ‘greenest’ companies ranking, i.e., those with a favourable environmental reputation, did not experience significantly more positive abnormal returns.

Table 16: Regression results over days [0;2] using nuclear percentage variable

	Model 1 (N=324)		**Model 2 (N=324)**		**Model 3 (N=324)**	
CAR [0;2]	***Coef***	***SE***	***Coef***	***SE***	***Coef***	***SE***
Nucl%	-0.0417	0.0356	-0.0449	0.0416	-0.0019	0.0405
EnvR			-0.0034	0.0215	-0.0036	0.0202
CSRR			0.0056	0.0372	-0.0034	0.0343
InvRH			0.0062	0.0160	0.0225	0.0154
InvRM			-0.0026	0.0092	0.0011	0.0100
InvRL			0.0071	0.0447	-0.0148	0.0414
NuclxEnvR			0.0345	0.0283	0.0286	0.0265
NuclxCSRR			0.0178	0.0427	-0.0045	0.0414
NuclxInvRH			-0.0314	0.0248	**0.0505	0.0297
NuclxInvRM			-0.0107	0.0210	*0.0612	0.0422
WE					***0.1885	0.0281
EE					***0.1276	0.0288
NA					***0.1467	0.0283
SA					***0.1668	0.0297
AP					***0.1502	0.0282
AMECA					***0.1416	0.0357
NuclxWE					**-0.0626	0.0311
NuclxEE					-0.0026	0.0443
NuclxNA					*-0.0617	0.0420
NuclxSA					-0.0151	0.0436
NuclxAP					-0.0337	0.0364
Size	***-1.28E-06	4.28E-07	***-1.62E-06	6.32E-07	***-2.23E-06	6.25E-07
Constant	0.0017	0.0040	0.0026	0.0048	***-0.1520	0.0273
Adjusted R^2		0.0485		0.0392		0.1955

*,**,*** denote statistically significant at 10%, 5% and 1% level , respectively.

Conducting the regression analysis using the nuclear percentage variable over the 26-day window (see Table 17), we find that utilities companies worldwide experiences, on average, positive abnormal return over the longer event window, as evidenced by a significantly positive constant in Model 1. This, however, does not hold for Model 2. Model 3 shows that Japanese utilities experience significantly negative abnormal returns over the longer event period, whereas utilities in all other locations experienced significantly more positive abnormal returns. Company size is again found to have a significantly negative impact on abnormal returns across all models over the longer event period. With respect to investment reputation, nuclear companies with a medium credit rating are found to experience significantly more positive abnormal returns as evidenced by the significantly positive medium investment reputation coefficient in Model 2. In addition, Model 3 shows that nuclear as well as non-nuclear companies with a medium credit rating are found to experience significantly more positive abnormal returns. This is consistent with our results over the longer event window using the nuclear dummy variable.

Table 17: Regression results over days [0;25] using nuclear percentage variable

	Model 1 (N=324)		Model 2 (N=324)		Model 3 (N=324)	
CAR [0;25]	***Coef***	***SE***	***Coef***	***SE***	***Coef***	***SE***
Nucl%	-0.0915	0.0893	-0.0850	0.1035	-0.0460	0.1070
EnvR			0.0205	0.0535	0.0433	0.0533
CSRR			0.0219	0.0927	0.0029	0.0905
InvRH			0.0114	0.0399	0.0517	0.0406
InvRM			0.0119	0.0229	**0.0465	0.0264
InvRL			0.0016	0.1112	-0.0074	0.1092
NuclxEnvR			0.0771	0.0705	0.0592	0.0701
NuclxCSRR			0.0496	0.1063	0.0133	0.1092
NuclxInvRH			**-0.1090	0.0617	-0.0680	0.0783
NuclxInvRM			-0.0435	0.0521	-0.0699	0.1115
WE					***0.2173	0.0742
EE					**0.1502	0.0762
NA					**0.1265	0.0747
SA					**0.1720	0.0786
AP					***0.2097	0.0745
AMECA					*0.1265	0.0944
NuclxWE					0.0467	0.0822
NuclxEE					0.0803	0.1169
NuclxNA					0.0643	0.1108
NuclxSA					-0.0551	0.1152
NuclxAP					0.0563	0.0960
Size	*-1.61E-06	1.07E-06	**-2.61E-06	1.57E-06	***-4.61E-06	1.65E-06
Constant	**0.0173	0.0100	0.0145	0.0119	***-0.1671	0.0721
Adjusted R^2		0.0137		0.0209		0.0762

*,**,*** denote statistically significant at 10%, 5% and 1% level , respectively.

5.2.1 Environmental reputation

Our results using the nuclear dummy variable show that nuclear companies that had a favourable environmental reputation prior to the Fukushima disaster, in terms of being listed in the Newsweek 'greenest' companies ranking, experienced significantly more positive abnormal returns over the shorter event period than companies not included in the index. Environmental reputation did, however, not appear to have a significant impact on abnormal returns over the longer event period. Nevertheless, we find some evidence to suggest that we can reject the null hypothesis (H_A^3) as environmental reputation appears to have a mitigating effect on the post-Fukushima market reaction for nuclear companies at least over the shorter term. This finding is consistent with Cho *et al*. (2012) who find environmental reputation to have a stronger impact on investor perceptions than their actual environmental performance when evaluating organisations. Maintaining a positive environmental reputation is thus found to be crucial for nuclear utility companies in the event of crisis, as it may counteract a negative share price reaction.

5.2.2 CSR reputation

With respect to CSR reputation, no evidence is found that being listed in the DJSI had a mitigating effect on the post-Fukushima share price reaction. We therefore accept our fourth null hypothesis (H_A^4) that abnormal returns were not different for companies listed in the DJSI. CSR reputation prior to the Fukushima disaster is thus not found to mitigate investor perceptions of the disaster. This may suggest that with respect to the utility sector, investors are more interested in utility companies' environmental performance than their engagement in CSR issues.

5.2.3 Investment reputation

The results concerning investment reputation show that over the shorter event window nuclear utility companies with a high and medium credit rating had significantly more positive abnormal returns. This suggests that a favourable investment reputation may counteract negative share price reactions following environmentally-related accidents over the short run. Investors may, for example, anticipate companies with a high credit rating and thus lower costs of finance to be in a better position to put procedures and systems into place to prevent future accidents from happening. Companies which are in a better financial situation may therefore be regarded as less risky than companies with a low financial credibility, which is reflected in relatively higher share prices. Over the longer event window, we find that utility companies that had a medium credit rating experienced significantly more positive abnormal returns. Our results suggest that there is some evidence that higher credit ratings have a mitigating effect on the post-Fukushima share price reaction, which is why we reject our fifth null hypothesis (H_A^5). With respect to lower credit ratings, we found no evidence that companies with a lower investment reputation experiences significantly different abnormal returns. Therefore, we accept our sixth null hypothesis (H_A^6).

5.2.4 Nuclear involvement

Our results show that being classed as a nuclear company has a significantly negative impact on abnormal returns over the shorter event window. The extent of the engagement in nuclear operations is, however, not found to have a significant impact on abnormal returns. Thus, there is some evidence of nuclear companies experiencing a more negative market reaction following the Fukushima disaster. As the effect does not increase with the extent of a company's nuclear engagement, we do accept our seventh null hypothesis (H_A^7).

5.2.5 Location

With respect to geographical location, we find when using the nuclear percentage variable Japanese utility companies had, on average, significantly negative abnormal returns over the shorter as well as the longer event period, while utilities in all other locations experiences significantly more positive abnormal returns. This may be the case because Japanese utility companies were directly affected by the disaster at the Fukushima Daiichi nuclear power plant but also by the natural disaster itself. The earthquake and tsunami affected utilities across the country due to resulting outages, which, in turn, lead to losses in energy generation and in sales. Japanese utilities that were directly affected by the tsunami, like the Fukushima power plant, were also faced with enormous clean up costs. The results thus suggest that investors in Japanese utility companies immediately adjusted share prices to account for lower expected cash flows in the future, due to higher costs as well as sales and production losses, and for higher risk, for example, of such a disaster to happen again. Using the nuclear dummy variable, the results of Japanese utility companies experiencing significantly negative abnormal returns over both event windows hold. Over the shorter event window, Western European, South American and Asian-Pacific utilities as well as Eastern European and South American nuclear companies experienced significantly more positive abnormal returns. Over the longer window, location did not appear to have an effect on abnormal returns. Our results show that there is strong evidence that Japanese utility companies experienced more negative abnormal returns compared to nuclear and non-nuclear utilities in other countries. Based on these findings we reject the eighth null hypothesis (H_A^8) that abnormal returns were the same for companies headquartered in countries other than Japan.

6. CONCLUSION

The primary aim of this paper was to identify whether investor perceptions of utility companies prior to the disaster at the Fukushima Daiichi nuclear power plant had a mitigating effect on the negative share price reaction within the utility sector worldwide that followed the disaster. The paper focused in particular on investor perceptions based on utility companies' environmental reputation, CSR reputation and investment reputation. In order to examine the post-Fukushima market reaction an event methodology was adopted to calculate abnormal returns for a sample of 495 utility companies worldwide. A regression analysis was conducted to explain these abnormal returns using the Newsweek ‘greenest’ company ranking as a measure for a favourable environmental reputation, the DJSI as a measure for a favourable CSR reputation, and corporate credit ratings as a measure for investment reputation. Over the first three trading days we find evidence that nuclear companies that had a favourable environmental reputation and/or a high and medium investment reputation prior to the Fukushima disaster experienced a more moderate share price reaction. Over the longer event period of 26 trading days we find that utility companies with a medium investment reputation experienced a positive effect on their share prices. These findings suggest that utility companies, specifically those with nuclear operations, may benefit from maintaining a positive reputation with respect to environmental and investment aspects, as this may have a positive impact on investor perceptions when evaluating utility companies’ future financial performance in the event of nuclear accidents, at least in the short run. The results also highlight the strategic nature of organisational reputation, as we find that companies with higher environmental and investment reputation have a competitive advantage over companies with a lower reputation, as they suffer a less severe share price reaction. Reputation can thus be seen as a highly valuable intangible asset (Chun, 2005).

An important implication of our findings is that utility companies can obviate severe negative share price reactions in the event of environmental disasters through positive investor perceptions based on a favourable environmental reputation and a high investment reputation. It is therefore advisable for utility companies to engage in reputation risk management by seeking a positive organisational reputation with respect to environmental and investment aspects. With respect to environmental reputation this may be done by means of releasing voluntary environmental disclosure, as it is found “*to be an effective tool*” to maintain a favourable environmental reputation (Cho et al., 2012, p. 10). This suggestion is consistent with Blacconiere and Patten’s (1994) findings that higher levels of environmental disclosure prior to chemical disasters resulted in more moderate share price reactions.

Our findings and implications are, however, subject to limitations. One limitation arises from the fact that we were not able to collect data about the nuclear involvement of 135 sample companies. Therefore, we have to limit our findings to the sample companies for which information about their operations was available, and cannot generalise them to all publicly listed utility companies worldwide. Another limitation is the use of proxies to measure aspects of corporate reputation. As Cho et al. (2012, p. 10) note, these measures "*may not perfectly reflect the true underlying attributes they attempt to capture*".

Based on these limitations, future research could investigate whether these findings hold when using different measures of environmental, CSR and investment reputation. Furthermore, it would be interesting to investigate whether investors actually take credit ratings and rankings such as the Newsweek 'greenest' companies ranking or the DJSI into account when assessing the financial performance of companies. This could be done by conducting interviews with investors.

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