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## **A REVIEW OF STOCK MARKET IMPACT OF ENVIRONMENTAL CATAclysms AND LESSONS FOR INVESTORS**

**Keywords:** environmental finance, stock markets, environmental disaster, environmental risks, investment arbitrage, risk reduction, adaptive capacity.

**J E L Classification:** D53, Q56, M41, G38, G40, G39.

**Abstract:** The objective of this paper is to present a review analysis of stock market impact of environmental disaster with the factors that orchestrate the impact, and to offer a novel framework for investors and managers. The paper applied an in-depth empirical review and synthesis method. Findings from the review and synthesis of empirical literature provide strong evidence that environmental disasters have diverse effects on the stock markets with majority of the literature reporting adverse effects on the stock markets. Additionally, findings are more preponderant on short run impact than on long run effects. Findings also show that environmental disasters may offer unique arbitrage opportunities for short-selling investors. The paper concludes by highlighting the capacity of environmental finance as one of the catalysts to bolster corporate adaptive capacity to environmental disaster. Furthermore, the degree of environmental disaster impact on stock market may depend on factors such as the type of environmental disaster, geographical location of environmental disaster, economic sector, stage of economic development, length of disaster and intensity of disaster. Accordingly, the paper develops a framework, which is recommended as a model for further research agenda on environmental disaster effect on stock markets.

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## ■■■ INTRODUCTION

Environmental sustainability advocacy and the attendant ripple to research and academic disciplines such as environmental accounting, environmental finance, environmental economics etcetera has bourgeoned towards a focus regarding the impact of environmental disasters on the wider economy and on the financial markets (Teitler-Regev & Tavor, 2019). Accordingly, the rising climate impact on stock markets has particularly given rise to climate- finance research focus, but this field of research is still embryonic (Pagnottoni, Spelta, Flori & Pammolli, 2022). More than ever, corporate finance and corporate stocks are exposed to the risk of contemporary environmental problems (Bauer & Hann, 2010). Accordingly, environmental finance is a growing concept in accounting discipline and in corporate finance studies (Vernimmen, Quiry & Le, 2022). This growth has become particularly exigent in light of unprecedented environmental disasters that wreak havoc to corporate financial stability. Therefore, the rampant nature of environmental disaster and their impacts on corporate assets has meant that corporate financial stability and by implication the value of its stocks can be measured by investors and stock markets based on the firms' installed capacity to adapt its assets to environmental disaster shocks. Accordingly, corporate information on environmental adaptive capacity and the availability of such information to the stock market is vital for investors' evaluation of a corporate financial resiliency to environmental disruptions (Seetharam, 2017). This means that corporate environmental conformity is no longer a matter only regulatory compliance, but the responsibility extends to all measures taken by the firm toward the safeguarding of corporate assets and stocks against environmental disasters (Vernimmen, Quiry & Le, 2022). Astute environmental finance practices become important because inclusion of environmental coping strategy is related to firms' cost of debt and credit ratings; hence, a firm that is proactively in control of its environmental practices has the capacity to experience lower cost of capital (Bauer & Hann, 2010).

Given the debilitating effect of environmental catastrophe on corporate assets and stocks, financial markets are sensitive to environmental disasters to reduce the risk of investing in stocks with little or no adaptive capacity to environmental disasters. As such, the extent to which the corporate can provide sufficient information regarding installed environmental adaptability and pro-

tection to their assets is an important practice and information for the stock markets to validate corporate stocks (Seetharam, 2017). The concept of environmental finance transcends beyond the provision of finance for environmental investments, it also includes practices and strategies used to protect corporate assets against vulnerability to environmental disaster – such as environmental disaster insurance and strategically locating plants in a somewhat low environmental disaster regions (Seetharam, 2017). It turns out that environmental disaster may constitute a specific form of unsystematic risk, which can become specific to individual companies depending on the adaptable capacity.

In financial portfolio management, there are two main broad categorisation of risks namely systemic and unsystematic risks (Waemustafa & Sukri, 2016). Systematic risk is the risk, which lays inherent within the market environment – hence somewhat unavoidable. However, unsystematic risk is the risk that lays uniquely associated to a particular company or particular to an industry. This is the reason why it may be referred to as specific risk and hence diversifiable risk; therefore, in portfolio management unsystematic risk may be reduced through a process of portfolio diversification (Waemustafa & Sukri, 2016).

Given the growth in calamitous disasters with attendant reduction in insurability, some researchers have engaged in research toward the understanding of how stock exchange may react to environmental disaster. These include inter alia Seetharam (2017) on stock market and environmental disaster. Others include climate risk and stock market (Faccini, Matin, & Skiadopoulos, 2016); climate risks and financial sector (Zobaa, 2005); framework for climate change risk on financial market (Alvarez, Cocco & Patel, 2020); however, there has not been much emphasis for the investor lessons; this paper expands existing literature by adding the investor lessons.

Accordingly, the objective of this review paper is to use existing empirical studies to understand different effects of environmental disaster on the stock exchange and to draw out the lessons for investors and to develop framework for further research on stock market implication of environmental disasters. Therefore, this review article contributes to the literature by serving as a synthesis that sieves out the divergent findings from different geographical regions, introducing the role of environmental finance toward bolstering corporate adaptive capacity to environmental disaster, identifying key lessons for investors and finally constructing a research framework for further research.

### **METHODOLOGY AND THE RESEARCH PROCESS**

The paper applies an in-depth review approach to review and synthesize prior empirical literature on environmental disasters and stock market performance. Thereafter the paper proceeds to sieve out the lessons for investors and thereafter develops a conceptual framework for further research. An in-depth review of previous empirical literature is a genre of recognised scientific approaches to research (Nature Education, 2014). Hence many scientific papers do focus on literature review as full papers by adopting variants such as systematic reviews (Davies, Ives & Dunn, 2015; Morrison, Polisena, Husereau, Moulton, Clark, Fiander, Mierzwinski-Urban, Clifford, Hutton & Rabb, 2012), meta-analyses (Valickova, Havranek & Horvath, 2015) or critical analyses (Naseer & Bin, 2015). This paper adopts and in-depth critical review. The in-depth review methodological stance contributes to previous research on the effect of natural disasters on stock markets in unique aspects. Firstly, this paper is not limited to any national environmental disaster, rather through the empirical literature review approach, it covers prior research on cross-country effect of environmental disaster effect on different stock markets. Furthermore, this paper pervades individual types of natural disaster, it covers many ranges of natural disaster, which the prior empirical research had focussed on, hence bolstering the breadth and width of this research paper. Additionally, it then slants on the catalytical effect of environmental finance in boosting corporate adaptive capacity to environmental disaster. Accordingly, this paper is scientific given that its findings have core rooting on the review and synthesis of previous empirical research; this echoes scientific paper description by Nature Education as follows:

“Scientific papers are for sharing your own original research work with other scientists or for reviewing the research conducted by others” (Nature Education, 2014).

Accordingly, this paper applies the following process under this review method. It collates, reviews and synthesizes previous literature under the theme of environmental disaster effect on stock or financial markets. Thereafter, it collates the findings under a table of commonly agreed factors that bolster the effect of environmental disaster on stock markets – with accompanying discussions. This culminates to the development of a framework (based on the

preceding empirical literature findings). The developed framework thus provides a model for expanding future research on this concept.

## LITERATURE REVIEW

### Environmental Disaster and Stock Market Effects

Pagnottoni et al. (2022) analysed the statistical impacts of global climate change and resultant natural disasters on global stock markets. They applied an event study procedure to investigate catastrophic shocks and capital markets to investigate the effects of different types of environmental disasters that occurred in one hundred and four countries on twenty-seven stock market indexes for the period 2001 to 2019. They found dissimilar stock market responses to natural disaster shocks, which is contingent on disaster event type and the location of disaster event occurrence. Specifically, they found that climate change disasters and biological disasters appear to prompt the greatest reactions from international financial markets. Additionally, they found that stock markets are more responsive to environmental disaster shocks, which occur in European countries more than other locations. Teitler-Regev and Tavor (2019) evaluated the impact of natural disaster events on stock markets to identify potential opportunities. They used data from 344 related events. They found that natural disasters have a wider negative effect on the economy; specifically their results show that the effect on the stock market provides an arbitrage opportunity for investors. This is because their analysis shows that the overall stock market index plummets on the day that natural disaster occurs including the following two days; it thus means that investors might want to short-selling (or going short) their stocks within these days whilst holding on for a rise in the stocks. Short selling of stocks involves borrowing weakening stocks from the brokers, selling such stocks with the anticipation of buying back the stock at a relatively cheaper price and returning the stock to the broker; the arbitrage price difference between the selling and buying price creates profit for the arbitrage investor (Engelberg, Reed & Ringgenberg, 2018). This suggests that whilst natural disaster may inflict a negative impact on the stock market, arbitrage investors may equally make a speculative profit out of natural disaster impacts on the stock market (Teitler-Regev & Tavor, 2019).

A related study on the effect of natural disaster on stock market by Worthington and Valadkhani (2004) found a similar trend of effect on stock market

on the day of natural disaster occurrence and the days that follow. However, the study by Worthington and Valadkhani (2004) found that environmental disasters such as cyclones and earthquakes had a significant impact on stock market returns – with positive or negative returns. Contrary to the effect of cyclones and earthquakes, storms and floods showed little or no comparable effect on stock market returns. Following the earlier results, Worthington (2008) conduct a repeated research to investigate the extent to which Australian stock market returns reacted to natural disasters; they made a surprising finding which showed that stock market volatility during the twenty three years of stock were not necessarily a reflection of natural disaster impact. This shows that capital markets in some regions of the world may become somewhat resilient to the shocks of natural disaster following lessons and adaptations from previous impacts. This finding relates to earlier empirical finding by Pagnottoni et al. (2022), which showed that stock market reaction to environmental disaster may depend on regional locations.

Other researchers, although still few in this climate-orchestrated domain, have various looked at the impact of environmental disaster on different stock markets. These includes inter alia, the effects on stock market from environmental disasters in Australia, South-East Asia, United States of America, and Japan respectively.

Worthington and Valadkhani (2005) analysed the effect of natural disasters on the Australian stock market through the application of Box and Tiao intervention model with data from daily returns in ten different market sectors. Amongst others, their findings show that natural disaster shocks affect the market sector returns in different dimensions contingent upon the type of sector under analysis. They found that the sectors that proved highest sensitivity to natural disasters of any kind are the consumer sector, the discretionary sector, the financial services sector and materials sectors.

Lee, Wu and Wang (2007) examined the effect of South-East Asia Tsunami on financial markets. They studied twenty-six international stock indexes to understand whether a contagion impact occurred within the financial markets arising from the earthquake of South-East Asia during December 26, 2004. They applied the heteroscedasticity biases with correlation coefficients; their findings showed no evidence that any individual country stock market was affected by the contagion impact. However, their results show that the foreign exchange markets of some countries such as India, Philippines and Hong Kong were hurt by the contagion effect of the Tsunami.

Wang and Kutan (2013) evaluated the influence of environmental disaster on the stock and insurance markets in USA and Japan. They applied the GARCH technique which considered the risk and return effect of natural disasters. GARCH models are employed to capture both wealth and risk effects of natural disasters. Their findings show that all the markets aside from the Japanese composite stock market experience the risk impact of natural disasters. Fakhry, Aktan, Masood, Tvaronavičienė and Celik (2018) evaluated the short and long run impacts of the 2011 Japanese Earthquake on the Japanese stock market by applying the generalized method of moments (GMM) technique. Their findings show that natural disasters affected the efficiency of the markets more significant within the immediate (short term) period of occurrence than within the long term. A related study by Lanfear, Lioui and Siebert (2019) found a significant abnormal impact of U.S. landfall hurricanes on the US stock markets during the period covering 1990 to 2017. Furthermore, previous empirical research found that albeit environmental disaster, its effect on stock market does depend on a number of factors, which includes inter alia the intensity of disaster (Mahalingam, Coburn, Jung, Yeo, Cooper & Evan 2018; Seetharam, 2017), stage of economic development of a country (Toya & Skidmore, 2007) and length of disaster (Malik, Chowdhury & Alam, 2023). Aside from the foregoing, some other strands of research have considered disease pandemic as another form of disaster that may affect stock markets. These research include amongst others the recent research appearing in the *Copernican Journal of Finance and Accounting*, which analysed COVID-19 pandemic effect on stock market herding and attendant stock price fluctuations (Abd-Alla, 2020), and the effect of COVID-19 disaster on the stock market volatility and risk-return through the lens of GARCH-in-mean and Threshold GARCH (Nageri, 2021).

The foregoing findings on the stock market does therefore indicate the likely implication of environmental disaster on the general economy, hence a snippet on this strand of research by Panwar and Sen, (2019) indicate that natural disasters have varied economic bearings across economic segments contingent on disaster categories and their concentration. Their findings indicate that the economic influences of natural disasters are statistically more significant for developing countries.

### **Environmental Finance for Corporate Adaptive Capacity to Environmental Disaster**

Despite the dangers posed by climate change and attendant environmental crisis, the corporate can adapt financially to the vagaries of environmental crisis by imbibing and growing its environmental finance capability. This is imperative given that environmental finance, amongst other functions enhances the reduction of negative ecological effect of corporate activities (Fullwiler, 2015); by implication therefore, environmental finance may reduce the adverse effect of environmental disasters and thus upgrade the corporate adaptive capacity to environmental disasters. It therefore implies environmental finance possess two-pronged ecological implications on the corporate as illustrated in figure 1. Capital providers, namely the banking institutions have already begun to apply the system of corporate environmental finance in their lending decisions, hence providing the stock market with additional information about corporate adaptive capacity to financial crisis (Schoenmaker, 2018). For instance, "financial institutions look for companies that balance the financial, social and environmental goals" (Schoenmaker, 2018). They proceeded to highlight the role of environmental finance in creating ecological compliance capacity as follows:

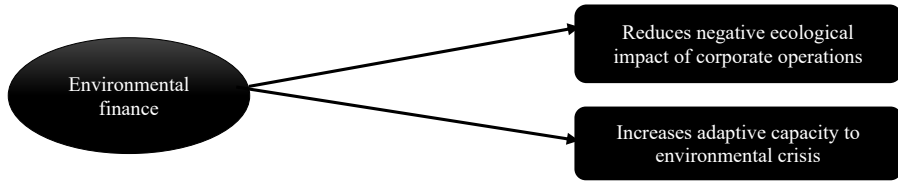
"Finance can play a leading role in allocating investment to sustainable companies and thus accelerate the transition to a low-carbon, circular economy. Sustainable finance considers how finance (investing and lending) interacts with economic, social and environmental issues" (Schoenmaker, 2018).

Accordingly, Schoenmaker (2018) highlight environmental finance is a catalyst that assist the corporate in dealing with the uncertainty, which emanate from environmental problems. In the same vein, Rambaud and Chenet (2021) stresses the importance of an ecological accounting that ensures ecological preservation through environmental finance. Ryszawska (2016) thus opines that:

"The role of finance is changing from the dominant view rooted in neoclassical economic theory (to maximize profits, and shareholder wealth) towards one supporting sustainable development, green economy, low carbon economy also adaptation and mitigation of climate change" (Ryszawska, 2016).



**Figure 1.** Two-Pronged Effect of Environmental Finance on the Corporate



Source : Author's graphic Illustration.

As an instance, a corporate may increase its transferable units for greenhouse gas emission with concomitant financial benefits therefrom (Jankowski, 2013). In the same vein a corporate may embark on generating green finance by increasing its level of renewable electricity generating capacity such as increasing solar generation capacity and selling the excess to the national grid. A company may also increase wind generation capacity beyond its consumption and sell the excess kilowatts to the national grid. If these green energy options are installed in less prone environmental disaster areas, they contribute in bolstering the corporate adaptive capacity to environmental disaster – as these form core components of corporate assets.

In addition to the foregoing discussions on the role played by environmental finance in bolstering adaptive capacity to environmental disasters, environmental assets, which also grow from environmental finance opportunity, are equally important in improving corporate adaptive capacity to environmental crisis. In this regard, environmental finance and environmental assets becomes somewhat pragmatically synchronous – they inter-exist to enhance ecological integration as core component of corporate existence. To this end, Więckowska (2013) highlights that corporate investment in green (environmental friendly) assets and technological components thereof towards meeting the Kyoto Protocol requirements or investments towards adapting to extreme climate or weather conditions are typical instances of sources of environmental assets acquired through environmental finance. The conventional assets can be elevated to adaptive capacity by enhancing the sustainability of such assets; this includes amongst others, making such assets to withstand the eventuality of environmental disaster – through environmental quality enhancement, or environmentally adaptive location of corporate assets.

## RESULTS AND CONCLUSIONS OF THE RESEARCH PROCESS

### Lessons For Investors and Conceptual Framework

Based on the foregoing in-depth literature review and synthesis, the results of this review paper are elucidated in the following paragraphs, which thus serve as lessons for investors with a culmination in a conceptual framework for further research.

Results from the reviewed literature show that natural disaster occurrence affects stock market performance depending on the type and location (Pagnottoni et al., 2022); this thus means that investors have additional information to add to their portfolio risk analysis and selection of investment alternatives including company category and country of investment or location. This implication and lesson are in alignment with the view, which indicates that the ability to understand environmental disasters assists in business risk reduction (Universal Class, 2022). Given the overriding empirical evidence, there is therefore additional variables to consider by investors and researchers, which is that environmental disasters should form an exogenous (non-financial variable) when analysing stock market volatility. This implication relates to the implicit risk hedging opportunity espoused by (Pagnottoni et al., 2022). Investors may also consider sectorial differences when considering investments during natural disaster times, this is because previous studies found that certain economic sectors are more vulnerable to natural disasters (Worthington & Valadkhani, 2005), these include the consumer sector, the discretionary sector, the financial services sector and materials sectors. Furthermore, the empirical research indicates that albeit the general harmful impact on the stock markets; investors may take a hedging position through a short selling of stock technique and stand the advantage of potential arbitrage profit.

Overall, with insight from the foregoing literature, some key variables or concepts becomes pertinent for the interest of investors and researchers. These include inter alia awareness of environmental disaster, type of environmental disaster (Mahalingam et al., 2018; Pagnottoni et al., 2022), geographical location of environmental disaster (Pagnottoni et al., 2022), economic sector (Worthington & Valadkhani, 2005; Pagnottoni et al., 2022), and stage of economic development (Toya & Skidmore, 2007), length of disaster (Malik et al.

(2023) and intensity of disaster (Mahalingam et al., 2018; Seetharam, 2017) (Table 1). Accordingly, this paper contributes by applying these key variables and/or concepts to create a conceptual framework for investors and researchers in Figure 2. Given that research on environmental disaster and stock market is still developing (Pagnottoni et al., 2022), this paper considers that a conceptual framework to guide further research will assist in bolstering academic researchers and investors’ analysis.

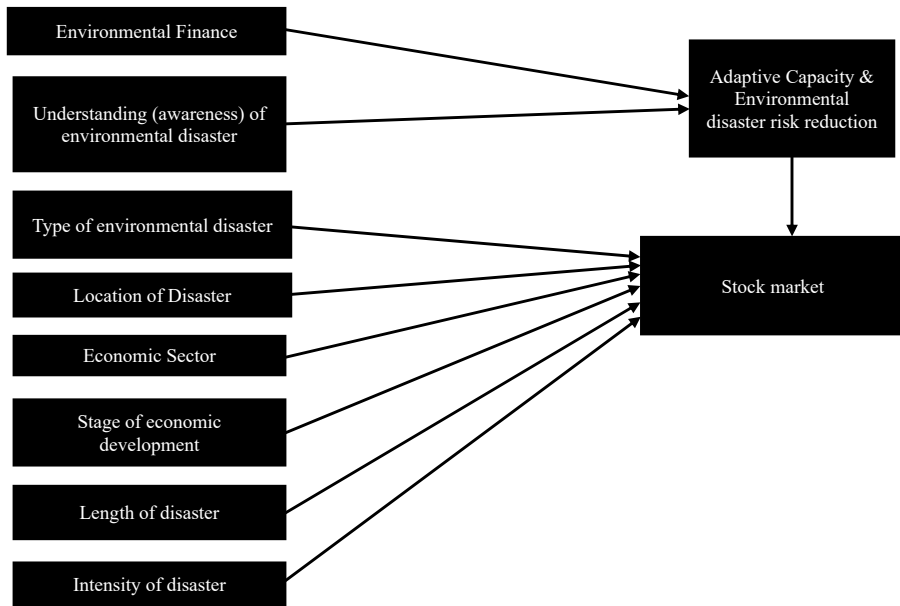
**Table 1.** Empirical Literature Findings of Environmental Disaster Factors That Impact Stock Markets

Factors (environmental disaster variable affecting stock market)	Empirical Research Author/s
Type of environmental disaster	Mahalingam et al., (2018); Pagnottoni et al., (2022)
Geographical location of environmental disaster	Pagnottoni et al., (2022)
Understanding of environmental disaster	Seetharam (2017); Faccini et al., (2016); Zobaa (2005)
Type of economic sector	Worthington & Valadkhani (2005); Pagnottoni et al., (2022)
Stage (level) of economic development	Toya & Skidmore (2007)
Intensity of disaster	Mahalingam et al., (2018); Seetharam et al., (2017)
Length of disaster	Malik et al., (2023)

Source: Author’s own tabulation of empirical literature findings.

Therefore, Figure 2 (conceptual framework) provides a schematic proposition for further research whereupon future empirical study on stock market performance during environmental disaster may consider diverse independent variables, which has been enriched based on considerations drawn from prior literature. The proposed framework conjectures that stock market performance (dependent variable) during environmental disaster may be contingent upon several variables, which appear on the left hand-side of the framework. This is the first integrated framework, which may be upgraded with time based on future research.

**Figure 2.** A framework for Environmental Disaster Effect on Stock Markets



Source : Author (based on different empirical literature findings in Table 1).

In addition, corporate managers need to understand that an environmental condition forecasts and/or rumours are sine qua non for integration in modern financial and investment planning and decisions to enhance corporate adaptive capacity to environmental disaster. This may require future considerations for accounting and finance department expansion to accommodate a new section, which perhaps might be referred to as ‘environmental finance and investment engineering sub-departments.

**CONCLUSION**

This paper aimed to use existing empirical studies to comprehend the diverse impacts of environmental disaster on stock exchanges and to highlight important lessons for investors and researchers. Findings from the literature provide empirical evidence that environmental disasters have various effects on the stock markets with almost all the literature reporting adverse effects on

the stock markets. The literature indicates that the effects exit more within the short run, and less within the long run. The literature findings also show that albeit the risks posed on the stock exchange by environmental disasters, such events also offer implicit arbitrage opportunities for risk takers who may want to take advantage of arbitrage profit by speculating stock price falls and thus sell short on the stock exchange. The review also brought to light some key variables that investors and researchers should consider in investment decisions within the periods of environmental disaster and the concomitant research. These include amongst others that some economic sectors are more vulnerable to natural disasters than others are. Furthermore, investors and researchers need to consider some variables unravelled from the literature in their future investment analysis pertaining to environmental disaster periods. Amongst others, these include consciousness that environmental disaster is unavoidable as these may be natural, type of environmental disaster, geographical location of environmental disaster, different economic sectors, the stage of economic development of the region under analysis, the length of disaster occurrence, and the intensity of disaster. The paper also introduces environmental finance as one of the tools to bolster corporate adaptive capacity to environmental disaster. This review paper contributes by creating a conceptual framework for environmental disaster effect on Stock Markets. Accordingly, this paper opens a further research agenda for applying the proposed framework in future empirical research.

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