Do Countries that Show Better Preparedness for Natural Disasters Exhibit Reduced Exchange Rate Volatility?

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Abstract

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This study investigates the relationship between a country's preparedness for natural disasters and its exchange rate valuation and volatility. Using data on 473 natural disaster events from 13 countries from 2000 to 2019, we examine whether countries that exhibit better preparedness for natural disasters also experience better currency valuation and reduced exchange rate volatility. Our results show that all else being equal, countries with higher scores on the Environmental, Social, and Governance Index (ESG score) tend to have higher currency valuation and lower exchange rate volatility. This suggests that the more prepared a country is for climate risk events, the more stable its exchange rate will likely follow a natural disaster. Our study contributes to understanding the factors that influence exchange rate volatility and provides insights for policymakers on how to mitigate the impact of natural disasters on their country's exchange rates.

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Dedication

I dedicate this dissertation work to my family and friends. A special message of gratitude to my loving parents, Diane Bouchard and Martin Bergeron, whose words of encouragement and constant support have kept me going during this challenging journey.

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Chapter 1: Introduction

Natural disasters like earthquakes, hurricanes, and floods can have significant economic and financial implications for countries worldwide. In addition to the human toll, natural disasters can lead to significant damage to infrastructure, disruption of supply chains, and loss of productivity. These effects can profoundly impact a country's currency valuation and exchange rate volatility.

The impact of natural disasters on exchange rates can be significant, as they can cause fluctuations in the supply and demand for a country's currency. For example, if a natural disaster leads to a decline in a country's output and production, it can cause a decrease in the demand for the country's currency, which can result in a depreciation of its exchange rate. Similarly, if a country's infrastructure is severely damaged, it can reduce its ability to trade with other countries, leading to a decrease in demand for its currency.

Moreover, the extent to which a country is prepared for natural disasters can also impact its exchange rate volatility. Countries with well-developed disaster response systems, adequate infrastructure, and strong financial institutions may be better able to absorb a natural disaster's economic and financial impact, which can help stabilize their exchange rates. On the other hand, countries with weaker disaster response systems and inadequate infrastructure may experience greater exchange rate volatility in the wake of a natural disaster.

Given the potential impact of natural disasters on currency valuation and exchange rate volatility, it is essential for policymakers and investors to understand the relationship between natural disasters and exchange rates. This can help them to develop effective strategies for mitigating the impact of natural disasters on their countries' economies and financial systems.

Natural disasters profoundly impact a country's macroeconomic factors, including GDP, inflation, and employment. These events can disrupt the order of production and trade, damage the foundation of infrastructure and property, and disrupt the lives of citizens. The destruction of property and infrastructure can lead to a decline in property values, an increase in construction costs, and a negative impact on the housing market and the overall economy.

Additionally, rebuilding and repairing infrastructure costs can be significant and serve as a test for the government's budget. This can lead to a decline in GDP and employment and an increase in inflation due to the rising cost of goods and services. Furthermore, natural disasters can also disrupt consumer spending and confidence, leading to a decline in economic activity. This is the truer for developing countries whose economies cannot bear such impacts.

As climate change worsens, natural disasters will understandably continue to raise concerns among the community. Global warming causes an increase in the frequency and severity of storms, fires, floods, hurricanes, and more, which will increasingly cause harm to the global economy. The Emergency Events Database (EM-DAT) provides worldwide data on natural disasters from 1900 to the present. It shows that since 1970 there have been, on average, 10,000 environmental disasters globally which caused over $2 trillion in damages. Similarly, according to the Federal Emergency

Management Agency (FEMA), from 1989 to 1993, environmental disasters caused an annual average loss of US$3.3 billion. By 1997, that number increased to US$13 billion. According to the Canadian Disaster Database by the Government of Canada, from 1989 to 1993, the average annual cost caused by natural disasters was approximately CAD$3 billion. From 1997 to 2001, the average annual total costs increased to approximately CAD$6 billion. These kinds of increases are reflected globally.

Natural disasters can significantly impact a country's currency exchange rate. The value of a currency can be affected by various factors, including economic conditions, political stability, and natural disasters. In the aftermath of a natural disaster, investors may become concerned about the country's economic prospects and sell off its currency, leading to a decline in value. Additionally, if a natural disaster severely impacts a country's economy, it may require a large influx of foreign aid or loans. This can lead to a decline in the currency's value as investors become concerned about the country's ability to repay its debt.

Previous literature, such as Stancik (2007), identified many factors, primarily country-specific, that can impact exchange rate volatility. The research highlights factors such as economic growth rate, trade openness, external debt, exchange rate regime, level of foreign reserve, and capital flows. The effect of these factors depends on the country's economic condition in terms of inflation, interest rates, output level, trade level, domestic and foreign money supply, independence of central banks, monetary and fiscal policies, and more (Stancki, 2007; Hassan et al., 2017). Considering how devastating natural disasters can be, it is clear that such events can significantly impact many of these factors.

However, it is important to note that the effect of natural disasters on a country's currency exchange rate can be mediated by a country's Environmental, Social, and Governance (ESG) score. ESG scores measure a company or country's performance in these three areas and are often used by investors to assess a particular investment's risk and potential return. Higher ESG scores are generally associated with lower risk and better long-term prospects. In the context of natural disasters, a country with a higher ESG score may be better prepared to cope with the impact of a natural disaster. For example, a country with a higher ESG score may have stricter building codes and regulations, which can help reduce the damage caused by a natural disaster. Additionally, a country with a higher ESG score may have a more resilient infrastructure and a stronger economy, which can help mitigate a natural disaster's economic impact.

As climate change increasingly became a topic of interest in recent years, ESG investments also significantly increased. At the start of 2005, the former UN Secretary-General, with the help of the United Nations Environment Program Finance Initiative (UNEP FI) and UN Global Compact, launched the six Principles for Responsible Investment (PRI). The United Nations Member States then adopted the 2030 Agenda for Sustainable Development in 2015 (Karaman, 2022). This agenda provides a blueprint for prosperity and peace for humans and our planet. This blueprint is based on 17 Sustainable Development Goals (SDGs), scored based on over 100 ESG indicators. The main aspects of SDGs are human well-being, sustainable economies, education and equality, innovation, decarbonization and energy, and environmental protection, all of which surround ESG indicators. These 17 SDGs aim to urge actions from developing and developed countries to tackle problems such as poverty, climate change, oceans and forests preservation, education, health, economic growth, and inequalities.

Our study focuses on enriching the current literature in three aspects. First, we examine if countries with better preparedness for natural disasters experience reduced exchange rate volatility, an issue the literature needs to explore more thoroughly. Second, we explore whether better-prepared countries exhibit more resilient currencies following a natural disaster. Finally, we provide a better understanding of the impact of factors related to countries' preparedness for climate-related events (including ESG score) on the nature of the relationship between natural disaster events and countries' currency exchange rates.

Using a sample of 473 natural disaster events between 2000 and 2019 in 13 countries, our results show that, on average, countries experience a decrease in their currency valuation (compared to USD) following the event and an increase in exchange rate fluctuation. We did not find any statistically significant relationship between the ESG score of the country and its currency valuation and risk; however, if we divide the sample into countries with high ESG scores (above the median in a given year) and low ESG scores, the positive (negative) impact of having a higher than median ESG score on currency valuation (risk) is observable. We also proxy for countries' preparedness for natural disasters based on the percentage of renewable energy consumption (compared to total energy consumption) and draw qualitatively similar conclusions.

The remainder of this thesis is as follows. Chapter 2 discusses the current literature and presents our hypotheses. Chapter 3 reviews the data collection, our sample, and the variables used in subsequent analyses. Chapter 4 dissects the base regression models and describes the methodology used. Chapter 5 presents an empirical analysis of the effects of natural disasters on countries' exchange rate valuation and volatility, considering the countries' preparedness for such natural events. Finally, Chapter 6 concludes this research with a thoughtful summary of our findings.

Chapter 2: Literature Review and Hypotheses Development

This research mainly focuses on whether countries with better preparedness for natural disasters exhibit reduced exchange rate volatility based on environmental disasters between 2000 and 2019. Over the past few decades, climate change has become one of the most critical challenges of our time. It has severe impacts on our politics, economies, and the entirety of humanity and will force every country to adapt. The rhythm at which global warming is advancing, mixed with the lack of radical changes in our daily lives, caused an already visible impact on our economy. Numerous countries face significant macroeconomic and financial risks that they cannot sustain, and these rapidly growing challenges can potentially cause fiscal disasters in many parts of the world.

Although climate change is a global phenomenon, its manifestation, and severity differ depending on the region. For example, North American regions will likely experience different effects of global warming than South American regions because of their different climate. As we will see later in the literature, developing countries with hot climates suffer disproportionally more significant losses because of their vulnerability to extreme events and their more robust temperature increase. Their lack of a diverse economy, insurance, and infrastructure makes them more vulnerable to global warming and natural disasters. Their reliance on agriculture, tourism, fishing, oil, and mining, causes them to be especially vulnerable after a disaster happens. Therefore, with already limited access to resources, it seems necessary to highlight the importance of having a clear and efficient plan ahead of natural disasters to allow these countries to get back on their feet quickly.

The literature shows that many determinants, such as capital flows, economic growth rate, external debt, financial development level, and trade openness, can impact exchange rate volatility. Since natural disasters have an external impact on the economy by ravaging cities and countries, it directly impacts exchange rate volatility. Fluctuations in exchange rate volatility lead to uncertainty within the economy. Uncertainty harms economic growth by impacting productivity, investments, investor confidence, consumption, prices, capital flows, and international trade. Unfortunately, the need for more resources and infrastructure in developing economies makes preparing for the increase in natural disasters caused by global warming a real challenge. Therefore, a better understanding of the impact of natural disasters on exchange rate volatility could provide greater economic stability.

2.1 Literature Review

2.1.1 Proactive Environmental Strategies

As climate change becomes a topic of interest, this research explores currency volatility and strength and how they are affected by natural disasters and countries' climate change preparedness. Many studies examine the importance of environmental preparedness at the firm level; some of these ideas also hold at the country level. According to Barney and Arikan (2005), the resource-based theory of the firm suggests that resources and capabilities that are valuable and expensive to replicate are the base through which firms can obtain a competitive advantage. In other words, competitive advantage is achieved only once a firm has resources and capabilities that are difficult to replicate by their competitors. These resources can be financial or physical assets or be assets specific to the firm, like organizational processes and skills obtained by its employees. In the latter case, this can also include an organizational green plan which can be difficult for a competitor to copy, considering that no two companies operate the same way. A firm's capabilities include many things, such as performing specific tasks that add value to the company. The recourse-based theory is mainly based on resources that are not easily transferable or tradable. In addition, Hart (1995) explains that resources are difficult to replicate because they are intangible and can be learned and accumulated through experiences and education. The firm can also acquire resources challenging to replicate through their employees' activities, teams, and life experiences. Russo and Fouts (1997) and Christmann (2000) argue that firms can acquire and maintain a competitive advantage by accumulating unique assets. Hart (1995) extends the resource-based theory to natural resources. He created the natural resource-based theory based on the idea that unique assets can be acquired through environmental strategies such as green products, sustainable development, and pollution control. Hart explains that firms can gain a competitive advantage by using these environmental strategies. He further notes that the resource-based theory can be extended to countries' environmental plans.

Sharma and Vredenburg (1998) study the relationship between environmental strategies, firm-specific capabilities, and competitive benefits. They use a survey to study 90 Canadian gas and oil companies and find that the resource-based view of the firm predicts firms' environmental strategies, firm-specific capabilities, and economic benefits. Similarly, Klassen and Whybark (1999) study the impact of firms' environmental commitments on their environmental performance and manufacturing. A survey of 66 furniture plants shows that commitment to the environment is positively linked to performance factors such as quality, cost, and on-time delivery. They also find that – based on toxic release data – commitment is linked to environmental performance. In addition, Christmann (2000) studies whether competitive cost advantages can be created from environmental strategies. Specifically, she explores whether a firm's ability to create and implement innovative processes affects its ability to implement environmental strategies successfully. Her survey data encompasses 88 chemical companies, and she can conclude that firms' ability to develop innovative processes and products creates "rare, valuable, non-substitutable, and imperfectly imitable" assets. This idea can be extended to countries' environmental plans. Some countries, especially poorer countries, do not have access to the skills and capital necessary to create and successfully implement new processes that can help them improve their current environmental plan or new environmental strategies.

Klassen and McLaughlin (1996) use event study methodology to examine the relationship between financial and environmental performance. They examine the market reaction to the announcement of positive environmental events like green awards and the adverse reaction after negative events, including environmental disasters such as oil spills. They find that, unsurprisingly, investors reward firms after positive events and penalize them after negative events. Their findings are consistent with the idea that positive environmental decisions and events are seen as favorable by investors and create a favorable perception for the future of firms' financial performance.

In the context of this research, it is helpful for a better understanding to look at many different effects of environmental strategies, including at the firm level, because of the limited previous literature on the effects of environmental strategies on country-level determinants.

2.1.2 Climate Change and Macroeconomic Factors

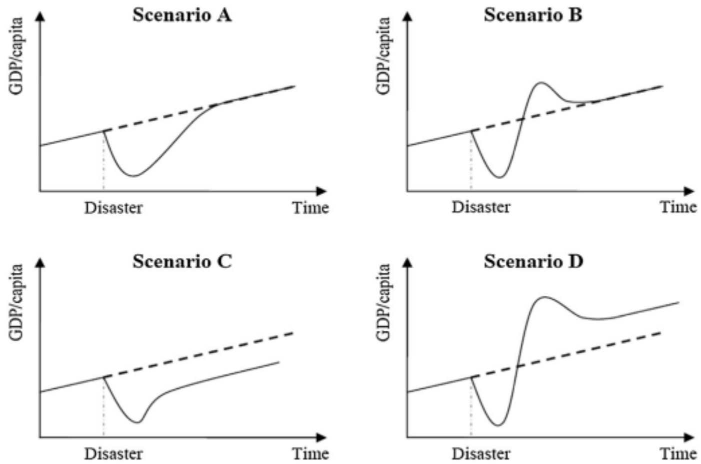
To this day, there is little literature on the long-term impacts of climate change on various economic determinants. Some studies try to quantify the effects of climate change on different parts of the economy, such as agricultural production, commodity prices, labor productivity, and economic growth (see, e.g., Stern, 2007; IPCC, 2014; Hsiang, 2016; Cashin et al., 2017; Letta & Tol, 2019; and Henseler and Schumacher, 2019). In addition, authors like Burke et al. (2015), Dell et al. (2009, 2012, 2014), and Hsiang (2016) have used panel data models to estimate the impact of weather events on the economy. The previous literature also uses a country's GDP per capita growth rate and temperature levels to examine the relationship between a country's macro-economy and weather.

2.1.3 The Impact of Natural Disasters on Economic Growth

The effects of climate change and natural disasters on economic growth have yet to be thoroughly studied, and the literature on this topic remains ambiguous. As we now know, the link between climate change and natural disasters is strong. Climate change impacts global temperatures and precipitation, impacting the intensity and frequency of extreme environmental events such as hurricanes, floods, storms, droughts, heat waves, and forest fires. Previous studies such as Rasmussen (2004) and Noy (2009) report that natural disasters negatively impact economic growth, while Caselli and Malhotra (2004) find, at times, a positive impact, which they argue is due to reconstruction efforts and government stimulus. According to economic principles, the impact of natural disasters on capital-labour ratios depends on whether the amount of physical and human capital is destructed or the population decline dominates. The current literature shows evidence that the reduction in the value of assets in most countries around the world outweighs the population effect. Fankhauser and Tol (2005) find an exception to this principle in vulnerable and emerging countries where disasters have a disproportionately high impact on health and where the amount of capital per worker is disproportionately low. Loayza et al. (2012) obtain similar results. They find that extreme natural disasters tend to put countries with minimal capital on a much lower economic growth trend. They argue that these countries may be stuck in a lower-level equilibrium of capital per worker.

Since the literature needs to be more apparent on the macroeconomic impacts of natural disasters, Chhibber and Laajaj (2008) propose four scenarios on how natural disasters can impact the long-run growth per capita. As seen in Figure 1, Scenarios A and B suggest that, following a natural disaster, capital-labour ratios decrease in the short run but that the effect is only temporary. The reason for the temporary effect is an increase in the return on capital afterward and an increase in savings and foreign direct investments. Other studies find that the longevity of reconstruction and a limited capacity for skills and supply in developing countries can slow these advancements. In Scenario B, overinvestments after the event cause a capital depreciation in the long run that is larger than the investments made to replace it. This leads the income to return to its initial pre-event long-term growth. In Scenario C, the decrease in capital-labour ratios is permanent. It is caused by the limited finances of households and the private sector, which causes capital reinvestments to become stagnant. The last scenario, Scenario D, suggests a positive impact of natural disasters on income in the long run because old and destroyed capital is being replaced with improved technology. In other words, scenario D assumes that countries are not only building back but also using the event to build back better.

Figure 1: Four scenarios of the long-run impact of natural disasters
Source: *Chhibber and Laajaj, 2008*



Several studies examined differences in the economic reactions to natural disasters between countries. As would be expected, poorer countries are more affected by natural disasters because their economies are less diversified than those of developed countries and often heavily rely on the agricultural sector. In addition to this heavy reliance on agriculture, developing countries need the appropriate policies, government disaster plans, and mitigation plans to cope with natural disasters. Aside from affecting economic growth, natural disasters can negatively impact a country's economic development. For example, they can greatly increase government debt. Finally, studies by Rasmussen (2004), Gassbner et al. (2010), and Oh and Reuveny (2010) find that major natural disasters can hurt the competitiveness of certain countries because of the destruction of their production capacities. This will lead to an increase in imports and a decrease in exports which causes a country's trade balance to be negatively impacted. A trade deficit can be worsened because of the outflow of foreign capital after the event, which raises uncertainty regarding the country's ability to repay its debt. When the trade balance worsens, it can put significant downward pressure on a country's exchange rate.

2.1.4 Exchange Rate Volatility and Government Responses

Exchange rate volatility has been studied thoroughly throughout the years. However, there needs to be more literature on the impact of government environmental strategies and their impact on exchange rate volatility. The COVID-19 pandemic can be used to understand better how exchange rate volatility is not only directly affected by the economy but also events such as environmental disasters, viruses, wars, and more. The COVID-19 pandemic will also bring light to the relationship between government reactions to disastrous events and exchange rate volatility. Devereux (2004) and Byrne and Davis (2005) show that the level of exchange rate volatility determines the stability of a country's foreign trade. Both studies also show that when exchange rate volatility increases, market risks and uncertainty increase while social welfare decreases. Sharma et al. (2019) study the effects of COVID-19 and investigate how shutdowns affect exchange rates. They find that shutdowns cause exchange rate volatility to increase.

Quin et al. (2020) show that during the second quarter of 2020, COVID-19 measures significantly impacted the world, with an 18.5% drop in the value of merchandise traded globally. This decrease in global trade directly impacted international capital flows, significantly increasing exchange rate volatility. Debelle (2020) provides evidence that this kind of market behavior causes financial institutions to be more alert to unbalanced demands for international assets. This unbalance leads investors to change their currency holdings, directly impacting exchange rate volatility. Feng et al. (2021) provide evidence on the impacts of government COVID-19 interventions on exchange rate volatility. Based on the biweekly number of cases, they find that increased cases lead to increased exchange rate volatility. They also find that both non-pharmaceutical and economic measures taken by the government, such as school closings, restrictions on travel, stimulus checks, and other governmental aid, were all able to help curb any spikes in exchange rate volatility.

Similarly, Zhou et al. (2021) also examine the impact of disasters on exchange rates using data from the COVID-19 pandemic. Their research uses a sample of 27 advanced and emerging economies where the number of COVID-19 cases represents the outbreak's severity. The time chosen is from when 20 cases were confirmed in each country to July 8th, 2021. First, a series of panel regressions show that COVID-19 is reflected in currency risk premiums. The authors also find that a 1% increase in confirmed COVID-19 cases decreases the value of the local currency by 0.01% in developing markets, while the effect in developed countries is insignificant. The authors further examine the impact of macroeconomic policies on exchange rates. They find that beneficial monetary policies caused an initial appreciation followed by a significant depreciation in the local currency.

In contrast, fiscal policies cause the local currency to appreciate lastingly. The authors conclude that COVID-19 has a significant negative impact on the currencies of emerging countries but has no effect on developed markets. They also conclude that unconventional monetary or expansionary fiscal policies reduce the negative pressure of COVID-19 on exchange rates. Conversely, conventional expansionary monetary policies have the opposite effect on exchange rates.

2.1.5 The Determinants of Exchange Rate Volatility

Exchange rate stability is vital for countries because it can help them achieve their macroeconomic policy objective. Exchange rate policies are essential for developing countries because it helps them reach a more stable exchange rate volatility. According to Hassan et al. 2017, exchange rate volatility is critical in maintaining risk worldwide. Their study on Nigeria between 1989 and 2015 finds that interest rates and foreign assets have a statistically significant and positive effect on exchange rate volatility, pol price, economic openness, and fiscal balance have a statistically positive and insignificant effect. They also find that gross GDP has a statistically negative and insignificant effect. A study by Mpofu (2021) used a GARCH model on South African currency (ZAR) between 1986 and 2013 to examine the determinants of exchange rate volatility. He finds that using a floating exchange rate positively and significantly impacts volatility. He also finds that money supply, price of commodities, and foreign reserves have a statistically significant impact on volatility.

Similarly, Chipili (2009) study on Zambia currency between 1964 and 2006 using a GARCH model finds that switching from a fixed to a flexible exchange rate positively and significantly impacts exchange rate and conditional volatility. Interestingly, the author also finds that real factors had a more negligible impact than monetary factors. Another study by Oaikhenan and Aigheyisi (2015) shows evidence based on Nigerian currency between 1970 and 2013 using the EGARCH model that government expenditures, interest rate movements, lagged exchange rate, and the economy all have a statistically significant impact and are important variables in determining exchange rate volatility. Kilicarshlan's (2018) study focuses on the effect of exchange rate volatility on different macroeconomic variables and the reasons for exchange rate volatility. This study uses an Augmented Dickey-Fuller Test (ADF), the Philips-Perron test (PP), and the GARCH model to show evidence that domestic investments, trade openness, and money supply directly increase the real effective exchange rate volatility. The author also finds that government expenditures, direct investments, and outputs decrease the real effective exchange rate volatility.

2.1.6 Natural Disasters and Stock Market

A study by Yamori and Kobayashi (2002) investigated the impact on Japanese insurance firms' stock prices after a Japanese earthquake called Hanshin-Awaji, which in 1995 violently hit the Tokyo metropolitan area. Using an event-study methodology based on the Ordinary Least Squares (OLS), they found that an earthquake of this magnitude cost insurance companies 77 billion yen. Their study uses a sample of 13 insurance companies to calculate the daily abnormal returns from day 0 to day nine post-event. They found that insurance companies did not benefit from increased demand after an environmental disaster and rejected their hypothesis. They do not explain why their results differ from other studies done in the US insurance sector.

Worthington and Valadkhani (2004) use the intervention analysis based on an Autoregressive Moving Average (ARMA) model to evaluate natural disasters' impact on the Australian stock market. Their sample is daily stock market returns from December 31st, 1982, to January 1st, 2002. They found that environmental disasters have a net positive and significant negative impact depending on the days that follow the event. On the contrary, additional research by Worthington (2008) found that disasters caused no significant impact on the Australian stock market. He uses the Generalized Autoregressive Conditional Heteroskedasticity (GARCH) and the GARCH-in-the-mean model in this research. His sample contains daily stock returns from January 1st, 1980, to June 20th, 2003.

2.1.7 ESG and Sovereign Credit Rating

Many researchers have studied the relationship between Environmental, Social, and Governance (ESG) and sovereign credit ratings. Margaretic and Pouget (2018) show evidence that countries that efficiently govern their financial, human, and natural resources can create earnings with socioeconomic measures, improving their capacity to pay their governmental obligations back. Jeanneret's (2018) study the impact that regulatory quality can have on sovereign bond spreads and provides evidence that it has a significant impact economically on sovereign default risk. In addition, Ciocchini et al. (2003) find that countries with low corruption levels must pay smaller risk premiums for bond issuance. Finally, recent research by Pineau et al. (2022) analyzes ESG ratings' impacts on sovereign ratings. Using a two-step, data-driven methodology, the authors find evidence that sovereign ratings are significantly impacted by ESG performance. The authors also provided evidence that different ESG factors drive credit ratings for emerging markets and developing economies compared to advanced economies. Third, this study showed that recessions and the financial crisis of 2008 caused a short and medium-term shift in the importance of ESG in assessing credit ratings.

2.2 Hypothesis Development

This research tests whether countries with better preparedness for natural disasters (e.g., countries with higher ESG scores) experience better currency valuation and reduced exchange rate volatility following an event. As mentioned in the previous section, research by Pineau et al. (2022) shows that ESG ratings impact sovereign ratings. Moreover, we argue that higher ESG ratings reflect a better preparedness for natural disasters. To test this, we consider a series of significant natural disasters that caused comparable damages in terms of the total damages of an event compared to the country's average total damages from 1980 to 1999. Then we examine whether countries with higher ESG ratings exhibit more resilient currencies after a disaster (regarding exchange rate volatility).

A study by Wang and Kutan (2013) examines the impact of natural disasters on the insurance sector and the Japanese and US stock markets. Using a GARCH model, they find no effects on the stock markets, showing evidence that they are diversified enough to sustain the impact. However, they find significant effects on the insurance sectors; investors in the US are negatively affected, while those in Japan are positively affected. Similarly, using autoregressive moving average (ARMA) models, Worthington and Valadkani (2004) find that cyclones, bushfires, and earthquakes significantly impact market returns, while floods and large storms do not. They also find that market returns can be positively or negatively impacted; the first-day post-event is when most of the impact is felt, while price levels revert during the following days.

Moreover, using a meta-regression analysis, Klomp and Valckx (2013) provide evidence of the relationship between natural disasters and economic growth per capita. Their study finds that natural disasters significantly negatively affect economic growth and that the impact is different depending on the country. Specifically, their study provides evidence that natural disasters have a significantly more damaging effect in developing countries.

As history shows, significant natural disasters are responsible for an overwhelming number of death and people negatively affected, especially in developing countries. The first impacts of natural disasters are the loss of people and infrastructure such as houses, electricity, telecommunication networks, roads, and other infrastructure. Consequently, these physical impacts negatively affect the economy, such as employment, production, income, inflation, and more. Studies by Strobl (2008) and Noy and Vu (2009) provide evidence that natural disasters in the short term negatively impact economic growth.

Based on the literature review and theoretical framework, we propose the following hypotheses to test the effect of environmental preparedness on exchange rate valuation in the aftermath of a natural disaster. We proxy for environmental preparedness using two measures: ESG score, and percentage of renewable energy consumption.

Hypothesis 1: Countries with better environmental preparedness will experience higher exchange rate valuation in the aftermath of a natural disaster, all else being equal.

The second hypothesis is based on the idea that countries with higher ESG scores are better equipped to manage environmental, social, and governance risks, which can help to promote economic stability and reduce exchange rate volatility. In the context of a natural disaster, countries with strong environmental policies, social safety nets, and governance structures may be better able to prevent and manage the economic impact of the disaster, resulting in lower exchange rate volatility.

Hypothesis 2: Countries with better environmental preparedness will experience lower exchange rate volatility in the aftermath of a natural disaster, all else being equal.

The third hypothesis is based on the idea that a natural disaster's severity can significantly impact a country's economic stability and exchange rate volatility, regardless of its ESG score. However, countries with higher ESG scores may be better able to mitigate the impact of the disaster on their economies, resulting in a weaker relationship between the severity of the disaster and exchange rate volatility.

Hypothesis 3: The effect of ESG scores on exchange rate volatility will be moderated by the severity of the natural disaster.

These hypotheses will be tested using regression analysis, with average exchange rate valuation difference (after minus before the event) and average volatility as the dependent variables.

Chapter 3: Data

3.1 Data Collection

According to Bodanski (2001), the 1980s marked the climate change regime's development and increased environmental activity because of the significant increase in global average temperature. Specifically, 1987 marks when scientists discovered the "ozone hole" in the stratosphere. This discovery caused global warming and its effects to skyrocket as a topic of interest. After many scientists rang the alarm about global warming in 1988, the Intergovernmental Panel on Climate Change (IPCC) was founded by the United Nations in 1989 to scientifically show climate change's political and economic impacts. In addition, another important step towards acknowledging global warming as an important issue was taken in 1997 when the Kyoto Protocol was concluded. The Kyoto Protocol is an international agreement that mentions clear obligations for industrialized countries to reduce and limit greenhouse gas emissions.

With that in mind, this study aims to provide evidence of the relationship between countries' preparedness for natural disasters and exchange rate valuation and volatility. Consequently, the period selected for this research's data consists of natural disasters between January 1st, 2000, and December 31st, 2019. It was crucial to leave out the period associated with the COVID-19 pandemic as it could create skewness in the results. Also, starting our time frame with the year 2000 gave countries the necessary time to understand the severity and importance of global warming and its effects on natural disasters. Since our initial sample was extensive, all events with missing data regarding the total number of people affected and the total damages in $USD were filtered out. It is also essential to filter out extra-terrestrial, such as meteorites, as they are not a product of climate change and cannot be prevented through government environmental plans and preventative actions.

To collect data for this research, we first access the Wharton Research Data Service (WRDS) website to access the Federal Reserve Bank Reports on foreign exchange rates. We select the data from January 1st, 2000, to December 31st, 2019. Since we selected the USD as the base currency for our study, we must filter out the United States from our data. We must also filter out all European countries as they use the same currency. We also removed countries with pegged currencies, countries that did not experience large natural disasters, and countries with missing or incomplete data. After leaving those countries out, we have a sample of 13 countries. We then retrieve the daily exchange rate of these countries (currency/USD) and the three-week (21 days) average exchange rate and volatility before and after each event. The reason for picking three weeks as our window of study is to have a sufficient number of observations in our calculations of average currency valuation and its volatility while at the same time reducing the risk of overlapping events.

Next, to test whether countries with higher ESG ratings exhibit a more resilient currency after a natural disaster, we need to retrieve countries' ESG ratings the year before a disaster to show countries' preparedness for each event. According to Robeco Institutional Asset Management US (RIAM US), a country's ESG score is defined as; "The country ESG score is based on 50 indicators, summarized in 15 criteria. Four of which environmental with a weight of 30%, 5 social with a weight of 30% and 6 governance with a weight of 40%. The score ranges from 1 to 10 with 10 representing the highest score and 1 the lowest."[1]

As previously mentioned, the 2030 Agenda for Sustainable Development by the United Nations was adopted by all members of the United Nations States in 2015 after decades of work. The 17 Sustainable Development Goals (SDGs) are the base of this agenda. These goals apply to all 193 UN Member States and are based on over 100 ESG indicators. These indicators were carefully selected because they are crucial for all developing and developed countries. The UN recognized that improving education, health, economic growth, and decreasing inequality is vital to ending poverty, preserving our oceans and forests, and slowing climate change. We used ESG scores as our base for countries' preparedness while collecting data on renewable energy usage (along with control variables) from World Bank publicly available datasets.

The Sustainable Development Report (SDG Index) is a website that provides a global assessment of countries' progress toward sustainability (Sachs et al., 2022). It offers a historical database of ESG scores from 2000 to 2022. The rankings report shows the overall performance of the 193 United Nations Member States. In this report, countries are ranked with an overall score based on the total progress toward achieving each of the 17 Sustainable Development Goals. Countries are given a score out of a hundred.

We then use the "Emergency Events Database" (EM-DAT) to collect the history of natural disasters for each of the 13 countries in our sample. The Center for Research on the Epidemiology of Disasters (CRED) created the EM-DAT database alongside the Belgian Government and the World Health Organization (WHO). Its objective is to provide worldwide coverage of natural disasters and to help humanitarian action at the national and international levels. This database means to ease countries' decision-making when preparing for disasters. The EM-DAT contains data on 22,000 significant disasters and the scale of their effects from 1900 to the present. It is made from multiple sources, such as non-governmental organizations, research institutions, UN agencies, insurance companies, and press agencies. The database also includes a fixed base for vulnerability assessment and priority setting. The EM-DAT is widely employed for research and is publicly available on CRED's website. For each natural disaster, the database provides valuable information such as the start/end date, the number of deaths, the number of injuries, the total number of people affected, and the total damages in USD. With this database, we collect 473 natural disasters from 2000 to 2019 for 13 countries. The question this research means to answer is whether a country's currency hit by a disaster experiences a spike in volatility and whether it appreciates or depreciates relative to a base currency. In this case, we choose the USD.

3.2 Sample Description

As previously mentioned, our sample contains 473 natural disasters between January 1st, 2000, and December 31st, 2019. Our sample is made of disasters that fall into the following categories: (1) climatological such as droughts and wildfires; (2) geophysical such as earthquakes, mass

[1] Website: *https://www.robeco.com/en-us/sustainable-investing/expertise/most-sustainable-countries-in-the-world*

movements (dry), and volcanic activity; (Masih, 2018) (3) hydrological such as floods and landslides; and (4) meteorological such as extreme temperature and storms.

3.3 Dependent Variables

We use two dependent variables, as described in Table 1. First, *AvgDiff* is the difference between the average exchange rate (Currency/USD) within three weeks (21 days) after the end date of the natural disaster, and three weeks before the start date (presented in decimals) is our proxy for currency valuation (if this difference is positive, it means that the currency appreciated compared to the US). Second, *RiskDiff* is the difference between the standard deviation of daily exchange rates (Currency/USD) within three weeks (21 days) after the end date of the natural disaster, and three weeks before the start date (presented in decimals) is our proxy for exchange rate volatility (if this difference is positive, it means that the volatility of exchange rate has increased). Notably, our results are not significantly sensitive to the choice of window (windows of 15 to 30 days give qualitatively similar results).

- Insert Table 1 -

3.4 Independent Variables

We define five independent variables for our models, as presented in Table 1. The first one is the ESG score of the country. We use the ESG score on the year prior to the event to proxy for countries' preparedness for natural disasters. As a robustness check (and not to merely rely on the ESG score, but to consider levels of it), we also define a dummy variable (*D_ESG*) that equals 1 if the ESG score of the country is above the median (within the list of 13 sample countries) in a given year, and 0 otherwise. We also use *Renewable E (%)* and *D_Severity* to test the three developed hypotheses. Detailed definitions of each variable can be found in Table 1.

3.5 Control Variables

In a study examining the effect of ESG scores on exchange rate valuation and volatility in the aftermath of a natural disaster, several control variables should be considered to ensure that other factors do not confound the estimated effect of ESG scores on exchange rate volatility.

Economic factors such as GDP, population, and population growth rate could be included as control variables to account for the impact of economic conditions on exchange rate volatility. Countries with higher levels of economic development may be less vulnerable to economic shocks and thus have lower exchange rate volatility. Political stability could be included as a control variable to account for the impact of political factors on exchange rate volatility. Countries with more stable political systems may be better equipped to manage economic risks and promote stability in their exchange rates. Trade openness could also be included as a control variable to account for the impact of international trade on exchange rate volatility. Countries with more open trade policies may be more exposed to external economic shocks and thus have higher exchange rate volatility. The level of financial market development in a country could also be included as a control variable to account for the impact of the country's financial infrastructure on exchange rate volatility. Countries with more developed financial markets may be better able to absorb economic shocks and thus have lower exchange rate volatility.

Overall, including these control variables in the analysis can help to ensure that the estimated effect of ESG scores on exchange rate volatility is not confounded by other factors and provide a more accurate assessment of the relationship between ESG proxies and exchange rate volatility in the aftermath of a natural disaster. For this study, it was crucial to include a list of control variables carefully chosen to enhance the results' validity and reduce the risks of omitted variables affecting our results. Based on prior studies and data availability, the first control variable we selected is *Duration*, which is the number of days that a natural disaster was ongoing, retrieved from the EM-DAT database. Then, we used the World Bank Data Center, which provided seven other important indicators directly related to a country's macroeconomic conditions. The list and definitions of all eight control variables used in this study are summarized in Table 1.

3.6 Overview of the Sample

Table 2 provides an overview of our sample. Panel A shows the frequency of natural disasters for each country within each period. Among the countries in our sample, India and Japan have the highest number of natural disasters from 2000 to 2019, respectively. Furthermore, the table shows that the period between 2010 and 2014 witnessed the highest frequency of natural disasters. Panel B of Table 2 shows the frequency of each subcategory of natural disasters in our sample (with natural hydrological disasters having the highest frequency).

Panel C of Table 2 provides the descriptive statistics on all variables. The mean value on *AvgDiff* shows that, on average, the currency valuation compared to USD has depreciated by 2% following natural disasters. Moreover, the mean value on *RiskDiff* shows that in the aftermath of a natural disaster in our sample, the exchange rate volatility increased by 11% on average. These results align with our Hypotheses 1 and 2, providing initial evidence for the negative effect of a natural disaster event on countries' currency valuation and volatility. Finally, Panel D presents the correlation matrix.

- Insert Table 2 -

Chapter 4: Methodology

Multiple regression models will examine the relationship between a country's preparedness for natural disasters, disaster severity, and country exchange rate valuation and volatility while controlling for potential confounding variables. The regression models will be estimated using ordinary least squares (OLS) regression. Since we are only looking at a short-term window before and after the disaster, and considering that our dependent variables can theoretically take any value, OLS regression seems suitable for our analysis.

To test Hypothesis 1, we develop the following base regression specification; however, we estimate different variations of the model in the empirical results section. The first model will examine the relationship between the preparedness proxy and exchange rate valuation, considering all control variables described in Table 1. It should be mentioned that since we are controlling for the country's economic indicators one year before the event (and since those variables uniquely identify each country within a year, the necessity to control for year-fixed effects is eliminated).

$$AvgDiff = \beta 0 + \beta 1(\text{Preparedness Proxy}) + \sum_{i=1}^{8} a_i Control_i + \varepsilon \quad (1)$$

Where Preparedness proxy can be *ESG*, and *Renewable E (%)*; as a robustness check, we repeat the regressions using *D_ESG* instead of *ESG* to compare the results. The definition of all control variables is provided in Table 1.

To test Hypothesis 2, we estimate the following base regression model, and like model 1, we estimate different variations of the model in the empirical results section. The first model will examine the relationship between the preparedness proxy and exchange rate volatility, considering all control variables described in Table 1.

$$RiskDiff = \beta 0 + \beta 1(\text{Preparedness Proxy}) + \sum_{i=1}^{8} a_i Control_i + \varepsilon \quad (2)$$

Where Preparedness proxy can be *ESG*, and *Renewable E (%);* as a robustness check, we repeat the regressions using *D_ESG* instead of *ESG* to compare the results.

Finally, to test Hypothesis 3, we repeat the estimation of the abovementioned equations, adding the *D_Severity* to the regressors (as an independent variable) to examine the effect of natural disaster severity on the dynamics of the relationship between preparedness and currency valuation and exchange rate volatility. *D_Severity* is defined as a dummy variable that equals 1 if total damages (in current USD) exceed the EM-DAT natural disaster dataset average (1980-2020).

Chapter 5: Empirical Results

Table 3 provides univariate results comparing descriptive statistics on each variable for the high ESG score countries to low score countries. As shown in Table 3, the four countries of Australia, Canada, the United Kingdom, and New Zealand have a mean value of 1 for *D_ESG*, i.e., these countries always ended up with scores above the median of the sample in any given year, while the mean value for the same variable in the sample of "other" countries is 0.41. Based on the results, the high ESG score countries have ended with a lower mean value for *AvgDiff* and a lower mean value for *RiskDiff*. In other words, initial evidence does not support that, on average, these high ESG score countries experience currency depreciation less, but it is in line with those countries having less volatility in their exchange rate. While these initial results are interesting, we elaborate on regression models controlling for important factors to derive our results.

- Insert Table 3 –

Table 4, Panel A shows the results of a multivariate linear regression model that estimates the effect of a country's ESG score on its exchange rate valuation after a natural disaster. The dependent variable is the *AvgDiff*, and the independent variables are the *ESG* (model 1) and Renewable E (%) (model 2). Based on the *ESG* proxy, no significant effect is detected. While the negative coefficient on Renewable E (%) is not in line with Hypothesis 1, but the economic significance is negligible.

Interestingly, when we use the alternative proxy of *D_ESG* (instead of *ESG*) in Panel B of Table 4 and repeat the regressions, the results are much more supportive of Hypothesis 1, with the positive and significant coefficient of *D_ESG,* suggesting that the level of ESG score might be more relevant in a country's preparedness for natural disasters rather than the actual score which might be noisy. The results show that the ESG score has a positive coefficient of 0.051, which indicates that higher ESG scores are associated with higher currency valuation after a natural disaster. This effect is statistically significant at the 0.01 level. Additionally, in unreported tests, we also included a dummy variable that controls for anticipated versus non-anticipated disasters. Our results remained qualitatively and quantitatively similar to our main regressions and are omitted for brevity.

- Insert Table 4 -

Overall, these results suggest that improving ESG scores could help reduce the negative response of a country's exchange rate in the aftermath of a natural disaster and could be an important factor for policymakers to consider in their disaster preparedness and response plans. However, it is important to note that these results are based on a linear regression model and may only partially capture the complex relationship between ESG scores and exchange rate valuation.

The results of the multiple regression analysis presented in Panel A of Table 5 entail similar results and reveal that a country's ESG score might not have a statistically significant negative effect on its exchange rate volatility after a natural disaster. In contrast, the high levels of ESG score (as shown in Panel B) generally have a significant effect in reducing the volatility.

- Insert Table 5 -

Findings are consistent with Hypothesis 2 and prior research that suggests that countries with higher ESG scores are better equipped to manage natural disasters and their economic impact. Several factors can explain the negative relationship between ESG scores and exchange rate volatility.

First, countries with higher ESG scores tend to have stronger environmental policies, which can help to mitigate the impact of natural disasters on their economies. For example, countries with strong environmental regulations may be better equipped to prevent and manage pollution-related disasters such as oil spills, which can have significant economic consequences. Second, countries with higher ESG scores tend to have stronger social safety nets, which can help mitigate natural disasters' impact on their populations. For example, countries with strong social welfare programs may be better equipped to assist those affected by natural disasters, which can reduce the economic impact of the disaster. Finally, countries with higher ESG scores tend to have stronger governance structures, which can help to mitigate the impact of natural disasters on their economies. For example, countries with strong governance structures may be better equipped to mobilize resources and coordinate disaster relief efforts, which can help minimize the disaster's economic impact.

Finally, we test Hypothesis 3 by adding the *D_Severity* to the regression models described in equations 1 and 2 and investigate its effect on currency valuation (Table 6) and exchange rate volatility (Table 7). We could not support Hypothesis 3 as the coefficient on *D_Severity* is insignificant in all models.

- Insert Table 6 & 7 -

In summary, the regression results provide evidence that a country's preparedness for natural disasters, as measured by a dummy variable that captures high levels of ESG scores (compared to the population), is a predictor of exchange rate valuation and volatility after controlling for other relevant factors. This finding has important implications for policymakers seeking to promote economic stability and reduce exchange rate volatility in their countries. By improving their countries' ESG scores, policymakers can help to mitigate the impact of environmental, social, and governance risks on their economies and promote long-term sustainability.

Chapter 6: Conclusion

In conclusion, the empirical results suggest that better preparedness, as measured by different proxies, is associated with higher currency valuation and lower exchange rate volatility in the aftermath of a natural disaster. This finding has important implications for policymakers who seek to mitigate the negative economic consequences of natural disasters on their countries. By improving ESG scores, countries may be better equipped to deal with the aftermath of a natural disaster and thus experience less exchange rate volatility. Specifically, environmental, social, and governance improvements can enhance a country's disaster preparedness and response, promoting long-term economic stability.

However, it is important to note that these results are based on a small sample and using linear models. Further research is needed to confirm the relationship between ESG scores and exchange rate volatility in the aftermath of a natural disaster. Other factors not considered in this study may also impact exchange rate volatility in the aftermath of a natural disaster (e.g., inflation rate, political stability of the country, and more). Future research can also follow a similar setting but use time series models within a country to mitigate the concerns related to the substantial differences between currency regimes.

We conclude with some practical recommendations. Based on the findings of this study, policymakers can take several steps to mitigate the impact of natural disasters on their country's exchange rates. First, policymakers can work towards improving their country's ESG scores to reduce the impact of natural disasters on their exchange rates. This can be done by implementing policies that promote environmental sustainability, social justice, and good governance. Policymakers can also strengthen their country's economic resilience by implementing policies promoting economic growth and stability. This can be done by investing in infrastructure, promoting innovation and entrepreneurship, and improving the business environment. Political stability is also an important control variable in determining exchange rate volatility. Therefore, policymakers can work towards improving political stability by strengthening democratic institutions, promoting transparency and accountability, and ensuring peaceful transitions of power. This study has found that natural disasters can significantly impact exchange rates, which can affect international trade and investment. Therefore, policymakers can establish risk mitigation mechanisms such as insurance schemes, contingency funds, and disaster risk reduction strategies to help cushion the impact of natural disasters on their country's economy and exchange rates. By taking the steps outlined above, policymakers can help to promote economic stability, resilience, and sustainability in the face of natural disasters.

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Appendices

Table 1: Variable Definitions

This table gives a detailed description of the data-gathering process and calculation methods for all variables. The table includes definitions of dependent variables, independent variables, and control variables that are used in regression models.

Variable Name	Description and Calculations	Sources
	Dependent Variables	
AvgDiff	Difference between average exchange rate (Currency/USD) within 3 weeks (21 days) after the end date of the natural disaster, and 3 weeks before the start date (presented in decimals).	Self calculated
RiskDiff	Difference between standard deviation of daily exchange rates (Currency/USD) within 3 weeks (21 days) after the end date of the natural disaster, and 3 weeks before the start date (presented in decimals).	Self calculated
	Independent Variables	
ESG	Environmental, Social, and Governance (ESG) score of the country, one year prior to the natural disaster event.	SDG Index
D_ESG	Dummy variable that equals 1 if the ESG score of the country is above the median (within the list of 13 sample countries) in a given year, and 0 otherwise.	Self calculated
Renewable E (%)	Percentage share of renewable energy in total final energy consumption of the country, one year prior to the natural disaster event.	World Bank Data Center
D_Severity	Dummy variable that equals 1 if total damages (in current USD) exceed the natural disaster dataset average (1980-2020).	Self calculated
	Control Variables	
Duration	Number of days between the natural disaster's start date and end date.	EM-DAT Database
Tariff (%)	Simple mean applied tariff which is the unweighted average of effectively applied rates for all products subject to tariffs calculated for all traded goods of the country, in a given year.	World Bank Data Center
PopGrowth (%)	Annual population growth rate for year t is the exponential rate of growth of midyear population from year t-1 to t, expressed as a percentage.	World Bank Data Center
Log_Population	Natural logarithm of total population of the country, in a given year.	World Bank Data Center
Stocks (%)	Total number of shares traded, both domestic and foreign, multiplied by their respective matching prices as a percentage of the GDP for a given country, in a given year.	World Bank Data Center
Imports (%)	The value of all goods and other market services received from the rest of the world as a percentage of the GDP for a given country, in a given year.	World Bank Data Center
GDP Growth (%)	Annual percentage growth rate of GDP at market prices based on constant local currency.	World Bank Data Center
Log_GDP	Natural logarithm of the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products for a given country, in a given year.	World Bank Data Center

Table 2: An Overview of Natural Disaster Events' Sample

This table presents an overview of the EM-DAT sample. Panel A shows the number of natural disasters within each period for each country. Panel B categorizes natural disasters into four subcategories and presents the number of each category for each country. Panel C provides summary statistics for all of the variables used in subsequent analyses (please note that all the non-dummy variables will be winsorized at 1% level on both sides and then used in the analyses to mitigate the effect of outliers or possible errors in dataset records), and Panel D presents the correlation matrix.

Panel A

Num.	Country	2000-2004	2005-2009	2010-2014	2015-2019	Total (#)
1	Australia	17	16	14	16	63
2	Brazil	5	6	9	7	27
3	Canada	7	2	8	5	22
4	India	17	17	23	30	87
5	Japan	26	12	23	19	80
6	Korea, Rep.	15	4	5	4	28
7	Malaysia	3	3	2	2	10
8	Mexico	8	9	18	10	45
9	New Zealand	5	3	6	7	21
10	South Africa	5	6	4	7	22
11	Sri Lanka	3	2	7	3	15
12	Thailand	8	10	7	6	31
13	United Kingdom	5	9	6	2	22
	Total	**124**	**99**	**132**	**118**	**473**

Table 2: An Overview of Natural Disaster Events' Sample—*continued*

Panel B

Num.	**Country**	***Climatological***	***Geophysical***	***Hydrological***	***Meteorological***	**Total (#)**
1	Australia	15	-	23	25	63
2	Brazil	-	-	24	3	27
3	Canada	3	-	11	8	22
4	India	-	5	58	24	87
5	Japan	-	18	10	52	80
6	Korea, Rep.	-	1	8	19	28
7	Malaysia	-	2	8	-	10
8	Mexico	-	5	4	36	45
9	New Zealand	-	5	11	5	21
10	South Africa	4	1	10	7	22
11	Sri Lanka	-	1	12	2	15
12	Thailand	-	2	25	4	31
13	United Kingdom	-	1	12	9	22
	Total	**22**	**41**	**216**	**194**	**473**

Table 2: An Overview of Natural Disaster Events' Sample—*continued*

Panel C

Num.	Variable	# Obs.	Mean	Std. Dev.	Min	Max
1	AvgDiff	473	-0.02	0.09	-0.20	0.16
2	RiskDiff	473	0.11	0.15	-0.17	0.44
3	ESG	473	69.30	8.41	51.60	80.38
4	D_ESG	473	0.57	0.50	0.00	1.00
5	Renewable E (%)	473	18.98	16.45	0.69	63.51
6	D_Severity	473	0.05	0.23	0.00	1.00
7	Duration	473	9.76	21.91	1.00	365.00
8	Tariff (%)	452	8.27	6.67	1.99	42.61
9	PopGrowth (%)	473	0.99	0.59	-0.19	2.53
10	Log_Population	473	18.37	1.48	15.16	21.04
11	Stocks (%)	469	58.47	37.79	1.31	160.72
12	Imports (%)	467	27.14	14.48	8.32	96.26
13	GDP Growth (%)	473	3.60	2.67	-5.29	11.47
14	Log_GDP	473	27.62	1.21	23.47	29.47

Table 2: An Overview of Natural Disaster Events' Sample—*continued*

Panel D

Num.	Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	AvgDiff	1													
2	RiskDiff	0.08	1.00												
3	ESG	-0.16	0.06	1.00											
4	D_ESG	-0.10	-0.03	0.84	1.00										
5	Renewable E (%)	0.08	-0.03	-0.58	-0.56	1.00									
6	D_Severity	-0.02	0.00	-0.10	-0.05	0.13	1.00								
7	Duration	0.00	0.01	-0.12	-0.06	0.08	0.10	1							
8	Tariff (%)	0.14	0.00	-0.69	-0.52	0.61	0.10	0.08	1.00						
9	PopGrowth (%)	-0.06	-0.05	-0.54	-0.45	0.33	0.08	0.11	0.35	1.00					
10	Log_Population	0.11	-0.10	-0.67	-0.56	0.38	0.10	0.03	0.53	0.01	1.00				
11	Stocks (%)	-0.03	-0.09	0.30	0.48	-0.42	0.00	0.01	-0.18	-0.32	-0.01	1.00			
12	Imports (%)	0.08	0.09	-0.05	-0.05	-0.07	0.00	0.11	-0.02	0.22	-0.24	-0.09	1.00		
13	GDP Growth (%)	0.18	-0.03	-0.54	-0.34	0.41	0.11	0.07	0.38	0.33	0.30	-0.06	0.25	1.00	
14	Log_GDP	-0.14	-0.10	0.25	0.21	-0.37	-0.01	-0.12	-0.29	-0.45	0.45	0.37	-0.54	-0.33	1

Table 3: Descriptive Statistics on High ESG Score Countries vs. Low ESG Score Countries
This table divides the sample into common wealth countries (Australia, Canada, UK, and New Zealand), and other countries, and provides summary statistics within each subsample.

		Country = Four Common Wealth					Country = Other				
Num.	**Variable**	**# Obs.**	**Mean**	**Std. Dev.**	**Min**	**Max**	**# Obs.**	**Mean**	**Std. Dev.**	**Min**	**Max**
1	AvgDiff	128	-0.06	0.09	-0.20	0.16	345	0.00	0.08	-0.20	0.16
2	RiskDiff	128	0.08	0.12	-0.13	0.44	345	0.12	0.16	-0.17	0.44
3	ESG	128	75.30	2.27	71.15	80.38	345	67.08	8.77	51.60	79.32
4	D_ESG	128	1.00	0.00	1.00	1.00	345	0.41	0.49	0.00	1.00
5	Renewable E (%)	128	13.24	9.79	0.85	32.65	345	21.10	17.87	0.69	63.51
6	D_Severity	128	0.07	0.26	0.00	1.00	345	0.05	0.22	0.00	1.00
7	Duration	128	9.41	12.87	1.00	65.00	345	9.89	24.44	1.00	365.00
8	Tariff (%)	126	3.71	1.26	1.99	6.74	326	10.03	7.06	2.33	42.61
9	PopGrowth (%)	128	1.25	0.46	0.33	2.25	345	0.89	0.61	-0.19	2.53
10	Log_Population	128	16.87	0.81	15.16	17.98	345	18.93	1.28	16.74	21.04
11	Stocks (%)	127	68.43	36.91	1.31	160.72	342	54.78	37.49	1.33	154.35
12	Imports (%)	128	25.88	4.99	19.86	38.25	339	27.61	16.69	8.32	96.26
13	GDP Growth (%)	128	2.85	1.23	-4.51	5.45	345	3.88	2.99	-5.29	11.47
14	Log_GDP	128	27.42	1.00	24.71	28.76	345	27.70	1.27	23.47	29.47

Table 4: Multivariate Analysis of Currency Valuation after the Event

In this table, we analyze the determinants of currency valuation measured by *AvgDiff* (OLS regression). All non-dummy variables are winsorized at the 1% level on both sides. *t*-statistics are in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A

	(1)	**(2)**
ESG	-0.001	
	(-0.34)	
Renewable E (%)		-0.001***
		(-3.08)
Duration	-0.000	-0.000
	(-0.64)	(-0.56)
Tariff (%)	-0.001	-0.001
	(-0.75)	(-0.72)
PopGrowth (%)	-0.039***	-0.034***
	(-3.43)	(-4.03)
Log_Population	0.015	0.026***
	(1.23)	(4.26)
Stocks (%)	0.000	0.000
	(0.68)	(0.08)
Imports (%)	0.000	-0.000
	(0.04)	(-1.15)
GDP Growth (%)	0.002	0.002
	(1.14)	(1.26)
Log_GDP	-0.027**	-0.040***
	(-2.22)	(-4.72)
Constant	0.536***	0.672***
	(3.05)	(3.91)
Observations	443	443
Adjusted R^2	0.078	0.097

Table 4: Multivariate Analysis of Currency Valuation after the Event —*continued*

Panel B

	(1)	(2)
D_ESG	0.017	
	(1.04)	
Renewable E (%)		-0.001***
		(-3.08)
Duration	-0.000	-0.000
	(-0.69)	(-0.56)
Tariff (%)	-0.001	-0.001
	(-1.20)	(-0.72)
PopGrowth (%)	-0.032***	-0.034***
	(-3.44)	(-4.03)
Log_Population	0.024***	0.026***
	(3.05)	(4.26)
Stocks (%)	0.000	0.000
	(0.36)	(0.08)
Imports (%)	-0.000	-0.000
	(-0.19)	(-1.15)
GDP Growth (%)	0.002	0.002
	(0.79)	(1.26)
Log_GDP	-0.035***	-0.040***
	(-3.87)	(-4.72)
Constant	0.520***	0.672***
	(3.14)	(3.91)
Observations	443	443
Adjusted R^2	0.080	0.097

Table 5: Multivariate Analysis of Exchange Rate Volatility after the Event

In this table, we analyze the determinants of exchange rate volatility measured by *RiskDiff* (OLS regression). All non-dummy variables are winsorized at the 1% level on both sides. *t*-statistics are in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A

	(1)	(2)
ESG	-0.000	
	(-0.15)	
Renewable E (%)		-0.001
		(-1.05)
Duration	0.000	0.000
	(0.24)	(0.27)
Tariff (%)	0.002	0.002
	(1.00)	(1.09)
PopGrowth (%)	-0.043**	-0.039**
	(-2.10)	(-2.58)
Log_Population	-0.013	-0.005
	(-0.59)	(-0.46)
Stocks (%)	-0.000*	-0.000**
	(-1.93)	(-2.11)
Imports (%)	0.001	0.001
	(1.33)	(0.93)
GDP Growth (%)	0.000	0.000
	(0.05)	(0.09)
Log_GDP	-0.004	-0.012
	(-0.16)	(-0.78)
Constant	0.501	0.582*
	(1.58)	(1.87)
Observations	443	443
Adjusted R^2	0.018	0.020

Table 5: Multivariate Analysis of Exchange Rate Volatility after the Event —*continued*

Panel B

	(1)	(2)
D_ESG	-0.067**	
	(-2.28)	
Renewable E (%)		-0.001
		(-1.05)
Duration	0.000	0.000
	(0.35)	(0.27)
Tariff (%)	0.003	0.002
	(1.63)	(1.09)
PopGrowth (%)	-0.057***	-0.039**
	(-3.41)	(-2.58)
Log_Population	-0.033**	-0.005
	(-2.31)	(-0.46)
Stocks (%)	-0.000	-0.000**
	(-1.08)	(-2.11)
Imports (%)	0.001	0.001
	(1.61)	(0.93)
GDP Growth (%)	0.003	0.000
	(0.67)	(0.09)
Log_GDP	0.011	-0.012
	(0.66)	(-0.78)
Constant	0.471	0.582*
	(1.59)	(1.87)
Observations	443	443
Adjusted R^2	0.029	0.020

Table 6: Multivariate Analysis of Currency Valuation Considering Event Severity

In this table, we analyze the determinants of currency valuation measured by *AvgDiff* (OLS regression) considering event severity. All non-dummy variables are winsorized at the 1% level on both sides. *t*-statistics are in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

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Panel A

	(1)	(2)	(3)
ESG	-0.001		
	(-0.34)		
Renewable E (%)		-0.001***	
		(-3.08)	
D_Severity			-0.008
			(-0.43)
Duration	-0.000	-0.000	-0.000
	(-0.64)	(-0.56)	(-0.59)
Tariff (%)	-0.001	-0.001	-0.001
	(-0.75)	(-0.72)	(-0.93)
PopGrowth (%)	-0.039***	-0.034***	-0.036***
	(-3.43)	(-4.03)	(-4.27)
Log_Population	0.015	0.026***	0.019***
	(1.23)	(4.26)	(3.27)
Stocks (%)	0.000	0.000	0.000
	(0.68)	(0.08)	(0.74)
Imports (%)	0.000	-0.000	-0.000
	(0.04)	(-1.15)	(-0.10)
GDP Growth (%)	0.002	0.002	0.002
	(1.14)	(1.26)	(1.15)
Log_GDP	-0.027**	-0.040***	-0.030***
	(-2.22)	(-4.72)	(-3.81)
Constant	0.536***	0.672***	0.515***
	(3.05)	(3.91)	(3.11)
Observations	443	443	443
Adjusted R^2	0.078	0.097	0.078

Table 6: Multivariate Analysis of Currency Valuation Considering Event Severity —*continued*

Panel B

	(1)	(2)	(3)
D_ESG	0.017		
	(1.04)		
Renewable E (%)		-0.001***	
		(-3.08)	
D_Severity			-0.008
			(-0.43)
Duration	-0.000	-0.000	-0.000
	(-0.69)	(-0.56)	(-0.59)
Tariff (%)	-0.001	-0.001	-0.001
	(-1.20)	(-0.72)	(-0.93)
PopGrowth (%)	-0.032***	-0.034***	-0.036***
	(-3.44)	(-4.03)	(-4.27)
Log_Population	0.024***	0.026***	0.019***
	(3.05)	(4.26)	(3.27)
Stocks (%)	0.000	0.000	0.000
	(0.36)	(0.08)	(0.74)
Imports (%)	-0.000	-0.000	-0.000
	(-0.19)	(-1.15)	(-0.10)
GDP Growth (%)	0.002	0.002	0.002
	(0.79)	(1.26)	(1.15)
Log_GDP	-0.035***	-0.040***	-0.030***
	(-3.87)	(-4.72)	(-3.81)
Constant	0.520***	0.672***	0.515***
	(3.14)	(3.91)	(3.11)
Observations	443	443	443
Adjusted R^2	0.080	0.097	0.078

Table 7: Multivariate Analysis of Exchange Rate Volatility Considering Event Severity

In this table, we analyze the determinants of exchange rate volatility measured by *RiskDiff* (OLS regression) considering event severity. All non-dummy variables are winsorized at the 1% level on both sides. *t*-statistics are in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A

	(1)	(2)	(3)
ESG	-0.000		
	(-0.15)		
Renewable E (%)		-0.001	
		(-1.05)	
D_Severity			0.018
			(0.55)
Duration	0.000	0.000	0.000
	(0.24)	(0.27)	(0.19)
Tariff (%)	0.002	0.002	0.002
	(1.00)	(1.09)	(1.00)
PopGrowth (%)	-0.043**	-0.039**	-0.041***
	(-2.10)	(-2.58)	(-2.70)
Log_Population	-0.013	-0.005	-0.010
	(-0.59)	(-0.46)	(-0.98)
Stocks (%)	-0.000*	-0.000**	-0.000*
	(-1.93)	(-2.11)	(-1.93)
Imports (%)	0.001	0.001	0.001
	(1.33)	(0.93)	(1.38)
GDP Growth (%)	0.000	0.000	0.000
	(0.05)	(0.09)	(0.01)
Log_GDP	-0.004	-0.012	-0.006
	(-0.16)	(-0.78)	(-0.43)
Constant	0.501	0.582*	0.488
	(1.58)	(1.87)	(1.63)
Observations	443	443	443
Adjusted R^2	0.018	0.020	0.018

Table 7: Multivariate Analysis of Exchange Rate Volatility Considering Event Severity —*continued*

Panel B

	(1)	(2)	(3)
D_ESG	-0.067**		
	(-2.28)		
Renewable E (%)		-0.001	
		(-1.05)	
D_Severity			0.018
			(0.55)
Duration	0.000	0.000	0.000
	(0.35)	(0.27)	(0.19)
Tariff (%)	0.003	0.002	0.002
	(1.63)	(1.09)	(1.00)
PopGrowth (%)	-0.057***	-0.039**	-0.041***
	(-3.41)	(-2.58)	(-2.70)
Log_Population	-0.033**	-0.005	-0.010
	(-2.31)	(-0.46)	(-0.98)
Stocks (%)	-0.000	-0.000**	-0.000*
	(-1.08)	(-2.11)	(-1.93)
Imports (%)	0.001	0.001	0.001
	(1.61)	(0.93)	(1.38)
GDP Growth (%)	0.003	0.000	0.000
	(0.67)	(0.09)	(0.01)
Log_GDP	0.011	-0.012	-0.006
	(0.66)	(-0.78)	(-0.43)
Constant	0.471	0.582*	0.488
	(1.59)	(1.87)	(1.63)
Observations	443	443	443
Adjusted R^2	0.029	0.020	0.018