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The Global Impact of Earthquakes on Multinational Enterprise Performance

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Abstract

Natural disasters, particularly earthquakes, are known to cause significant damage to communities and organizations. While extensive research has examined the societal and environmental effects of earthquakes, the impact on multinational enterprises (MNEs) remains underexplored. This study aims to fill this gap by investigating how earthquakes influence MNE business performance, with the moderating roles of firm size and firm age. This study investigates the impact of earthquakes on the business performance of MNEs using a quantitative research approach. By employing data from Orbis and the NOAA/NCEI databases, a comprehensive dataset of MNEs affected by earthquakes between 2013 and 2022 is constructed. The initial regression analysis did not support the hypothesized negative effect of seismic impact on MNE performance. However, alternative measurements of seismic impact, such as social and environmental factors, revealed a positive relationship. This unexpected finding suggests that MNEs may benefit from enhanced performance under seismic conditions when broader impacts are considered.

1. Introduction

Natural disasters, the formidable forces of nature, strike with devastating power, leaving lives shattered and landscapes altered. As shown by multiple studies, natural disasters not only affect communities, but they also have detrimental consequences for organizations and the individuals working within them (Gregg et al., 2022; Kohn et al., 2012; Sadiq & Graham, 2016). The reason why natural disasters are so impactful for organizations is not only because they can cause significant damage to individuals and communities (Gregg et al., 2022); they are also systematic in their disruption and depletion of resources within social systems, e.g., organizations (Kohn et al., 2012; Sadiq & Graham, 2016). One of the most detrimental and frequent natural disasters known is the earthquake (Ritchie & Rosada, 2022; World Health Organization, 2024).

As shown in the news, a lot of attention is paid to what consequences earthquakes have for the people affected by them, especially on the number of casualties that result from this type of natural disaster (Reuters, 2023). However, the indirect effects on the global business environment due to these disasters, in particular earthquakes, remain to be discovered (Gregg et al., 2022; Nielsen et al., 2023; Oh & Oetzel, 2022). The current literature is thus informative on what kind of effect earthquakes have on society and the environment (Agarwal, 2020; Choudhury et al., 2016; D'Amico, 2015), and what effects natural disasters in general have on firms and the business environment (Salvato et al., 2020; Tierney & Webb, 2001). Furthermore, some qualitative studies have shown that earthquakes can have a severe negative impact on the business performance of multinational enterprises (hereafter MNEs) (Altay & Ramirez, 2010; Fabeil et al., 2019; Yildiz & Bostan, 2024). However, the literature does not highlight what kind of quantitative effect earthquakes can have on the business performance of MNEs, emphasizing a gap in the current literature (Gregg et al., 2022; Salvato et al., 2020; Tierney & Webb, 2001).

The reason for zooming in on the effects of earthquakes on MNEs in particular is as follows. Since MNEs are located in multiple countries and locations, it is easier for them to retract their businesses in 'affected' areas and move them to their other locations in order to keep their business performance afloat (Buckley & Ghauri, 2004; Rugman & Verbeke, 2001). Local firms on the other hand, are only operating in one place and location, and do not have the luxury of moving their operations elsewhere to ensure the survival of their company (Dawar & Frost, 1999). By only looking at MNEs, this thesis could thus delve deeper into understanding how MNEs use their multiple locations to keep their businesses running accordingly during times of distress.

As mentioned before, MNEs are able to shift their businesses between locations in order to save their performance (Buckley & Ghauri, 2004; Rugman & Verbeke, 2001). How they do so, however, depends on the characteristics of the firm. Firm size and firm age are two of these important firm

characteristics that have an influence on the reallocation strategy (Buckley & Ghauri, 2004; Rugman & Verbeke, 2001). However, how these firm characteristics precisely influence the business performance after an earthquake has struck, is missing from current literature.

Over the last few decades, the literature has extensively investigated the relationship between firm age, firm size, and business performance (Dogan, 2013; Halil & Hasan, 2010; Ilaboya & Ohiokha, 2016; Majumdar, 1997; Papatogonas, 2007). The current literature shows that firm age, firm size, and profitability have been commonly linked together. The relationship between the three has been a subject of mixed empirical results (Ilaboya & Ohiokha, 2016). Where some scholars indicate a positive relationship (Halil & Hasan, 2010; Papatogonas, 2007), and others show a negative relationship (Dogan, 2013; Majumdar, 1997). Furthermore, the relationship between firm size and profitability has been widely explored within the literature (Abeyrathna & Priyadarshana, 2019; Hall & Weiss, 1967), highlighting that firm size has a positive effect on profitability. Moreover, firm age has also been widely explored by researchers, showing an ambiguous relationship between firm age and firm performance (Coad et al., 2013; Kipasha, 2013; Loderer & Waelchli, 2010; Majumdar, 1997; Osunsan et al., 2015). The current literature thus provides us with the notion that firm size and firm age can have either a positive or negative influence on the performance of a firm, indicating that they can have an important influence on the main relation of this research. Showing that these variables are crucial as moderators in this research.

The aforementioned gap thus presents us with a problem, since the information that is missing from the literature is quite important for MNEs when they are considering going abroad. Especially when they wish to go abroad to certain high-risk earthquake areas. It is therefore important that the possible effects of said earthquakes are known beforehand, so that MNEs can act accordingly and assess what types of risks are associated with locating in certain areas around the world. It can thus be seen as a critical component of location choice (Flores & Aguilera, 2007) and of the choice to engage in foreign direct investment in itself (Dunning, 1980; Meyer et al., 2009), which is why it is such a problem for MNEs that this information is not yet complete and not yet extensively covered within the current literature.

In order to fill the gap, this study aims to answer the following research question:

"How do earthquakes impact the business performance of multinational enterprises, and is this effect moderated by firm size and firm age?"

Academically, this research advances the understanding of the nuanced effects of earthquakes on MNE business performance, highlighting the moderating roles of firm size and firm age (Battisti & Deakins, 2017; Qin & Jiang, 2011). By specifically analyzing these moderating factors, the study

contributes to theoretical frameworks in disaster management, international business, and organizational studies. This research offers precise insights into how organizational characteristics influence resilience and performance in the face of natural disasters, thus enriching scholarly discourse and providing a valuable reference for future academic inquiries (Strulik & Trimborn, 2019).

From a societal perspective, this study offers practical implications for MNEs, government agencies, and policymakers in enhancing disaster resilience and mitigating the adverse effects of earthquakes on business operations and communities. By understanding the nuanced dynamics between natural disasters, firm size, firm age, and business performance, stakeholders can develop more effective risk management strategies and allocate their resources more efficiently. Furthermore, by shedding light on the significance of location choice and foreign direct investment decisions in earthquake-prone regions, the research equips MNEs with valuable knowledge to make informed decisions, minimize risks, and contribute to sustainable development goals.

In the following chapters, this thesis will explain the following; first, this thesis will dive deeper into the current literature and provide a conceptual model and a few hypotheses. Second, this thesis will explain what methods have been used to study the research question and provide the conceptual model. Next, the results of the analysis will be discussed. Furthermore, the results will be interpreted and a conclusion will be drawn. Lastly, this thesis will provide some limitations and suggestions for further research.

2. Theoretical Framework

The following chapter will delve into the conceptual underpinnings that guide this research, presenting an overview of relevant literature, theoretical perspectives, and definitions that will be used throughout this paper. The topics that will be touched upon are earthquakes, seismic impact, business performance, and the role of firm size and firm age. This literature review will be at the base of the hypotheses, conceptualizing the expected relations between the variables. To enhance the understandability of the conceptual model, a visual representation is added at the end of this chapter.

2.1 Earthquakes

An earthquake, as defined by the World Health Organization (hereafter the WHO), is a "violent and abrupt shaking of the ground, caused by movement between tectonic plates along a fault line in the earth's crust" (2024). Scientists have shown that there are certain areas in the world that are more prone to experiencing earthquakes than other areas (Alden, 2019; Rodrigue, n.d.). This is mostly due to the fact that certain countries and areas are located above multiple tectonic plates and therefore have a higher likelihood of being affected by the movement between those tectonic plates (Alden, 2019; Rodrigue, n.d.). The areas that are more likely to be impacted by earthquakes due to these tectonic plates are shown in Figure 1 below, and are indicated with the orange and dark orange colors.

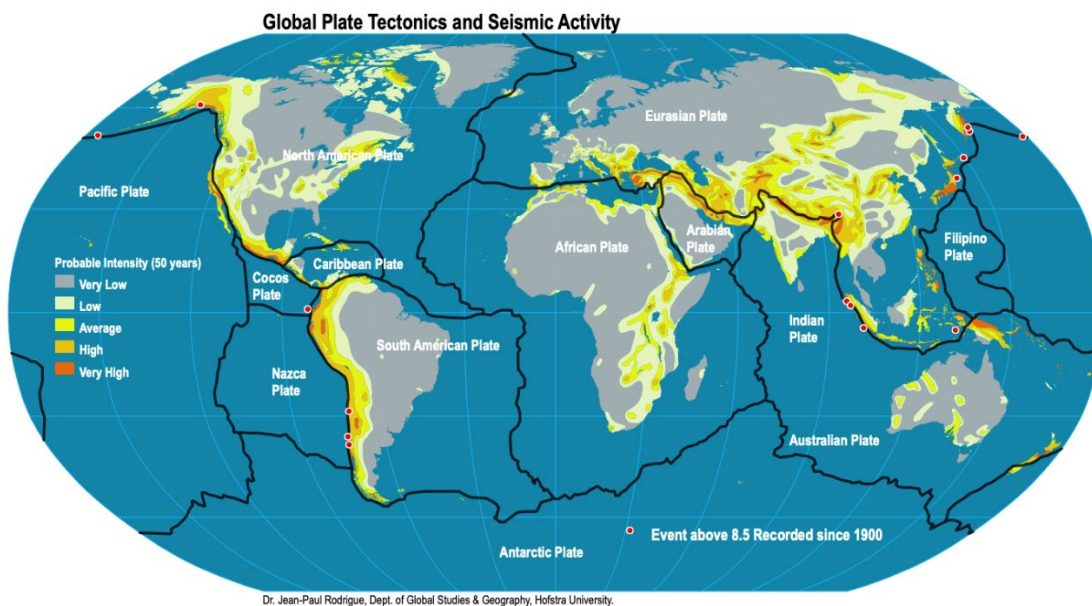


Figure 1: Global Plate Tectonics and Seismic Activity Map (Rodrigue, n.d.).

As mentioned before, the earthquake is one of the most frequent and detrimental natural disasters (Ritchie & Rosada, 2022). Earthquakes have different kinds of consequences for the world and the areas where they occur. These consequences can be defined along the lines of social, environmental, and economic aspects (Potter et al., 2015). The social consequences of an earthquake are, for example, the number of casualties, displaced or missing persons, and loss of social networks. The environmental

consequences of an earthquake are related to the level of destruction and disruption of the landscape; and the economic consequences of an earthquake are along the lines of the financial setbacks following the earthquake, the changes in infrastructure, and the costs related to rebuilding the affected communities (Potter et al., 2015).

As is apparent, the world has seen its fair share of detrimental earthquakes, with the most recent significant one being the earthquake that happened in Turkey and Syria on February 6th 2023 (The Associated Press, 2023). The aftermath of this earthquake, with a magnitude of 7.8 causing extensive damage and resulting in significant loss of life, was widely shared within the news (British Red Cross, 2024; The Associated Press, 2023; United Nations, 2023). However, one thing stands out with regard to the news that has been shared. It is the fact that only the social and environmental aspects, the number of deaths and damage to the areas, have been shared. The consequences that this earthquake had on the economy and certain business-related aspects were left out of the picture. Even though it is also important to mention and highlight the economic consequences of earthquakes, since recent literature pointed out that earthquakes not only affect communities and the environment, but also have detrimental consequences for organizations and their employees (Gregg et al., 2022; Kohn et al., 2012; Sadiq & Graham, 2016). Pointing to the previously stated gap in the literature on how earthquakes economically effect businesses.

Since the economic consequences of an earthquake with regard to MNE business performance are currently underrepresented in the literature, this study will focus on the global impact of earthquakes on MNE business performance. In order to do so, this research will focus on the relationship between the level of seismic impact and MNE business performance. Furthermore, it will also look at what influence firm size and firm age will have on this relationship.

2.2 Seismic impact and MNE business performance

As mentioned before, earthquakes can have various types of impact on society, such as social, environmental and economic affects (Potter et al., 2015). In order to make sure that a coherent answer can be given on the research question, this study will only look at the economic affects that earthquakes can have. The literature shows that there is already a lot of information available on what earthquakes can do the society and the environment, but not so much how it influences the business world (Gregg et al., 2022; Nielsen et al., 2023; Oh & Oetzel, 2022). The main focus of this research will thus be on the economic aspects of seismic impact, since this study focuses on the differences in business performance of MNEs. The economic consequences of earthquakes will be referred to as seismic impact throughout the remainder of this research.

Business performance is a concept that is widely known within the current literature and it has been defined by many researchers in an array of different definitions (Fainshmidt, et al., 2017; Geringer et al., 1989; Xue et al., 2020). According to Richard et al. (2009, p.722), business performance can be defined as "encompassing three specific areas of firm outcomes: (a) financial performance (profits, return on assets, return on investments); (b) product market performance (sales, market share); and (c) shareholder return (total shareholder return, economic value added)". Throughout this research, business performance will be assessed by looking at financial indicators, namely the profit levels of the firm. In particular, this paper will focus on the profit levels of MNEs by looking at the return on sales of the firm. This in order to enhance the comparability later on, since seismic impact is also measured in economic terms.

Current literature shows that natural disasters can have a significant influence on business performance (Altay & Ramirez, 2010; Fabeil et al., 2019). Altay and Ramirez's (2010) and Fabeil et al.'s (2019) studies show that natural disasters can have a severe negative impact on the business performance of MNEs. This negative impact is mostly explained by the physical damages resulting from the disasters, the unpreparedness of firms in response to the disasters, and from the emotional damage the employees experienced due to post-traumatic symptoms (Altay & Ramirez, 2010; Fabeil et al., 2019). However, the effect that earthquakes by themselves have on MNE business performance, has been given less attention.

Furthermore, some research has been done regarding the business environment and seismic impact. For instance, Donà et al.'s (2019) study examined the relationship between business recovery strategies and seismic impact and found that recovery strategies that do not require any initial investment are always worthwhile and thus generally applied when high levels of seismic impact have affected certain areas. Indicating that when seismic levels are high, there are significant effects on the social and environmental aspects of earthquakes, which require certain business recovery strategies in order to overcome and recover from those damages.

However, the literature lacks research that specifically focuses on seismic impact and the economic consequences of earthquakes, such as the effect on MNE business performance. The main relation that this research tries to explain is thus underrepresented in the literature. From what has been discussed above, however, it follows that the relation between seismic impact and MNE business performance is expected to be a negative relation. Additionally, the studies that qualitatively examined this relationship showed that the severe impact of natural disasters has led to poorer business performance of the examined firms (Altay & Ramirez, 2010; Donà et al., 2019; Fabeil et al., 2019), providing us with the first hypothesis:

H1: Seismic impact negatively influences the business performance of MNEs.

2.3 The role of firm size

Firm size can be defined in multiple ways and the best way to define it depends on the purpose of the study at hand (Shalit & Sankar, 1977). This research will use the size classification that the Orbis database uses to classify the different companies. There are four size classifications in Orbis, namely: small company, medium sized company, large company and very large company. These classifications are based upon the operating revenue, total assets, number of employees and whether the company is listed or not (Bureau van Dijk, n.d.2). The classifications will be further elaborated upon in chapter 3.3.3.1.

Over the last half century, a lot of research has been done regarding firm size, especially on firm size and profitability (Abeyrathna & Priyadarshana, 2019; Hall & Weiss, 1967; Niresh & Velnampy, 2014). For instance, Ozcan et al.'s (2017) study showed that there exists a statistically significant positive linear relationship between firm size and firm profitability. Furthermore, Serrasquero and Nunes' (2008) findings suggest that there is a positive relationship between the size and performance of small and medium-sized Portuguese companies.

However, other studies show that there is no considerable relationship between firm size and profitability. Abeyrathna and Priyadarshana (2019), for example, found that firm size has no considerable impact on the profitability levels of manufacturing firms in Sri Lanka. Additionally, Niresh and Velnampy (2014) also showed that size has no profound impact on the profitability of manufacturing firms.

Furthermore, most literature on firm size and performance shows that the bigger the firm, the higher the profitability, since they have more resources to create more products, which in return create more profits (Hall & Weiss, 1967; Ozcan et al., 2017; Serrasquero & Nunes, 2008). This argument logically follows from the resource-based view (hereafter RBV) of firms. The RBV suggests that firms' performance differs because of the different resource endowments that firms have access to (Lockett et al., 2009). Indicating that the more resources - more specifically VRIN (Valuable, Rare, Inimitable, Non-substitutable) resources - a firm has, the more chance of gaining competitive advantages it has, ultimately resulting in more sales (Lockett et al., 2009; Lockett & Thompson, 2001).

The relation between firm size, level of seismic impact, and business performance has had very little recognition in the literature. One could argue, however, that since larger firms have access to more resources (Wernerfelt, 2013), they could be more resistant to the negative consequences of high levels of seismic impact. This argument is supported by Chang et al., (2022), who found that recovery from disasters tends to be more difficult for smaller businesses since they have less access to recovery resources. This argument is further supported by the earlier mentioned fact that MNEs have the possibility to shift their operations between different locations, allowing them to better and more efficiently respond to sudden disasters, a possibility that smaller local firms do not possess (Buckley &

Ghauri, 2004; Dawar & Frost, 1999; Rugman & Verbeke, 2001). These studies thus indicate that smaller firms face more difficulty recovering from disasters due to their resource constraints. When looking at this argument from the other side, one could thus argue that bigger firms experience less difficulty recovering from disasters since they have better access to the necessary resources.

Combining all of the information above brings us to the following possible conclusion: the bigger the firm, the more resources it has available to adequately deal with the consequences of earthquakes. On the other hand, smaller firms have less availability to the necessary resources and would thus not be able to adequately deal with the consequences of earthquakes. Firm size will thus positively influence the main relationship when it concerns big firms, and negatively influence the main relationship when it concerns small firms, providing us with the second hypothesis:

H2: Firm size has a positive moderating effect on the main relationship. Where bigger firms have a positive moderating effect on the main relationship and smaller firms have a negative moderating effect on the main relationship.

2.4 The role of firm age

Firm age is often defined as the period of existence of the firm (Ilaboya & Ohiokha, 2016). There is some controversy on the best method of measuring a firm's age. Ilaboya and Ohiokha (2016) and Pickering (2011) suggest that it relates to a firm's date of incorporation as a legal entity. Referring to the number of years of incorporation of the company. Shumway (2001), however, argues that listing should be used to define firm age, because a company's life starts from the moment of listing. This study will define firm age as the number of years of incorporation of the company, since it is more grounded and commonly used in theory (Ilaboya & Ohiokha, 2016; Pickering, 2011).

Quite some research has already been done on the relationship between firm age and profitability, mostly in combination with firm size. As mentioned before, the literature has mixed results on the relationship between the three variables. Some scholars indicate a positive relationship between firm size, firm age and profitability (Halil & Hasan, 2010; Papatogonas, 2007), whereas others show a negative relationship (Dogan, 2013; Majumdar, 1997).

When looking at the relationship between firm size and firm performance alone, there is also some ambiguity. Some literature suggests that a positive relationship can be seen (Coad et al., 2013; Kipesha, 2013; Osunsan et al., 2015), whereas others suggest a negative relationship (Loderer & Waelchli, 2010; Majumdar, 1997). Coad et al. (2013) revealed that older firms have higher productivity and profits, larger size, lower debt, and that they are better able to convert sales growth into subsequent profits. These findings are consistent with Kipesha's (2013) study, which also found a

significant positive relationship between firm age and its financial performance. Additionally, Osunsan et al.'s (2015) study found that experience through age helps firms to perform better.

The negative relationship follows from the fact that, due to rapid globalization and digitalization, older firms often fall behind and experience a stagnation of growth, leading to lower revenue levels, since the costs stay the same or sometimes even get higher and the profit levels go down (Loderer & Waelchli, 2010; Majumdar, 1997).

The relation between firm age, level of seismic impact and business performance has had very little recognition in the literature. However, since more literature supports the positive relationship between firm age and firm performance, this study will follow that thought. Following Osunsan et al.'s (2015) study, it shows that older firms are better able to recover from disasters, since they have more experience in navigating tricky situations. Furthermore, previous research highlights that MNEs learn from their own past experience with disasters to form their response decisions (Oh & Oetzel, 2022), indicating that older firms have more overall experience and knowledge in how to react to sudden external shocks, like earthquakes. Moreover, since Coad et al.'s (2013), and Kipesha's (2013) studies all showed that firm age is positively related to firm performance one can assume that older firms generate higher levels of profits due to their past experiences and greater abilities to convert sales growth into profits.

Following the logic presented above, the following possible conclusion can be drawn: the older the firm, the more experience it has, the better it is able to handle tricky situations and the more profit it can generate. On the other hand, younger firms have less experience and will thus have a harder time dealing with the tricky situations that are associated with earthquakes. Older firms will thus positively influence the main relationship, whereas younger firms will negatively influence the main relationship, providing us with the third hypothesis:

H3: Firm age has a positive moderating effect on the main relationship. Where older firms have a positive moderating effect on the main relationship and younger firms have a negative moderating effect on the main relationship.

2.5 Conceptual model

To sum up all of the abovementioned hypotheses, a conceptual model has been made. This model can be found in Figure 3 below. The conceptual model used in this study contains four variables: the dependent variable, which is business performance; the independent variable, which is the level of seismic impact; and the moderators, which are firm size and firm age.

This conceptual model shows H1, which proposes that higher levels of seismic impact leads to poorer business performance. H2 and H3 can be seen in the expectation that the bigger or older the

firm, the less negative the main relation is expected to be. Indicating that the bigger and older the firm, the less business performance will be lost.

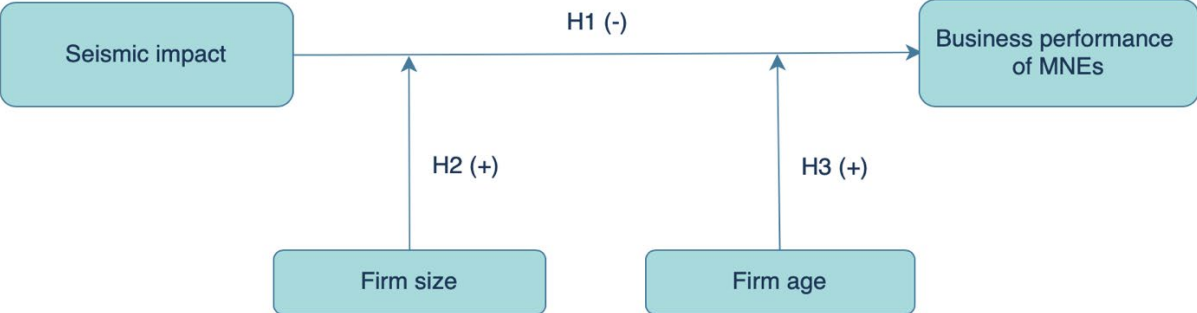


Figure 3: Conceptual model.

3. Methodology

This section discusses the methods and data used for conducting this study. The first section will discuss the research method that was chosen for this particular study. The section after that will describe the data collection method and the precise sample description. Next, the dependent, independent, moderating, and control variables will be described, along with all of their metrics. The statistical model will be highlighted in chapter 3.4. Finally, this chapter will finish with the research ethics this study will abide by.

3.1 Research method

Based on the following reasons, a quantitative research approach will be taken in order to answer the research question. First of all, quantitative research allows for the collection and analysis of numerical data (Field, 2018; Hair et al., 2019), which is essential for understanding the magnitude and scope of the impact of earthquakes on business performance. By quantifying variables such as profitability, researchers can objectively measure the extent to which earthquakes affect multinational enterprises.

Moreover, quantitative research facilitates the exploration of moderating factors (Field, 2018; Hair et al., 2019), such as firm size and firm age, that may influence the relationship between earthquakes and MNE business performance. By collecting data on various firm characteristics, including size, age, and profit researchers can assess whether the impact of earthquakes on business performance varies depending on the size and age of the multinational enterprise. This quantitative analysis enables researchers to identify potential moderators and better understand the nuances of how earthquakes affect different types of businesses.

Furthermore, quantitative research allows for generalization of findings to broader populations (Field, 2018; Hair et al., 2019). By collecting data from a representative sample of multinational enterprises across different industries and regions, researchers can draw conclusions that are applicable beyond the specific companies and contexts studied. This generalizability enhances the practical relevance and applicability of the research findings for policymakers, business leaders, and other stakeholders concerned with understanding the implications of earthquakes on multinational enterprises.

3.2 Data collection

The data for the dependent variable, business performance, will come from the Orbis database. Orbis is a comprehensive global database of corporate information and financial data provided by Bureau van Dijk (Moody's, 2024). It is one of the most extensive company databases, as it contains information on millions of public and private companies from around the world (Moody's, 2024). Orbis collects its data from various sources, including annual reports, company websites, news sources and other public and private databases (Moody's, 2024). Bureau van Dijk has a team of data analysts

that collect, verify, and update the information regularly to ensure its accuracy and reliability (Moody's, 2024). The database covers a wide range of company data, such as financial statements, ownership structures, corporate governance details, and much more. The data for return on sales, otherwise known as profit margin, can be found within this database. The data can be accessed by logging in via a student's personal Radboud University account.

Since this study looks at the business performance of MNEs, it is important to highlight what MNEs exactly are. An MNE can be defined as an enterprise that engages in foreign direct investment (FDI) and which contains value-added activities in several countries (Dunning & Lundan, 2008). Since MNEs are actively operating in at least two countries, it can be rather difficult to assess the profit levels of all subsidiaries altogether. Therefore, this paper will only look at the MNE business performance as the profit levels of the headquarters (HQ) of the firm. In other words, it will only look at the financial levels of the originally established firm before the MNE went abroad. This in order to make sure that all MNEs are measured the same throughout this research. The measurement of seismic impact, which will be further explained below, will therefore also be assessed by looking at the seismic impact levels of the home country of the MNE.

The data for the independent variable, seismic impact, will come from the National Oceanic and Atmospheric Administration/National Centers for Environmental Information, otherwise known as the NOAA/NCEI, database. It is a publicly available database with the purpose of "providing environmental data, products, and services covering the depths of the ocean to the surface of the sun to drive resilience, prosperity, and equity for current and future generations" (NOAA/NCEI, n.d.1). The database is run by the NOAA, which is an agency within the US Department of Commerce, and the NCEI, which is one of its primary centers responsible for archiving and providing public access to a wide range of environmental data, including climate, weather, ocean, and geophysical data (NOAA/NCEI, n.d.2). The data is updated regularly and comes from many different sources, including individual researchers, other government organizations, and research institutions from all over the world (NOAA/NCEI, n.d.2).

The data for the moderators, firm size and firm age, will also come from the Orbis database, since both firm size classifications and year of incorporation can be found within this database. Both control variables will also use data from the Orbis database, since both the measure for industry, the NACE codes, as well as for risk, the liquidity ratio, can be found within this database.

3.2.1 Sample size and description

Out of the data available, it is necessary to create a data file that fits the needs of this research. The first step is to decide what time period this study wants to focus on. Since the Orbis database does not always have all data available for all past years, it is important to assess what years are available for the variables used in this research. After filling in the variables into Orbis, it became clear that for almost all variables, the years 2013 till 2022 were completely present. The timeframe for this study will therefore be from 2013 till 2022.

Next, it is important to consider what countries to include in the final dataset. Since this study aims to look at the global influence, it is important to determine what areas were impacted by earthquakes over the timeframe of 2013 till 2022. By using the NOAA/NCEI database, it showed that the following countries were hit by earthquakes over the given time period: Balkans, Chile, China, Ecuador, Greece, India, Indonesia, Iran, Italy, Japan, Mexico, Myanmar, Nepal, New Zealand, Pakistan, Papua New Guinea, Philippines, South Korea, Taiwan, Tanzania, Thailand, United States. The previously mentioned countries were also selected in Orbis for the given time period to produce a list of companies that could be used for this particular analysis.

Lastly, the decision was made to focus on only the listed companies that were available in Orbis. The reason behind this is due to the fact that listed companies are more consistent with updating their information on a yearly basis than non-listed companies are (Moody's, 2024). Combining all selections, Orbis delivered 77,6785 multinational companies from the 28 countries mentioned above, over the time period of 2013 till 2022. The data from the NOAA/NCEI database was entered into this Orbis dataset, by adding the damage data for the given earthquake per year and country to the matching home country of the MNEs.

3.3 Operationalization

3.3.1 Dependent variable

The evaluation of business performance can be measured in numerous ways (Xue et al., 2020). Since this study is aiming to look at the profit levels that are generated by MNEs, the measures for the daily operations could be useful. Where gross profit indicates how much of the revenue remains after accounting for costs, ROA, ROS and ROE evaluate the performance and profitability of a company (Xue et al., 2020). Because this study aims to look at the profit levels achieved by MNEs, the most useful metric will be the ROS. ROS, or profit margin, measures the percentage of profit generated by a firm from its sales revenue (Corporate Finance Institute, 2023). This study will refer to ROS as the profit margin throughout the remainder of this report. A higher profit margin indicates better profitability from its sales, thereby indicating a higher profitability of the firm. This measure is at the ratio measurement level, since there is a true zero point and the data can be categorized or ranked (Field, 2018; Hair et al., 2019).

The formula of this metric in Orbis, which this study will use, is:

$$ROS \text{ or profit margin} = (\text{Net income} / \text{total sales revenue}) * 100 \quad (1)$$

3.3.2 Independent variable

Even though seismic impact is commonly referred to as entailing all three consequences; the social, environmental and economic consequences of earthquakes (Potter et al., 2015), this thesis will define seismic impact along the lines of only the economic consequences. As seen before, economic consequences of an earthquake are usually defined by looking at the financial setbacks following the earthquake, the changes in infrastructure, and the costs related to rebuilding the affected communities and areas (Potter et al., 2015).

The database that will be used to capture these consequences is the NOAA/NCEI database. This database captures all three consequences within the same database. The database covers a lot of different variables, however, not all variables that are present within this database will be used for this specific research. For this research, we only need to represent the economic consequences of earthquakes. The variable 'Damage' will therefore be used and it considers the damage in millions of \$ in costs needed to restore the area and its buildings to pre-earthquake state (NOAA/NCEI, n.d.2). This study will thus only focus on the following two variables from the NOAA/NCEI database:

- Year: from 2013 till 2022.
- Damage in millions of \$: all values over 0.

3.3.3 Moderators

Firm size

As mentioned in chapter 2.3, firm size can be defined along many different ways. This research will use the size classification that the Orbis database uses to classify the different companies. There are four size classifications in Orbis, namely: small company, medium sized company, large company and very large company.

The following criteria are used in order to be classified into a certain size classification. Companies are considered to be very large companies in Orbis when they meet all of the following criteria: operating revenue greater than or equal to 10 million euros / total assets greater than or equal to 20 million euros / employees greater than or equal to 150 / and the company is listed (Bureau van Dijk, n.d.2).

Companies are considered to be large by Orbis when they meet all of the following conditions: operating revenue greater than or equal to 100 million euros / total assets greater than or equal to 200 million euros / employees greater than or equal to a thousand / they are under the criteria for the very large companies / and the company is listed (Bureau van Dijk, n.d.2). Medium sized companies need to adhere to all of the following criteria: operating revenue greater than or equal to 1 million euros /

total assets greater than or equal to 2 million euros / employees greater than or equal to 15 / they are under the criteria for the very large and large companies / and the company is listed (Bureau van Dijk, n.d.2). A company is considered to be small when it is not included in any of the three categories mentioned above (Bureau van Dijk, n.d.2).

In order to run the analysis, dummy variables have been created for each of the size classifications. The dummy variables Medium, Large, and VeryLarge will correspond to big firms, whereas the dummy variable Small, will refer to small firms.

Firm age

Firm age will be measured by looking at the number of years of incorporation of the company. The Orbis database has data on the year of incorporation of millions of public and private companies from all around the world, and will therefore be used in evaluating and assessing this variable.

Scholars usually find a firm to be young when it has been in operation for up to 5 years, and old when they have been in operation for more than 5 years (Noordin & Mohtar, 2014). This study will follow this distinction and will thus define firms to be young up to 5 years since incorporation and define firms to be old when they are 5 years or older. In order to use this distinction in the analysis, dummy variables were created. Since the years of incorporation run back to the 1800s, the years have first been converted to centuries. The years 1800-1899 form century 19, the years 1900-1999 form century 20, the years 2000-2017 form century 21 and the years 2018-2022 form century 22. Century 22 was created to highlight the first 5 years in operation, when a firm is still considered to be young. For each century, a dummy variable was created. The dummy variables for centuries 19, 20 and 21 thus refer to old firms, whereas century 22 refers to young firms.

3.3.4 Control variables

Control variables are variables that are held constant in order to prevent them from interfering with the results (Field, 2018; Hair et al., 2019). Control variables that are of importance with regard to assessing business performance, as proposed by prior studies, are: size of the firm, industry, age of the firm, and risk (Moohammad, et al., 2014). Since firm size and firm age are used as moderators in this study, they will not be controlled for in the analysis.

Industry

Each industry has unique characteristics, competitive dynamics, and market conditions that significantly influence business performance (Porter, 1979). When assessing a firm's performance, controlling for industry helps ensure that comparisons are made with relevant competitors, accounting

for differences in industry norms, regulations and market conditions (Moohammad, et al., 2014). In order to measure industry quantitatively, several approaches can be taken. This research will use the industry classification of NACE-rev2 codes, that are available within the Orbis database (Bureau van Dijk, n.d.1). These codes refer to the sector within which the business is operating. All of the different codes within this NACE-rev2 classification system are presented in Appendix 1.

Risk

Risk is inherent in business operations and can arise from various sources, including economic volatility, market uncertainties, operational challenges, and external shocks (Aaker et al., 1987; Miller et al., 1988). Controlling for risk factors helps account for the potential impact of uncertainty on business performance and allows for a more nuanced analysis of company performance relative to its risk exposure (Moohammad, et al., 2014). Since risk can result in both positive and negative effects with regards to business performance, it is important to keep the variable constant when looking at the main variable.

By looking at financial ratios such as the liquidity ratio, or profitability ratio, one can assess a company's risk profile (Aaker et al., 1987). These metrics provide insights into the company's financial health, stability, and ability to withstand adverse market conditions (Xue et al., 2020). This study will use the liquidity ratio, which is used to determine a company's ability to pay its short-term debt obligations and is calculated by dividing total current assets by total current liabilities (Corporate Finance Institute, 2023). The data on liquidity ratios can be found within the Orbis database.

The formula of this metric in Orbis, which this study will use, is:

$$\text{Liquidity Ratio} = (\text{total current assets} / \text{total current liabilities}) * 100 \quad (2)$$

3.3.5 Overview of the variables

To sum up the definitions of the variables, how they are measured and what databases will be used in this study, Table 1 below was created.

Table 1: Overview of the variables, how they are measured and where the data comes from.

Variable definition	Measures	Data sources
Business performance	Profit margin (%).	Orbis
Seismic impact	Per location: year and damage (in \$ millions).	NOAA/NCEI
Firm size	Firm size classification.	Orbis
Firm age	Year of incorporation.	Orbis
Industry	NACE (code for industry classification).	Orbis
Risk	Liquidity ratio.	Orbis

3.4 Method of analysis

The method of analysis for this research will be a regression analysis. This decision has been made based on the evaluation of what type (continuous or categorical) and how many outcome and predictor variables this research has. Since this study has one continuous outcome variable - business performance - and multiple continuous predictor variables - level of seismic impact, firm size, firm age, industry and risk - the most fitting method of analysis is the regression analysis (Field, 2018; Hair et al., 2019), specifically the multiple regression analysis.

However, since this study uses panel data, this thesis will analyze the data using a random effects model. The random effects model can account for unobserved heterogeneity in the data, leading to more accurate parameter estimates (Field, 2018; Hair et al., 2019). Furthermore, it can be used to model the correlation structure of the data, which is particularly important in clustered and panel data, which this thesis uses (Field, 2018; Hair et al., 2019).

Assumptions

Each analysis knows its own assumptions. Since this research will use multiple regression analysis, the multiple regression analysis assumptions apply and should be met before running the analysis.

According to Hair et al. (2019) the multiple regression analysis assumptions are to be examined in four areas:

1. Linearity of the phenomenon measured (linearity).
2. Constant variance of the error terms (homoscedasticity).
3. Normality of the error term distribution (normality).
4. Independence of the error terms (multicollinearity).

Chapter 4.2 will dive deeper into the assumptions and how they are met.

3.5 Research ethics

Since this research uses secondary data, assessing the ethics of this research is somewhat harder. In order to evaluate how ethically the data has been retrieved, it is essential to look at how the data was gathered by the original researcher(s). Since both databases - the NOAA/NCEI and Orbis - are publicly available sources, it can be assumed that the data it contains has been ethically sourced. As mentioned before, Orbis gathers its data from a variety of sources, such as annual reports, company websites, news sources and other public and private databases. Furthermore, since Orbis is a product of Bureau van Dijk, they employ a team of data analysts who collect, verify, and update the information regularly to ensure its accuracy and reliability.

The NOAA/NCEI database is a product of data that is gathered with the help of several data sources, with some of them being individual researchers, other government organizations, and research institutions from all over the world. This database also has a team of data analysts that collect, verify and update the information regularly to ensure its accuracy and reliability. Furthermore, there are

certain criteria that the data has to adhere to before the data can be added to the NCEI archive. Some of these criteria are, for example, the NOAA Procedural Directives, certain project-specific guidelines that apply to the NOAA funded projects, and the scientific appraisal process which applies to data collected without NOAA funding or support (NOAA/NCEI, n.d.2).

4. Results

Chapter four will show the statistical results derived from the methods described in the previous chapter. The first paragraph will describe the dataset using the descriptive statistics table. The following chapter will test the assumptions as discussed in chapter 3.4. The next section will show the regression results, providing answers to the formulated hypotheses from chapter 2. Lastly, the robustness of the results will be examined.

4.1 Descriptive statistics

The following section will provide context to the data before running the regression analysis. To elaborate some more on the variables in the dataset, a short explanation will be given on the variable seismic impact and what the 'N' stands for in this particular study. A single 'N' in this analysis stands for a company in a particular year. Since this study uses panel data, the companies featured in this study will occur several times, from 2013 till 2022. Furthermore, the variable seismic impact is also measured per year. In some countries, multiple earthquakes occur in one year. In this case, the sum of the seismic impacts for that year have been used, for example, in 2014 two earthquakes occurred in China, so the sum of these two earthquakes has been taken and used as the singular measure for the year 2014 for seismic impact in China.

Table 2 below shows all six variables used and their respected frequency distributions. The six variables consist of four main variables: the outcome variable, which is MNE business performance; and the three predictor variables consisting of the independent variable seismic impact, and the moderators' firm size and firm age. The two control variables, industry and risk, have been added for interpretation purposes.

Table 2: Frequency distributions for all variables.

	Mean	Std. Deviation	Skewness Statistic	Skewness Std. Error	Kurtosis Statistics	Kurtosis Std. Error
MNE Business Performance	5.621	21.267	-.901	.005	5.766	.009
Seismic impact	858.035	2785.954	4.624	.005	24.741	.009
Firm size	3.929	.335	-5.316	.005	30.262	.009
Firm age	1990	24.210	-2.192	.005	8.514	.009
Industry	3956	2185.473	.561	.005	-.650	.009
Risk	2.317	4.807	9.928	.005	135.707	.009

As can be seen in the Table 2 above, the data shows high levels of positive kurtosis, otherwise known as a leptokurtic distribution (Field, 2018; Hair et al., 2019). These high levels of kurtosis can also be found in the Histogram, which is shown in Appendix 2, by looking at the heavy-tailed distribution. Normally, high levels of kurtosis are a sign that there is a high risk of outliers and that some transformations should be made to the data before running the analysis (Field, 2018; Hair et al., 2019).

Typically, one would run the significance tests of skew and kurtosis to show whether the assumptions are violated or not (Field, 2018; Hair et al., 2019). However, according to Field (2018), since this is a very large sample (> 500), the significance tests of skew and kurtosis should not be used, because the tests are likely to be significant even when they are not too different from normal.

Moreover, kurtosis is expected to be rather high when looking at data that has to do with extreme events, such as financial market crashes and natural disasters (Field, 2018). Since this study is looking at one particular type of natural disaster, the earthquake, it was expected that the kurtosis values for this dataset would be quite high. It is therefore decided at this stage to not transform the data, since the unique values from the earthquake specific data could get lost if the data would be transformed.

Next, a missing value analysis is conducted to see whether the number of missing values is problematic. According to Field (2018) and Hair et al. (2019), this happens often and has to be examined before conducting further analyses. If missing values are below 10%, they should not pose a problem (Field, 2018). As can be seen in Table 3, the highest percentage of missing values is 0.2%, which is well below to 10% threshold. Indicating that the missing values of this sample are not problematic and can be included in the analysis.

Table 3: Missing value analysis.

	Missing Count	Missing Percent
MNE Business Performance	28	.0
Seismic impact	28	.0
Firm size	28	.0
Firm age	279	.1
Industry	534	.2
Risk	28	.0

4.2 Assumptions

Before the analysis can be run, a few assumptions must be met. Each analysis knows its own assumptions. Since this research will use a random effects model, the multiple regression analysis assumptions should be applied and met. The assumptions for the multiple regression are described in chapter 3.4.1.

The first assumption, linearity, can be easily examined by looking at the scatter plot (Hair et al., 2019). The same goes for the second assumption, homoscedasticity (Hair et al., 2019). The scatterplot presented in Appendix 2.3, which has been conducted for all 6 variables, shows a negative and slightly

correlated relationship. Indicating that when seismicity of earthquakes increases, the business performance decreases, which was also theoretically supported in chapter 2.2.

As can be seen, the data points follow a downward, linear pattern, suggesting a negative linear relationship between the variables. Thereby supporting the linearity assumption, since a downward, linear pattern simply suggests that a linear relationship exists, albeit it being a negative one. Furthermore, on the basis of the scatterplot in Appendix 2.3, it can be concluded that the observed values of the variables are fairly evenly distributed, thereby satisfying the assumption of homoscedasticity.

For the third assumption, normality, one can look at the histogram and the P-P plot (Field, 2018; Hair et al., 2019). As seen in chapter 4.1, in Table 2, some variables had a very high kurtosis value. This can also be seen in the histogram in Appendix 2.1, since high positive values of kurtosis, result in a heavy-tailed distribution (Hair et al., 2019). As explained before, the reason for the high values of kurtosis in this dataset are due to the fact that this dataset is resolved around an extreme event, the earthquake. Therefore, the values will be kept within the database and no alterations will be made before running the regression analysis.

The P-P (probability-probability) plot, is a graphical tool used in statistics to assess the goodness of fit, the departure from normality, and provides insights into the shape of the distribution (Field, 2018; Hair et al., 2019). As one can see in Appendix 2.2, the points on the plot form an S-shaped curve above the diagonal line, suggesting that the distribution has heavier tails than the theoretical distribution (Field, 2018; Hair et al., 2019). Supporting the results from the histogram in Appendix 2.1, and the descriptive statistics in Table 2.

For the final assumption, multicollinearity, it is important to look at the VIF (Variance Inflation Factor) and tolerance levels of the model (Field, 2018; Hair et al., 2019). The VIF and tolerance levels are represented in Appendix 2.5. The VIF is a measure of multicollinearity between each independent variable and the other independent variables in the model. A VIF value of 1 indicates no multicollinearity, whereas VIF values greater than 10 suggest significant multicollinearity. The tolerance is the reciprocal of VIF and indicates the proportion of variance in an independent variable that is not explained by the other independent variables in the model. Tolerance values close to 1 indicate low multicollinearity, whereas values closer to 0 suggest high multicollinearity. Appendix 2.5 shows that the model has low VIF (highest value of 1.010, indicating little to no multicollinearity) and high tolerance values (lowest .991, indicating low multicollinearity), suggesting that there are no problematic values in terms of multicollinearity.

To verify this result, a correlation matrix is constructed from all used variables. The output of this correlation matrix can be found in Appendix 2.4. The Pearson Correlation is used to find

multicollinearity among the variables (Hair et al., 2019). Most scholars accept a broad level of >0.8 before indicating problematic collinearity, while others believe a value of >0.5 is a sign of caution (Field, 2018; Nettleton, 2014). Since the values in the model used for this thesis are not even close to reaching the >0.5 level, they meet the assumption of no multicollinearity and verify the previously mentioned results. Now that the final assumption is met, the regression analysis can be executed.

4.3 Regression Analysis

The random effects model for the multiple regression analysis, with all variables was carried out with a sample size of 273130. The results of each model and its respective findings can be found in Table 4, where significant findings are shown with one asterik for $p < .05$, two asteriks for $p < .01$, and three asteriks for $p < .001$.

Table 4: Overview of the regression results of all 6 models and its respective variables.

	BUSINESS PERFOR- MANCE (1)	BUSINESS PERFOR- MANCE (2)	BUSINESS PERFOR- MANCE (3)	BUSINESS PERFOR- MANCE (4)	BUSINESS PERFOR- MANCE (5)
Seismic impact	0.000*** (1.228E-5)	0.000*** (0.000)	0.000*** (0.000)	0.000*** (0.000)	0.000*** (0.000)
Industry	0.000*** (4.204E-5)	0.000*** (0.000)	0.000*** (0.000)	0.000*** (0.000)	0.000*** (0.000)
Risk	0.353*** (0.008)	0.359*** (0.008)	0.363*** (0.008)	0.353*** (0.008)	0.353*** (0.008)
Sample size (N)	273130	623	272507	269282	3848
* $p < 0.05$	** $p < 0.01$	*** $p < 0.001$			

4.3.1 Model 1

In Table 4 above, an overview can be seen of all five models. The first model was performed with the entire sample size of 273130, in order to assess the effects of control variables industry and risk on the likelihood that earthquakes have a negative effect on the business performance of MNEs. The main relationship whilst controlling for the control variables is thus tested in this model. When looking at the results from model 1 in Table 4, we can conclude that damage ($\beta = 0$, $p < .001$) has no significant influence on the business performance of MNEs.

4.3.2 Model 2

The second model was performed with a sample size of 623, which contains only the small firms. This in order to assess what kind of effect a small firm size has on the relationship between seismic impact and MNE business performance. Looking at the results of this model in Table 4, we can see that the effect of damage has remained the same ($\beta = 0$, $p < .001$). Indicating that smaller firms have no moderating effect on the main relationship.

4.3.3 Model 3

The third model was performed with a sample size of 272507, which contains only the big firms. This in order to assess what kind of effect a big firm size has on the relationship between seismic impact and MNE business performance. Looking at the results of this model in Table 4, we can see that the effect of damage has remained the same ($\beta = 0, p < .001$). Indicating that bigger firms also have no moderating effect on the main relationship.

4.3.4 Model 4

The fourth model was performed with a sample size of 269282, with only old firms in the sample. This in order to assess whether old firms have an influence on the relationship between seismic impact and MNE business performance. Looking at the results of this model in Table 4, we can see that damage still remains the same ($\beta = 0, p < .001$). Indicating that old firms do not have a moderating effect on the main relationship.

4.3.5 Model 5

The fifth model was performed with a sample size of 3848, with only the young firms. This in order to assess what kind of effect a young firms have on the relationship between seismic impact and MNE business performance. Looking at the results of this model in Table 4, we can see that the effect of damage has again remained the same ($\beta = 0, p < .001$). Indicating that young firms have no moderating effect on the main relationship.

4.3.7 Hypotheses

Table 5 presents an overview of the hypotheses results. The first hypothesized effect of this thesis is a negative effect of seismic impact on business performance of MNEs. This hypothesis, although theoretically supported, could not be supported by the data used within this research. The data found no significant influence of seismic impact on business performance, whereas theory suggested a negative influence was to be found. The first hypothesis is therefore rejected.

The second hypothesis expected a positive moderating effect of firm size on the relationship posed in the first hypothesis, where bigger firms have a positive moderating effect on the main relationship and smaller firms have a negative moderating effect. The data does not support this hypothesis, since both model 2 and 3 did not have any moderating effect on the main relationship. Thereby rejecting the second hypothesis.

The third and final hypothesis expected a positive moderating effect of firm age on the relationship posed in the first hypothesis, where older firms have a positive moderating effect on the main relationship and younger firms have a negative moderating effect. Although theoretically supported, the data used within this research could also not support this hypothesis. The data showed that both older and younger firms do not yield a moderating effect on the main relationship. Thereby rejecting the third hypothesis, resulting in a rejection of all three hypothesis.

Table 5: Overview hypotheses results.

	Hypothesis	Accepted
1	Seismic impact negatively influences the business performance of MNEs.	No
2	Firm size has a positive moderating effect on the main relationship. Where bigger firms have a positive moderating effect on the main relationship and smaller firms have a negative moderating effect on the main relationship.	No
3	Firm age has a positive moderating effect on the main relationship. Where older firms have a positive moderating effect on the main relationship and younger firms have a negative moderating effect on the main relationship.	No

4.4 Validation of results

To check whether the multiple regression results are robust, several steps are taken to validate the results. In Chapters 1 and 2, we saw that seismic impact can be defined along three types of consequences, the social, environmental and economic consequences. Since this study had the primary focus on the financial aspects of MNEs, it was decided to only focus on the economic consequences of seismic impact. To check the validity of the results, the same model will be run, but now with either the social consequences or the environmental consequences. Two more models will thus be executed to check whether the results hold.

The first robustness check is executed for the social consequences of earthquakes. This variable is measured by looking at the number of deaths that follow an earthquake. In this model, the variable seismic impact thus entails the social consequences instead of the economic consequences. The results of this regression analysis can be found in Appendix 3.1. We can see that this time, the regression results show a significant positive relationship between seismic impact and MNE business performance (beta = .001, $p < .001$).

The second robustness check is executed for the environmental consequences of earthquakes. This variable is measured by looking at the magnitude of the earthquakes. In this model, seismic impact thus refers to the environmental consequences instead of the economic consequences. The results of this regression analysis can be found in Appendix 3.2. We can see that this time, the regression results show a significant positive relationship between seismic impact and MNE business performance (beta = .090, $p < .001$). By looking at seismic impact from the environmental point of view, we can see that this measurement method yields the highest positive results.

5. Discussion

In the paragraphs below, the regression results will be compared with the current literature. None of the three hypothesized effects was found to be present in the used sample. The possible explanations for the absence of the predicted effects are discussed in this following chapter. The primary hypothesized effect will be addressed first, followed by a discussion on the moderating firm characteristics, and the chapter ends with a brief debate on the control variables.

5.1 Seismic impact and MNE business performance

The first hypothesized effect in this study is the effect of seismic impact on business performance of MNEs. This effect was hypothesized to be negative, whilst the multiple regression results gave a deviating result and showed no effect from seismic impact on increasing or decreasing the business performance of MNEs. This is an unexpected result, especially after the conclusions drawn by Altay and Ramirez (2010) and Fabeil et al. (2019), whom did establish a relationship in similar studies but focused on natural disasters in general.

One plausible reason for this surprising result could be that the hypothesized negative effect of seismic impact on business performance only applies to local firms and not to MNEs. As mentioned in chapter one, since MNEs are located in multiple countries and locations, it is easier for them to retract their businesses from certain areas and move them to their other locations in order to keep their business performance afloat (Buckley & Ghauri, 2004; Rugman & Verbeke, 2001). Local firms on the other hand, are only operating in one place and location, and do not have the luxury of moving their operations elsewhere to ensure the survival of their company (Dawar & Frost, 1999). Explaining why the business performance of MNEs in this study is not affected by seismic impact. This would then also explain why other authors found significant results that support the hypothesized effect (Altay & Ramirez, 2010; Fabeil et al., 2019) and why the broader sample of this thesis does not yield similar findings.

The robustness checks provide other possible explanations for not finding a relationship between seismic impact and MNE business performance in the sample. This is attributed to the measurement method of seismic impact, as using the social and environmental consequences instead of the economic consequences resulted in a positive relationship between seismic impact and MNE business performance. Even though the robustness checks show the opposite of the hypothesized results, they do yield significant relationships in comparison to the original model. Looking at all three measurement methods, it becomes clear that the environmental consequences yield the highest positive, significant results. Indicating that the damage to the environment in a particular location has more (positive) effect on business performance than the number of deaths or financial losses has.

5.2 Firm characteristics

Within chapter two, two moderating effects were hypothesized on the relationship between seismic impact and MNE business performance; firm size and firm age. It was hypothesized that both moderating effects would be positive. However, the analysis resulted in no significant moderating effects on the main relationship. The plausible reasoning behind these results will be discussed below.

Both firm size and firm age showed no significant relationship as a moderator in the regression results. Instead of the hypothesized positive effect, firm size and firm age showed no moderating effect on the main relationship. As mentioned before, the current literature provides the notion that firm size and firm age have an ambiguous relationship with the performance of a firm (Dogan, 2013; Halil & Hasan, 2010; Ilaboya & Ohiokha, 2016; Majumdar, 1997; Papatogonas, 2007), hence why they were chosen as moderators in this research. However, the results of this study indicate that these variables do not pose moderating effects on the business performance of MNEs, once they have been hit by an earthquake.

One plausible explanation could be that since MNEs have geographically diversified operations (Dawar & Frost, 1999), this diversification could dilute the impact of a seismic event in one location. Given the fact that all MNEs can relocate their operations in order to ensure survival, no matter their age or size, this could help explain why firm size and firm age turned out to have no moderating effect on the main relationship. Another plausible explanation could be explained by government and regulatory support. Government policies and support mechanisms, such as subsidies for disaster recovery or strict building codes, might be equally accessible to firms, no matter their age or size. Thereby minimizing the differences that firm size and firm age could otherwise create.

5.3 Control variables

The results of the control variables also call for further discussion. Industry and risk are, in theory, well-established predictors of MNE business performance (Moohammad, et al., 2014). However, only risk was found to be significant in affecting the main relationship. This result was as expected and contributes to the extensive literature on the firm characteristics and its influence, in this case, on business performance (Moohammad, et al., 2014).

Regarding industry, no effect was found from industry increasing or decreasing the main relationship of seismic impact and business performance of MNEs. One plausible explanation could be that earthquakes are so destructing, that it does not matter in what sector you are operating in order to feel the consequences. Therefore, resulting in the absence of an effect on business performance.

6. Conclusion

The final chapter of this thesis concludes the most important findings and puts forward implications for academics and managers. The limitations of this research will be listed within paragraph 6.3, and finally, the main body of this thesis will be concluded with insights that could guide future research.

6.1 Concluding

This thesis aimed to provide better insights into the effect of earthquakes on MNE business performance. A secondary aim was to view and evaluate potential moderators of this relationship. While the impact of earthquakes on numerous aspects of business, including business performance, has been studied before, there was still little known about the influence it had on MNE business performance and the possible moderating effects of firm size and firm age. The first chapter of this thesis defined a research question that acts as a common thread throughout this paper. The question was formulated as follows:

"How do earthquakes impact the business performance of multinational enterprises, and is this effect moderated by firm size and firm age?"

In conclusion, the regression analysis revealed that the hypothesized negative effect of seismic impact on MNE business performance was not supported. However, when alternative measurements of seismic impact were considered, specifically social and environmental measures, a positive relationship emerged. This unexpected positive effect suggests that MNEs may experience enhanced business performance in response to seismic impacts when these broader dimensions are taken into account. Additionally, the analysis of moderating variables provided further insights; firm size and firm age were found to have no significant moderating effect on the relationship between seismic impact and business performance. These findings show the complexity of the main relationship and highlight the importance of considering multiple dimensions and moderating factors when assessing the impact of seismic events on MNE business performance.

6.2 Implications

Theoretical implications

Several theoretical implications rise from the findings that progress the literature on earthquakes and MNE business performance. In contrast to many previous studies, this thesis treated firm size and firm age as moderators instead of control variables. However, the results indicate no significant moderating effects of firm size and firm age on the relationship between seismic impact and business performance. Challenging the conventional wisdom that larger or older firms would handle seismic events differently from younger or smaller firms.

The lack of a significant moderating effect of firm size suggests that the presumed advantages of larger firms do not necessarily translate into better performance post-earthquakes. Implying that

theories on disaster resilience should consider that firm size may not be as critical a factor as previously thought. The resilience strategies that enable firms to withstand seismic events may be uniformly adopted across firms of varying sizes, leading to similar outcomes regardless of size.

The absence of a significant moderating effect of firm age suggests that both older and younger firms exhibit similar levels of adaptability and responsiveness to seismic events. This finding prompts a reexamination of theoretical perspectives on the lifecycle of firms and their capacities to handle external shocks. The findings of this study suggest that firm age does not inherently pose an advantage or disadvantage in managing seismic impacts, and that both young and old firms may possess similar levels of flexibility and innovative capabilities.

Furthermore, the findings challenge the assumption that natural disasters, specifically earthquakes, have a negative impact on business performance. The lack of a significant relationship between seismic impact and business performance suggests that MNEs might have developed resilience strategies or adaptive mechanisms that effectively mitigate negative impacts. This necessitates a reevaluation of existing theories on disaster impacts, incorporating the potential for firms to maintain stable performance levels despite seismic events.

Lastly, the discrepancy between economic and non-economic (social and environmental) measurements in assessing the influence of seismic impacts on business performance underscores the importance of the metrics used in such studies. Theoretical frameworks need to account for the multifaceted nature of disaster impacts, recognizing that economic, social, and environmental dimensions can yield different insights. This finding suggests that comprehensive impact assessments should integrate multiple dimensions to provide a holistic understanding of how MNEs are affected by natural disasters.

Managerial implications

The findings indicate that neither firm size nor firm age significantly moderates the relationship between seismic impact and MNE business performance. Suggesting that managers, regardless of their firm's size or age, should focus on universally applicable resilience-enhancing strategies.

Moreover, managers should recognize the importance of evaluating seismic impact not only from an economic standpoint but also considering social and environmental dimensions. The positive impact observed through social and environmental measurements suggests that firms can potentially derive benefits from disaster preparedness and community engagement. Managers should therefore adopt a holistic risk assessment framework that includes these dimensions, ensuring a comprehensive understanding of how seismic events might affect their operations.

6.3 Limitations

This study has some limitations that need to be considered to provide full context for interpreting the results and implications. The first note of caution should be about the way the moderators have been

added into the analysis. After multiple tries and help from peers, SPSS kept given an error when trying to add the moderators into the model using an interaction effect. For this reason, the moderators have been converted into dummy variables before running the analysis, which is not the proper way of analyzing them.

Second, the study did not fully account for the influence of external economic conditions, such as global economic downturns or booms, which could confound the observed effects of seismic impact on MNE business performance. These external factors could impact the generalizability of the findings and should be considered in future research.

Finally, the data used in the study covered only a short time span and did not include events analysis, which might not capture the long-term impacts of earthquakes on MNE business performance. Temporal limitations could result in an incomplete understanding of how seismic events affect business over extended periods, including delayed or lingering effects.

6.4 Future research

To conclude this thesis, a few interesting directions for future research that arose from the findings are listed. Starting with expanding the scope of measurement. Future research should explore additional dimensions beyond just the economic, social, and environmental impacts of earthquakes. Investigating factors such as technological resilience, organizational culture, and employee well-being could provide a more comprehensive understanding of how seismic events affect MNE business performance.

Furthermore, conducting longitudinal studies to track the long-term effects of earthquakes on MNE performance could offer insights into how these impacts evolve over time. Such studies could help identify phases of recovery and growth, as well as any delayed adverse effects that may not be immediately apparent in studies similar to this thesis.

Moreover, comparing the effects of various natural disasters, such as hurricanes, floods, wildfires, and tsunamis, on MNE performance could help determine if the findings related to earthquakes are unique or if they apply to other types of disasters as well. This could aid in developing more generalizable theories of business resilience and disaster management.

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Appendices

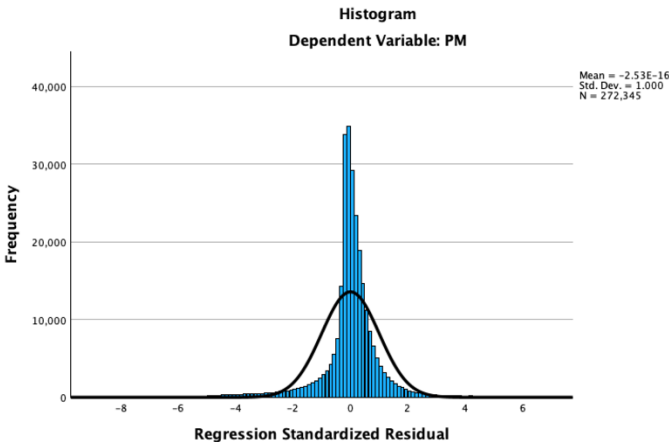
Appendix 1 - Industry NACE-rev2 codes used in this research

Since there are so many classification codes, a link to the overview is provided instead of an overview table. The link can be found below.

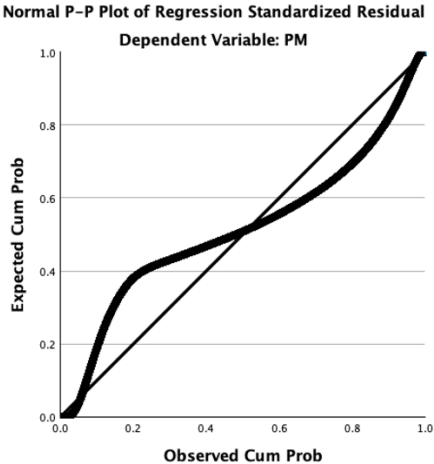
https://help-bvdinfo-com.ru.idm.oclc.org/LearningZone/Products/orbis4.1/Content/I_Data/Industry/NACE_REV2.htm

Appendix 2 - SPSS output of the multiple regression assumption tests

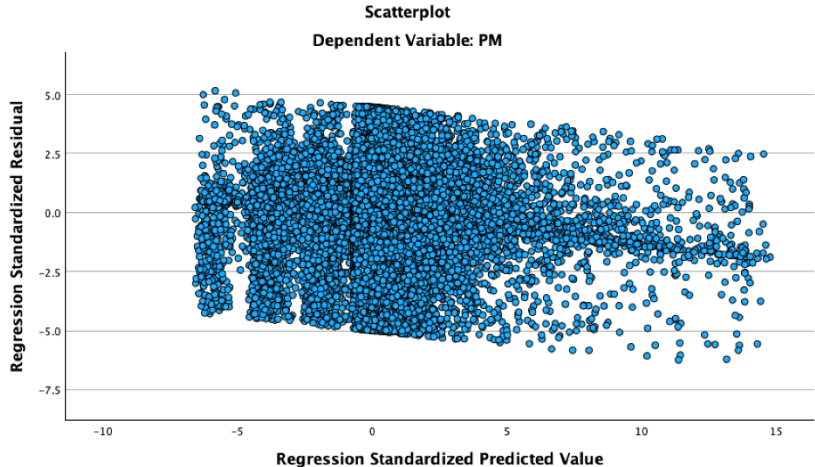
Appendix 2.1 Histogram



Appendix 2.2 P-P Plot



Appendix 2.3 Scatterplot



Appendix 2.4 Pearson Correlations matrix

	MNE Business performance	Damage	Firm size	Firm age	Industry	Risk
MNE Business performance	1.000	.021	.073	-.010	.031	.082
Damage	.021	1.000	.014	-.045	.040	-.011
Firm size	.073	.014	1.000	.073	-.036	-.029
Firm age	-.010	-.045	.073	1.000	-.010	-.010
Industry	.031	.040	-.036	-.010	1.000	.081
Risk	.082	-.011	-.029	-.010	.081	1.000

Appendix 2.5 Coefficients table

	Tolerance	VIF
(Constant)		
Damage	.996	1.004
Firm size	.992	1.008
Firm age	.992	1.008
Industry	.991	1.010
Risk	.992	1.008

a. Dependent variable: MNE business performance.

Appendix 3 - SPSS output of the robustness checks
Appendix 3.1 SPSS output with social consequences

Parameter	Estimate	Std. Error	Sig.
Intercept	18.201	2.672	<.001
Deaths	.001	.000	<.001
Firm size	5.579	.218	<.001
Firm age	-.019	.001	<.001
Industry	.000	4.176E-5	<.001
Risk	.210	.009	<.001

a. Dependent variable: MNE business performance.

Appendix 3.2 SPSS output with environmental consequences

Parameter	Estimate	Std. Error	Sig.
Intercept	11.191	2.718	<.001
Magnitude	.090	.006	<.001
Firm size	5.617	.218	<.001
Firm age	-.015	.001	<.001
Industry	.000	4.170E-5	<.001
Risk	.211	.009	<.001

a. Dependent variable: MNE business performance.