

Natural disasters and economic growth: Exploring the intervening role of insurance and reinsurance.

By

Samantha Luthuli



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School of Business Sciences, University of the Witwatersrand

Supervisor: Dr. Sylvester Horvey

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ABSTRACT

Natural disasters/catastrophes have been recognized as significant threats to economic growth as they result in one of the highest economic losses. However, previous studies have found conflicting results, and the role of moderating variables such as insurance and reinsurance, in this relationship has been under-researched. This dissertation aims to address this gap by investigating the intervening role of insurance and reinsurance in the relationship between natural disasters and economic growth focusing on OECD nations. By addressing this gap, the study contributes to a deeper understanding of how insurance and reinsurance mechanisms can mitigate the economic impacts of natural disasters and foster resilience in affected economies. This study examines the period 1990-2023 due to the increase in frequency, severity, and occurrence of natural disasters in this period. Using panel data and the Generalized Methods of Moments (GMM) estimation model the results reveal that natural disasters variables have an overall negative impact on economic growth. Additionally, the empirical results show that insurance and reinsurance positively influence economic growth. More so, the findings present that insurance and reinsurance significantly and positively moderate the relationship between natural disasters and economic growth. This implies that strengthening insurance and reinsurance mechanisms enhances economic resilience and supports economic growth in the face of natural disasters. Thus, in the absence of insurance and reinsurance, natural disasters place a heavy financial burden on public systems such as healthcare, thereby impeding economic growth. The presence of these risk mechanisms fosters financial stability in the presence of natural disasters. The study recommends public-private partnership to broaden insurance participation and accessibility. It also encourages investment in new and innovative insurance mechanism such as Insurtech and or parametric insurance to effectively mitigate disaster losses.

DECLARATION

I, Samantha Swelihle Luthuli, declares that this research report is my own work except as indicated in the references and acknowledgements. It is submitted in partial fulfilment of the requirements for the degree of Master of Management in Insurance and Risk management at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination. in this or any other university.

Name: Samantha Swelihle Luthuli Signature:

A handwritten signature in black ink, appearing to read 'S. Swelihle Luthuli', written over a horizontal line.

Signed at Melrose Gate, Melrose Arch

On the 17 day of May 2025

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DEDICATION

To my family and every little girl who has big dreams.

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List of Abbreviations

Abbreviation	Meaning
EM-DAT	Emergency Event Database
GDP	Gross Domestic Product
OECD	The Organisation for Economic Co-operation and Development

CHAPTER ONE: INTRODUCTION

1.1 Introduction

Natural disasters, defined as natural processes of the earth that result in catastrophic outcomes – such as earthquakes, hurricanes, tsunamis, and floods- globally pose significant challenges. These events cause severe damage to property, society, infrastructure, and the economy (Aon, 2024; Arcaya et al., 2017). Due to climate change, these disasters are occurring more frequently and with greater intensity which has raised their economic impact. Natural catastrophes such as hurricanes, floods, earthquakes, and wildfires can cause massive financial losses over the short (can be defined as in the year of a natural disaster) and medium to long term (few years after a natural disaster (Swiss Re, 2023; Cavallo, Becerra & Acevedo, 2021). For instance, Swiss Re 2023 report indicates that natural catastrophes resulted in about 760 thousand fatalities, \$35 billion in residential losses and \$280 billion in economic losses (Swiss Re, 2023). These destructions impede economic activity thereby reducing productivity. In addition, fatalities, demographic shifts, and community unrest exacerbate the economic downturn as labour markets destabilize and consumer behaviour shifts. With continuous disruptions and rising severity, it is imperative to understand their influences on the economy.

Different types of natural disasters have different impacts on the economy due to their nature. Natural disasters can be categorized into four types: climatological, hydrometeorological, geological, and topological disasters. Climatological disasters involve changes in ecological climate patterns, such as extreme heatwaves, altered rainfall patterns, and increased weather events (Touma et al., 2014). Hydrometeorological disasters are characterized by increased flood frequency and intensity due to shifts in river discharge, sea levels, and inadequate drainage systems (Kundzewicz et al., 2013). Geological disasters, such as earthquakes and tsunamis, result from tectonic plate movements and volcanic activity (Singh, 2005; Wells & Coppersmith, 1994). Topological disasters are a result of changes in arrangement of natural and artificial physical features in an area. Landslides, volcanic eruptions, and avalanches fall into the category of topological disasters (Touma et al., 2014). Geological disasters have the largest negative impact on livelihoods and the economy. In 2023, earthquakes, severe storms, flooding, droughts, and tropical cyclones were among the top five perils, resulting in global economic losses of \$99 billion, \$94 billion, \$85 billion, \$45 billion, and \$35 billion, respectively (Aon, 2024). These perils accounted for more than 10% of global economic losses in 2023 (Gallagher Re, 2024).

In the event of a natural disaster, negative effects arise as resources intended for long-term development are diverted to mitigate immediate losses. This diversion of resources decreases the long-term positive economic growth of affected countries. In 2022 the EM-DAT recorded about 387 natural catastrophic events worldwide, surpassing the average of approximately 370 events from 2002-2021 (CRED, 2023). This necessitates the need for mitigation instruments such as insurance and reinsurance (Swiss Re, 2023).

Insurance plays a vital role in managing risk and the economic impact of natural disasters. Financial risk transfer, financial stability, economic recovery, and risk mitigation are among the benefits that insurance offers which reduce the implications of natural disasters (Cummins & Mahul, 2009). Policy payouts inject liquidity into the economy, facilitating economic recovery by rebuilding infrastructure and property (Ackomah et al., 2024; Ackomah, 2024; Cao & Wang, 2021;

Choi & Kim, 2023). Insurance policy covers such as business interruption help minimize the negative economic effects of disasters in the long term by insuring businesses against income and profit loss in the event of a natural disaster. Additionally, insurance incentivizes prevention measures, reducing the severity of economic losses (Cummins & Mahul, 2009).

Similarly, reinsurance is a risk management strategy used by insurance companies to manage large-scale risks (Cummins et al., 2021). Reinsurance products are divided into proportional and non-proportional coverage. Proportional reinsurance involves transferring a specific percentage of risk to the reinsurer in exchange for premiums in the same percentage. Non-proportional coverage reinsures large losses, such as natural catastrophes, where the reinsurer is responsible for losses exceeding a predetermined amount. Reinsurance, on a larger scale, offers insurance to insurance companies similarly to how insurance companies offer coverage to policyholders. A crucial role is played by reinsurance in mitigating enormous losses (Nzuza & Msomi, 2023; Kajwang, 2022; Bressan, 2018; Huang & Chen, 2022). Since 2017, reinsurance companies paid out more than \$650 billion in losses due to the occurrence and severity of natural catastrophes (Swiss Re, 2023), emphasizing their systemic importance.

The findings of this study confirm that natural disasters generally exert negative effects on economic growth, especially through human capital losses such as fatalities and injuries. At the same time, they reveal that insurance and reinsurance both directly support growth and significantly moderate disaster impacts, reducing economic instability and enabling faster recovery. These results help reconcile inconsistencies in the literature: some studies emphasise contraction (Noy, 2009; Felbermayr & Gröschl, 2014), while others highlight reconstruction-led growth opportunities (Skidmore & Toya, 2002; Onuma, Joo & Managi, 2021). This study shows that outcomes largely depend on the depth of insurance penetration, the strength of reinsurance systems, and the quality of institutions.

Accordingly, the contribution of this dissertation is twofold. Theoretically, it extends neoclassical, endogenous, and resilience frameworks by evidencing how financial risk-transfer mechanisms act as buffers that accelerate capital re-accumulation, support innovation, and enhance systemic resilience (Hallegatte & Vogt-Schilb, 2019; Bah & Abila, 2024; Huang & Chen, 2022). Empirically, it advances the disaster and economic growth literature by jointly examining insurance and reinsurance as moderating variables in the disaster and economic growth relationship, addressing a gap in prior research that has typically treated them separately (Zhang & Liu, 2020; Choi & Kim, 2023; Dawd & Benlagha, 2023). In doing so, the study demonstrates that robust insurance and reinsurance markets are not merely supportive instruments but foundational determinants of macroeconomic resilience and stability in the face of natural disasters.

1.2 Context of the study

This paper considers all OECD countries to clearly demonstrate the intervening role of insurance and reinsurance on different countries' circumstances and preparedness. OECD nations have comparable economic systems, political systems, and phases of development, which makes it easier to examine the connection between insurance, reinsurance, natural disasters, and economic growth more uniformly. They also have accessibility of comprehensive data which entails well-developed and formalized insurance and reinsurance markets. This provides a solid and interesting background to explore how the varying levels of insurance and or reinsurance reduces the adverse

effects of natural disasters on economic growth. The full list of OECD member countries included in this study is provided in **Appendix A** for clarity and transparency.

Figure one (Activity of natural disasters) below illustrates the 2023 total economic loss, total insured losses, total natural catastrophic events, and total insured natural catastrophic events. These demonstrate the richness of the database pertaining natural disasters for OECD countries. It further highlights that only 38% of natural disasters are covered by insurance in OECD countries. This statistic highlights the protection gap increase and need for mitigating strategies as the occurrences of natural disasters increase. It further demonstrates that the preparedness and readiness to tackle these losses differs in different regions which allows the study to achieve a more comprehensive conclusion. Figure two (Insured natural catastrophes versus total natural catastrophes) displays the total natural catastrophes and the corresponding total insured natural catastrophes. The graph reveals that, over time, the number of catastrophes has increased while the number of insured catastrophes has not risen to the same proportion. This divergence (protection gap) can be properly observed from 1990 till 2023. This continues to highlight the difference in regions circumstances as the frequency and severity of these disasters rises (Swiss Re, 2023). Furthermore, it enables the study to observe the role of the moderating variables (insurance and or reinsurance) in buffering the adverse impact of natural disasters on economic growth.

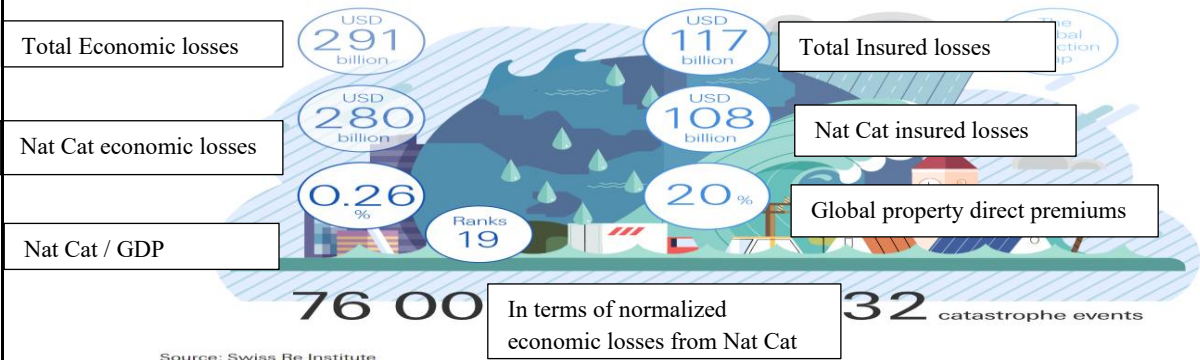


Figure 1: Activity of Natural disasters.

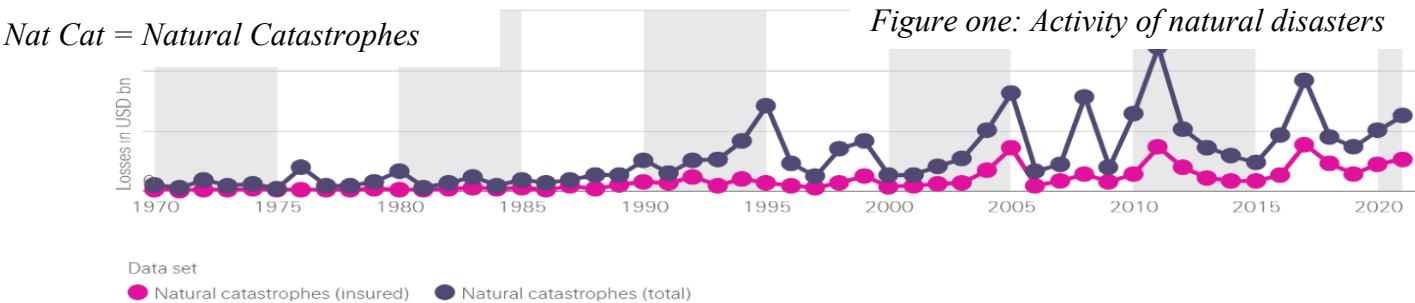


Figure 2: Insured Nat Cat vs Total Nat

1.3 Problem Statement

Natural catastrophes, such as earthquakes, floods, and hurricanes, have long been recognized as significant threats to economic growth as they result in one of the highest economic losses. These disasters can devastate economies, particularly in the absence of effective risk management strategies. The literature has explored the impact of natural disasters on the short-term, medium-term, and long-term economic growth (Cavallo, Becerra & Acevedo, 2021; Strulik & Trimborn, 2018; Linnerooth-Bayer & Hochrainer-Stigler, 2014; Fomby, Ikeda & Loayza, 2011; Noy, 2009). These writers have revealed that natural disasters hinder economic growth by causing substantial damage to infrastructure, disrupting economic activities, and leading to long-term negative effects, particularly in low-income countries. These effects are exacerbated in areas prone to frequent disasters, such as coastal regions, making the destruction of physical and human capital more prominent (Fomby, Ikeda & Loayza, 2011; Breckner et al., 2016).

On the other hand, other scholars such as Onuma, Joo, and Managi (2021); Ikefuji, Horii, and Masako (2020) and Skidmore and Toya (2002) have contended that well-prepared countries with robust mitigation measures can experience a short-term and or medium-term economic boost from reconstruction efforts, which can stimulate growth through investment in resilient infrastructure. These conflicting views underscore the need for further investigation into understanding the relationship between natural disasters and economic growth in different circumstances, to determine in which cases is growth promoted and not promoted. Again, existing literature has focused on the relationship between insurance and economic growth (Haiss & Sumegi, 2008, Outreville, 2013; UI Din et al., 2017; Singhal et al., 2022; Horvey et al., 2024), without considering how insurance might alter the impact and persistence of natural disasters on economic growth. Linnerooth-Bayer and Hochrainer-Stigler (2014); Ibararan et al. (2008) and Noy (2009) emphasize the critical importance of risk management strategies, including insurance, in enhancing economic resilience. However, empirical investigation considering how insurance and reinsurance can buffer economies against the shocks of natural disasters, particularly in different economic contexts, have not been fully explored. This study addresses this gap by utilizing empirical data and quantitative methodology to highlight the need for effective mitigation mechanisms particularly, the moderating role of insurance and reinsurance in the relationship between natural disasters and economic growth.

1.4 Purpose of the study

The purpose of this study is to examine the intervening role of insurance and reinsurance in mitigating the economic impact of natural disasters. It aims to analyse the effectiveness of these mechanisms in enhancing economic resilience and stability across different contexts.

1.5 Research objectives

Specifically, the study seeks to address the following objectives:

1. To examine the impact of natural disasters on economic growth.
2. To examine the influence of insurance and reinsurance on economic growth.

3. To explore the intervening role of insurance and reinsurance on the relationship between natural disasters and economic growth.

1.6 Questions

This paper aims to answer three research questions:

1. What is the impact of natural disasters on economic growth?
2. What is the influence of insurance and reinsurance on economic growth?
3. What is the intervening role of insurance and reinsurance on the relationship between natural disasters and economic growth?

1.7 Significance of the Study

The significance of this study lies in its potential to shape policy, practice, and research in the field of disaster risk management and economic growth. By investigating the intervening role of insurance and reinsurance in the relationship between natural disasters and economic growth, this study aims to provide valuable insights that can guide policymakers and stakeholders in enhancing economic resilience. The findings underscore the importance of optimizing insurance mechanisms to mitigate the economic impacts of natural disasters, support sustainable recovery, and foster long-term economic growth. Importantly, this research fills a critical gap in the literature by exploring the under-researched area of how insurance and reinsurance interact with natural disasters to influence economic growth, thereby advancing our understanding and informing future research directions.

For policymakers, this research offers evidence-based strategies to close the protection gap, thereby reducing the financial burden on governments during and after natural disasters. Successful examples from countries like Japan, the United Kingdom, New Zealand, Mexico, and the United States demonstrate the effectiveness of collaborations between governments, insurance companies, and the reinsurance sector in managing disaster risk and enhancing economic stability. For instance, the United Kingdom's Flood Re program, which helps homeowners in flood-prone areas access affordable insurance, and Japan's Earthquake Insurance System, which shares risk between the government and private insurers, highlighting how public-private partnerships can mitigate the financial impact of natural disasters (Flood Re, 2020; Sompo Japan Insurance, 2020). Mexico's FONDEN program, which utilizes a combination of government funds and insurance to provide immediate financial support after disasters, and New Zealand's Earthquake Commission (EQC), which provides government-backed insurance for earthquake damage, further exemplify how integrated approaches can facilitate recovery and resilience (World Bank, 2012; EQC, 2021).

In practice, the study emphasizes the need for strengthening insurance and reinsurance frameworks as essential components of disaster risk management. The collaboration among governments, re/insurance companies, and the private sector is crucial in reducing vulnerability to natural disasters, narrowing the protection gap, and promoting economic stability. Additionally, the study highlights the importance of promoting public awareness and education on the benefits of insurance coverage and disaster preparedness, encouraging broader participation and support for measures that enhance economic resilience in the face of natural catastrophes.

1.8 Delimitations

This dissertation focuses exclusively on OECD countries from 1990 to 2023, drawing on data from OECD Stats, EM-DAT, and the World Bank. The decision to limit the analysis to OECD countries is based on three key reasons: (1) the availability of consistent, long-term macroeconomic and disaster-related data; (2) the presence of mature, structured insurance and reinsurance markets; and (3) the relatively high exposure to natural disasters despite advanced economic development. These countries provide a unique context to investigate how financial risk-transfer mechanisms can influence post-disaster economic outcomes. Over the past three decades, the frequency and intensity of natural disasters in OECD countries have risen significantly — with major events such as Hurricane Harvey (USA, 2017), the Typhoon in Japan (2019), the 2021 European floods, and the 2024 Hurricanes Helene and Milton (NESDIS, 2024; Tradowsky et al., 2023; Irasawa et al., 2020).

In this context, insurance and reinsurance are introduced as moderating variables to assess their role in cushioning the economic impact of natural disasters. These mechanisms are crucial in OECD economies, not only for facilitating faster recovery but also for reducing the financial burden on governments. By acting as financial shock absorbers, insurance and reinsurance may moderate the otherwise negative relationship between disaster events and economic growth — a dynamic this study aims to empirically test.

1.9 Definition of keywords

Key Term	Definition
1.9.1 Natural-Disasters	A natural disaster is the Earth's natural process which can cause catastrophic outputs, such as earthquakes, hurricanes, floods, hailstorms and or tsunamis, which causes significant damage to property, infrastructure, and human life. These events lead to substantial recovery and financial efforts by affected communities and governments (CRED, 2023; UNDRR, 2023; Chaudhary & Piracha, 2021).
1.9.2 Economic-Growth	Economic growth is defined by an increase in production and consumption of services and or goods in a countries or region's economy over a specific time-period. This is frequently measured by the rise in Gross Domestic Product (GDP) per Capita. It is a critical indicator of economic health, associated with improved living standards and increased

	income levels. (World Bank, 2021; OECD, 2023; Moiseev et al., 2020).
1.9.3Insurance	Insurance is a risk management tool that provides financial protection to individuals, businesses, and governments against losses from unanticipated circumstances for example illnesses, accidents, or natural disasters. By pooling risks among many policyholders, insurance stabilizes financial outcomes and supports economic stability and growth (Swiss Re, 2021; Munich Re, 2022; Choi & Kim, 2023).
1.9.4Reinsurance	Reinsurance is a type of insurance bought by insurance companies to mitigate large losses. In this agreement, an insurer (cedent) transfers some of its risk to another insurer (reinsurer) to reduce the potential financial impact of significant claims. Reinsurance enhances the stability and solvency of insurance companies, thus supporting the broader economy (Aon, 2023; Nzuza and Msomi, 2023).

1.10 Structure of the research

This dissertation structure continues as follows, chapter two tackles the literature review of the three objectives of this study. Chapter three discusses the method, approach, and estimation procedure. Chapter four presents the estimated results and interpretations. Chapter five discusses the results and finally chapter six concludes the dissertation.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

Neoclassical growth theory, Endogenous growth theory and Resilience theory provide frameworks for analysing how economies can achieve long-term progress while adapting to disruptions such as natural disasters. Each theory offers unique perspectives on how economies rely on capital accumulation, human capital, investment and or innovation. The theories emphasize the importance of institutional policies which support economic growth in the presence of disruptions.

2.2 Theoretical Review

2.2.1 Neoclassical Growth Theory

In this study, Neoclassical Growth Theory is the main theory utilized to explore the intervening role of insurance and reinsurance in the relationship between natural disasters and economic growth. Rooted in the work of Robert Solow this theory provides a model for understanding sustained or long-term economic progress through capital accumulation, workforce expansion, and technological advancement. According to the theory, economic growth is driven by increasing investments in physical capital and labour, supplemented by technological progress which enhances productivity. The theory introduces the concept of a steady-state equilibrium where growth eventually stabilizes due to diminishing returns to capital and labour, with technological progress serving as the primary driver of sustained growth. Additionally, it suggests that poorer economies may experience faster growth compared to richer ones, a phenomenon known as convergence (Solow, 1956; Mankiw, Romer, & Weil, 1992). Recent studies, such as Masoud, (2013); Glawe and Wagner (2020), have reaffirmed the core principles of Neoclassical Growth Theory while highlighting its limitations in addressing human capital and institutional quality. Kasim (2018) explores how capital accumulation and technological advancement drive growth in emerging economies, while Glawe and Wagner (2020) critique the theory's neglect of institutional factors, leading to further developments like Endogenous Growth Theory to address these gaps.

In the context of natural disasters, Neoclassical Growth Theory is applied to understand how such events impact economic growth. According to the theory, natural catastrophes disrupt economic growth primarily by damaging physical capital and labour markets. These disruptions typically cause a short-term economic slowdown as resources are diverted from productive activities to recovery efforts. Over time, the theory posits that economies can resume their growth trajectories through continued capital accumulation and technological progress (Barro & Sala-i-Martin, 2004).

Recent studies have expanded the application of Neoclassical Growth Theory to incorporate the influence of natural catastrophes on economic progress. Okuyama (2019) explores various theoretical models and simulations to illustrate how different types of natural disasters, such as earthquakes and floods, uniquely impact capital accumulation and labour productivity. This work provides a more nuanced understanding of how disasters disrupt economic growth and recovery. Strulik and Trimborn (2018) apply advanced econometric techniques to analyse how natural disasters influence long-term growth and recovery, finding that while Neoclassical predictions are generally accurate, the effectiveness of policy responses and the economic structure are also critical in shaping recovery outcomes. Inoue and Todo (2019) further investigate the role of

institutional quality in disaster recovery, highlighting that effective governance can significantly influence the pace and success of economic recovery.

Felbermayr and Gröschl (2014) examine the impact of institutional quality on disaster recovery, demonstrating that governance and institutional factors have a crucial influence in crafting economic results following natural disasters. Cavallo and Noy (2011) review empirical studies on disaster impacts, integrating factors such as policy effectiveness and international aid into the traditional Neoclassical framework, providing a broader perspective on how economies recover from disasters. Noy (2009) empirically assessed the macroeconomic implications of natural disasters, supporting the theory's prediction of temporary economic slowdowns while revealing significant variations in recovery rates based on specific economic and social contexts. Kahn (2005) extends the theory by incorporating regional characteristics and institutional quality, showing that these factors greatly influence the severity and pace of recovery.

Recent research by Papageorgiou and Spatafora (2021) explores how modern economic policies and international aid frameworks interact with disaster recovery processes, highlighting the importance of continued advancement in the ability of economies adjusting and recovering from natural catastrophes. Hallegatte and Vogt-Schilb (2019) extend on this and displayed that disasters lower productivity by destroying effective capital but confirmed the Neoclassical prediction that economies reconverge through renewed investment. Jooste, Hallegatte, and McIsaac (2022) reinforced this by emphasizing infrastructure as a critical form of capital, with rebuilding enabling steady-state recovery. Otto (2023) demonstrated that strong insurance markets accelerate this convergence by financing capital replacement, while Bah and Abila (2024) provided evidence that greater insurance penetration strengthens GDP recovery post-disaster. Together, these studies reaffirm the Neoclassical principle that while disasters cause short-term deviations, economies return to long-term growth when capital is replenished and institutional mechanisms, including insurance and reinsurance, support the recovery process.

2.2.2 Endogenous Growth Theory

This theory posits that economic growth is primarily driven by internal factors such as technological innovation and human capital, rather than external shocks alone. This theory suggests that while natural disasters can disrupt internal growth mechanisms by damaging critical infrastructure and reducing investments in human capital, they can also catalyse recovery and growth if the reconstruction process leverages advanced technologies and innovative practices. The theory implies that societies with robust innovation capabilities can potentially experience accelerated growth following a disaster, as they rebuild with improved technologies and practices.

Ikefuji, Horii, and Masako (2020) explore the role of natural disasters within an endogenous growth framework by developing a two-sector model that incorporates both physical capital and human capital. Their study highlights how disasters can disrupt economic activities by damaging infrastructure crucial for innovation and productivity. However, they also discuss how investment in reconstruction can foster technological advancements and economic growth, aligning with the endogenous growth perspective that emphasizes internal factors in driving recovery and long-term development.

Onuma, Joo, and Managi (2021) investigate the immediate, intermediate, and lasting growth effects of both severe and non-severe natural disasters. Their research aligns with Endogenous Growth Theory by analysing how different types of disasters affect growth trajectories over various time horizons. They find that while the immediate impacts are generally negative, the recovery phase can potentially lead to accelerated growth if the reconstruction process incorporates improvements in infrastructure and technology, thus supporting the theory's emphasis on the role of innovation and capital accumulation in driving recovery.

Douenne (2020) examines the role of preferences and decision-making in the context of disaster risks and economic growth. His study contributes to Endogenous Growth Theory by highlighting how societal preferences for risk management and investment in resilience can influence the economic impacts of disasters. By focusing on how preferences shape disaster response and recovery, Douenne's research underscores the importance of internal factors, such as societal attitudes towards risk and investment in innovation, in determining the long-term growth outcomes following natural catastrophes.

Cavallo, Becerra, and Acevedo (2022) provide a comprehensive analysis of the impact of natural disasters on economic growth by examining how these events affect both immediate and long-term economic performance. Their research supports Endogenous Growth Theory by showing that while natural disasters initially disrupt economic activities and infrastructure, effective recovery strategies that incorporate technological advancements and infrastructure improvements can lead to enhanced growth over time.

Recent studies provide updated evidence of this mechanism. Bănică, Kourtit, and Nijkamp (2020) argue that natural disasters can serve as “development opportunities,” acting as catalysts for reinvestment and the modernization of capital stock. They emphasize that endogenous growth processes are reinforced when reconstruction brings higher productivity and structural transformation. Similarly, Díaz, Paniagua, and Larroulet (2024), in a comparative study of Chile and New Zealand, demonstrate that disasters can yield divergent outcomes: Chile's Maule earthquake led to economic decline due to weaker institutions, while New Zealand's Canterbury earthquake produced positive growth effects through effective reconstruction and institutional support. Their findings confirm that disaster outcomes depend heavily on institutional quality and reconstruction design, consistent with the endogenous growth view that innovation, policy, and human capital investment shape long-term growth.

Overall, these studies demonstrate that while natural disasters generally create short-term disruptions, their long-term effects depend on how reconstruction processes foster technological innovation, institutional reform, and investment in human capital. Endogenous Growth Theory therefore provides a compelling framework for understanding how disasters can either hinder or stimulate growth depending on internal capacities.

2.2.3 Resilience theory

Resilience theory is a conceptual framework that investigates the capacity of systems—whether ecological, social, or economical—to endure and adapt to disturbances while retaining their core functions and structures. Originally articulated in the field of ecology by Holling (1973), resilience theory emphasizes not only the ability to return to a pre-disturbance state but also the capacity to

adapt and reorganize in response to changes. This foundational idea has been expanded to various disciplines, including economics, where it is used to understand how systems like economies can withstand and recover from shocks such as natural catastrophes.

In the economic context, resilience theory is applied to explore how economic systems absorb and recover from disruptions such as natural disasters. It helps in understanding how different mechanisms, including insurance and reinsurance, contribute to economic stability and recovery. For instance, studies such as Strulik and Trimborn (2018), Breckner et al. (2016), and Fomby, Ikeda, and Loayza (2011) have demonstrated that resilience mechanisms like insurance can play a crucial role in mitigating the economic impact of natural catastrophes and supporting long-term economic growth.

Crespo Cuaresma (2020) advances resilience theory in economics by conceptualizing resilience in three dimensions: vulnerability to shocks, the capacity to absorb them, and the speed of recovery. This framework underscores that economies with strong financial systems, effective policies, and institutional quality are more likely to withstand catastrophic shocks and return to growth. Similarly, Papageorgiou and Spatafora (2021) emphasize that resilience is not merely about bouncing back but also about transformation—adapting systems and policies to reduce future vulnerabilities. This multidimensional perspective is particularly relevant when considering how disasters affect OECD economies, where both physical and institutional resilience play key roles.

Insurance and reinsurance are central to economic resilience because they provide liquidity, spread risks, and reduce fiscal pressures on governments. Choi and Kim (2023) show that higher insurance penetration enhances resilience by stabilizing household consumption and maintaining investment levels following disasters. Bah and Abila (2024) provide further empirical evidence that countries with greater insurance density experience faster GDP recovery post-disaster, demonstrating that financial resilience directly supports macroeconomic stability.

Overall, these studies highlight that resilience is not only an ex-post process of rebuilding but also an ex-ante process of preparedness. By pooling risks and mobilizing resources before disasters occur, insurance and reinsurance embody the preventive dimension of resilience, ensuring that shocks do not derail long-term development.

These theories highlight the importance of economic policies that account for disruptions, such as natural disasters, to sustain growth. This is particularly relevant in examining the intervening role of insurance and reinsurance in the relationship between natural disasters and economic growth.

2.3 Empirical review: Natural disasters and economic growth

The economic impact of natural catastrophes has been a focal point of research, reflecting both the immediate and long-term consequences of such events on economic growth. Within more developed nations, Strulik and Trimborn (2018) explored the effects of hydrometeorological and geophysical disasters, using neoclassical and empirical models. They argue that while disasters often reduce GDP due to the loss of services, the post-disaster period can see conflicting results, with some scenarios showing GDP growth driven by durable goods. However, the long-term impact typically involves a deterioration of productive capital, leading to decreased growth levels. Contrasting these findings, Skidmore and Toya (2002) conducted a study covering 89 nations

through the period of 1960–1990, which examined the implications of natural disasters on investment choices and lasting economic growth. Their analysis revealed positive long-term effects of climatic disasters on GDP, suggesting that the reconstruction and investment in resilient infrastructure following such disasters could stimulate economic growth.

By comparison, studies focusing on more emerging economies point to significant negative impacts. Shabnam (2014) utilized a panel dataset encompassing 187 countries from 1960 to 2010 to analyse the relationship between floods and GDP. This comprehensive study revealed a negative impact of floods on economic growth, attributing this effect to significant physical damage and the subsequent redirection of resources from productive activities to recovery efforts. Ibararán et al. (2007) reviewed the body of work on the economic and social effects of climate-change-related natural disasters, highlighting the increasing frequency and severity of such events.

They argue that natural disasters have widespread effects, including fatalities, injuries, production losses, and the significant cost of replacing damaged infrastructure, which has macroeconomic implications. Noy (2009) investigates the macroeconomic consequences of natural disasters, focusing on their impact on forgone production and the cost of disaster mitigation. Using data from 109 countries between 1970 and 2003, Noy finds that property damage negatively affects GDP growth, specifically in emerging nations where smaller economies are more vulnerable to such shocks. Similarly, Berlemann and Wenzel (2015) interrogated the effect of droughts on economic progress utilizing data of 153 countries through the period of 1960–2002. Their research found that droughts have long-term negative effects on GDP, primarily due to decreased agricultural output and prolonged economic instability.

In the case of OECD countries, Breckner et al. (2016) interrogated the effect of natural catastrophes on economic progress utilizing data from 129 countries throughout the period of 1980–2014. Their research found that natural disasters tend to have more severe economic impacts in non-OECD countries due to weaker institutional frameworks and less effective risk management. This study underscores the importance of institutional quality in mitigating the adverse effects of natural disasters.

At a broader level, Díaz, Paniagua, and Larroulet (2024) contrasted Chile’s Maule earthquake and New Zealand’s Canterbury earthquake using synthetic controls, showing Chile’s GDP per capita declined by 5% while New Zealand gained 10%, highlighting institutional quality as the decisive factor. Kulanthaivelu (2023) re-examines the growth effects of tropical cyclones in the U.S. using state- and county-level panel data from 1970–2020 combined with cyclone intensity measures from the Tropical Cyclone Exposure Database. Applying spatial econometric models, the study finds no significant effect at the national level, but highlights substantial heterogeneity within regions. Florida, the most cyclone-prone state, shows persistent short-term growth losses: ARIMAX time-series estimates reveal that cyclone intensity reduces quarterly personal income growth by about 0.005–0.006 percentage points in the quarter of occurrence and two quarters later. At the county level, growth penalties accumulate for up to three years, underscoring localized vulnerability. These results stress that while aggregated U.S. impacts appear muted, regional and sectoral analyses uncover significant economic disruptions, particularly in exposed and tourism-dependent states like Florida.

Some studies adopt a mixed global perspective. Panwar and Sen (2018) analysed data of 102 countries over a 34-year period and conducted a systematic literature review to explore the interaction between natural disasters and economic growth, focusing on the varying short-term and long-term economic impacts across different contexts. They found that while developed countries often recover quickly due to strong institutions and infrastructure, developing countries face prolonged economic challenges due to weaker systems. The study emphasized the critical role of insurance and reinsurance in enhancing economic resilience and called for targeted policy interventions to improve disaster risk management, particularly in developing countries.

Khan et al. (2023) examines how natural disasters affect economic growth across 98 countries (1995–2019), innovating on prior work by constructing comparable infrastructure and human capital indices and estimating a dynamic growth model with two-step GMM by World Bank income group. They find that disasters reduce income overall, with the economic costs concentrated in low-income and lower-middle-income countries and comparatively milder in upper-middle and high-income countries. Beyond the disaster effect, infrastructure quality, FDI inflows, human capital, globalization, and gross fixed capital formation consistently support growth, and these factors help offset disaster losses—highlighting strong heterogeneity by development level. The study's contribution is to embed disaster risk within a broader socio-economic framework, showing that capacity-enhancing policies (infrastructure upgrading, human capital development, and investment climate improvements) are central to reducing vulnerability and speeding post-disaster recovery. These results align with Sendai Framework priorities and argue for targeted resilience investments to narrow disparities in disaster impacts across income groups.

Nguyen, Feng, and Garcia-Escribano (2025) analyse 190 large disasters ($\geq 1\%$ of GDP damage) across 179 countries (1980–2019) using local-projection methods. They find GDP growth falls by about 1.3 percentage points in the disaster year, rebounds by 0.8 the following year, and normalizes by $t+2$, leaving a permanent output-level loss. Effects differ across contexts: advanced economies offset shocks through rapid government spending, while non-small-island EMDEs experience sharp investment declines and small-island EMDEs suffer export-driven contractions. Greater fiscal space and adaptive capacity mitigate losses, while larger damages intensify them. Overall, the study confirms short-run contractions with lasting scarring and highlights fiscal and structural capacity as critical for recovery.

Fomby, Ikeda, and Loayza (2011) explored the macroeconomic effects of natural catastrophes in 87 countries from 1960 to 2007, distinguishing between rich and poor countries. Their study revealed that while natural disasters have unfavourable implications on economic growth, the severity of these effects is more pronounced in poorer countries. Cavallo, Becerra, and Acevedo (2021) conducted a comprehensive analysis of 12,377 natural disaster events from 1970 to 2019, focusing on both developing and developed countries. Their findings indicated that while natural disasters have negative short-term effects on economic growth, effective mitigation strategies and reduced human impact can help in managing these effects in the long term.

These divergent results across studies can be attributed to factors such as development level, institutional quality, and disaster type. While some evidence suggests that reconstruction can offset losses in advanced economies, much of the literature confirms that disasters typically erode productive capacity and weaken long-term growth, especially in less resilient settings. However,

the role of financial mechanisms in mitigating these adverse effects remains underexplored, particularly in OECD contexts. To address this gap, the study advances the following:

Hypothesis 1 (H1): Natural disasters negatively affect economic growth.

2.4 Insurance and economic growth

Insurance is a fundamental mechanism for managing financial risks and fostering economic stability. Numerous studies have explored how insurance impacts economic growth, highlighting its significance across various regions and economic contexts.

Recent research continues to stress the pivotal function of insurance in economic development. Zhang and Liu (2020) conducted a study examining the impact of insurance on economic growth in emerging markets, utilizing data from 1995 to 2018. Through panel data analysis across 30 emerging economies, they found a strong favourable relationship between insurance penetration and economic progress. This research paper demonstrated that increased insurance coverage enhances financial stability and promotes investment conditions, thereby supporting economic development. The findings underscore the importance of expanding insurance markets to foster growth and financial security in emerging economies.

Similarly, Cao and Wang (2021) explored the connection between development of the insurance market and economic progress among 20 regions from 2000 to 2019. By employing a dynamic panel data approach with GMM estimation, they analysed insurance density and penetration in relation to GDP growth. Their results revealed that insurance market development positively affects economic growth in both advanced and emerging economies. The study highlighted that well-developed insurance markets contribute to economic stability by improving risk management and capital accumulation, emphasizing the crucialness of effective regulatory frameworks in enhancing insurance sector development.

Bah and Abila (2024) explores the institutional factors influencing insurance demand in Africa by analysing a panel of 42 countries from 1996 to 2017. Utilizing the GMM estimation, the authors found that institutional quality, including regulatory quality, rule of law, control of corruption, political stability, and government effectiveness, significantly impacts insurance penetration in Africa. Their findings suggest that governments should focus on improving the business landscape and strengthening the political environment to enhance the demand for insurance, particularly for non-life insurance.

Karagyozyova (2023) investigated the role of microinsurance in Africa and found that it significantly promotes economic growth, particularly in low-income countries where conventional insurance markets are underdeveloped. This study underscores the importance of inclusive insurance mechanisms in enhancing resilience and driving growth in developing economies.

Choi and Kim (2023) further examined the effect of insurance penetration on economic progress in a panel evaluation of developed and developing countries from 2010 to 2021. Using a panel autoregressive distributed lag (ARDL) model, they assessed the immediate and lasting effects of insurance penetration on GDP growth. Their research found that increased insurance coverage has a favourable and substantial influence on economic growth across diverse economic settings. The

study stressed that insurance enhances economic resilience by improving financial stability and supporting investment, reinforcing the critical role of expanding insurance markets to sustain economic growth and stability.

Dawd and Benlagha (2023) explore the relationship between insurance development and economic growth in 16 OECD countries from 2009 to 2020. The study employs linear dynamic panel-data approaches and reveals a non-linear, inverted U-shaped connection between insurance premiums and economic progress. This indicates that while insurance development contributes to economic growth, there is a threshold beyond which additional financial expansion may harm growth. The findings suggest that policymakers should carefully regulate insurance market activities to optimize their contribution to economic growth without overextending the financial sector's growth.

Ajide, Osinubi, and Ojeyinka (2023) investigated the role of the insurance sector in enhancing economic complexity across 28 OECD countries between 1995 and 2020. Utilizing mainly GDP as a proxy for economic performance, this study used the Economic Complexity Index (ECI) to capture the sophistication and diversity of national productive structures. Employing pooled mean group estimators, panel dynamic OLS, and quantile regression, the authors found robust evidence that total insurance, life insurance, and non-life insurance penetration significantly improve economic complexity in OECD economies. The findings suggest that insurance markets not only provide risk transfer and financial intermediation but also mobilize long-term capital for innovation, research, and the production of sophisticated goods, thereby driving sustainable economic growth. Importantly, the results support the “supply-leading” hypothesis, indicating that well-developed insurance markets in advanced economies act as catalysts for economic transformation and resilience by fostering knowledge-intensive production and export diversification.

Overall, the reviewed studies emphasize that insurance enhances macroeconomic resilience, stabilizes financial systems, and mobilizes resources that foster investment and innovation. Yet, despite this evidence, limited attention has been given to how insurance functions within the disaster–growth nexus, particularly in mediating shocks. Recognizing this research gap, the study proposes:

Hypothesis 2a (H2a): Insurance has a direct positive influence on economic growth.

2.5 Role of reinsurance on economic growth

Reinsurance has a crucial function in backing the primary insurance industry and, by extension, the broader economy. It provides risk diversification and financial stability, helping insurers manage large and catastrophic losses.

Nzuza and Msomi (2023) examine the connection between macroeconomic variables alongside the profitability of reinsurance companies in Africa using data from 121 listed companies across 48 countries from 2008 to 2019. By applying a GMM model, the research reveals that GDP,

interest rates, and exchange rates positively influence profitability, while inflation rates and money supply have a negative impact. These results highlight the importance of stable macroeconomic environments for the profitability of reinsurance companies in Africa and suggest that targeted economic policies could enhance the sector's performance to ensure constant coverage offered by these companies. Which encourages lower economic losses thus higher economic growth.

Kajwang (2022) explored the role of reinsurance in stabilizing the insurance industry and the broader economy. The study, focusing on data from various sources, found that reinsurance is essential for the operational efficiency of insurance companies. The research highlighted that reinsurance covered over half of the losses from natural disasters in 2011 and plays a significant role in absorbing and managing catastrophic losses. Earlier studies such as (Cummins and Mahul, 2003) analysed the role of reinsurance in managing financial risks from natural disasters. Their research focused on how reinsurance helps mitigate the financial impact of disasters by providing additional coverage and risk sharing. They argued that public intervention, such as establishing reinsurance pools and integrating reinsurance into disaster planning, is necessary to enhance reinsurance effectiveness.

Bressan (2018) examined the impact of reinsurance on insurers' solvency, profitability, and tax implications from 2009 to 2017. Utilizing a large sample of firm-year evaluations, this study developed hypotheses to assess reinsurance's role as a substitute for capital, its effect on profitability, and its influence on taxes. The findings indicated that reinsurance enhances insurers' solvency and profitability, with minimal impact on taxes. This research highlighted reinsurance's importance in maintaining financial stability and supporting economic growth.

Huang and Chen (2022) further examines the connection between reinsurance and economic progress in the context of catastrophic events. Analysing data from 2010 to 2021, they employed an event-study methodology to assess how reinsurance coverage influences economic performance following major disasters. Their findings indicate that effective reinsurance mechanisms are crucial for economic recovery and growth, as they provide essential financial resources for rebuilding and risk mitigation. This research emphasizes how reinsurance enhances economic resilience and supports long-term development in the wake of catastrophic events.

Collectively, the literature underscores reinsurance as a critical stabilizer: it diversifies risks globally, maintains insurer solvency, and provides essential capital to sustain economic activity after large-scale shocks. Yet most studies stop at firm-level outcomes (profitability, solvency, or claims absorption) without fully articulating reinsurance's broader macroeconomic contribution to growth. This leaves a gap in understanding its direct role in strengthening economic performance at the national level. To address this, the study advances the following:

Hypothesis 2b (H2b): Reinsurance has a direct positive influence on economic growth.

2.6 Natural disasters and economic growth: Intervening role of insurance and reinsurance

Xie et al. (2024) investigated the role of agricultural insurance in the economic resilience to natural disasters in China on a micro-level scale during the period of August 2020. The writers conducted a micro-survey in the region of China that accounts for more the 80% of wheat production.

Utilizing the OLS estimation models the writer concluded that insurance plays a crucial and significant role in the economic resilience of household in the event of natural catastrophe. The writers emphasize that the transfer of the financial risk from famers to insurers promotes production stability, income improvement, efficiency, and increased output levels. The writers argue that this encourages economic resilience even on a micro-economic level.

A recent study done in Africa on the role of insurance on natural disaster and economic growth investigated a period of 2000 to 2020 utilizing GMM estimation. The writers discovered that insurance plays a pivotal in economic recovery after a natural disaster in the short-term. Insurance provides liquidated capital and promotes productivity. The writers argue insurance plays a less efficient role in an underdeveloped insurance market such as the African market due to insufficient insurance coverage. The writers recommend that government should promote an increase insurance coverage to assist mitigate economic losses due to natural disasters. This shall decrease the effect of unforeseen economic loss, financial instability, and long-term adverse effects of natural disasters (Ackomah et al., 2024, 2024).

Kalfin et al., (2022) conducted a literature review on the role of insurance in the aftermath of natural disaster. The writers highlight that insurance is necessary to restore economic stability in the affected communities and countries. The writers reviewed studies during the period of 2000-2021 retrieved from google scholar and Scopus. The writer highlights the six main types of insurance disasters in the world such as floods, earthquake, property, crop, and natural disasters. The writers highlight that these natural disasters insurance coverages are influenced by the severity and frequency of adverse weather conditions. Writers argue that the adverse weather conditions are highly influenced by climate change emphasizing the need for post-disaster insurance as it promotes infrastructure rebuilding and provides emergency funds supporting short term and long-term recovery efforts. The study points out the premium increases fosters unaffordability and increases the negative effects of adverse weather events. This perpetuates the protection gap thus negatively impacts economic recovery and progress.

Previous studies affirm that insurance facilitates short-term recovery, income stability, and resilience, yet they often focus narrowly on particular regions, products, or disaster types. What remains underexplored is how both insurance and reinsurance jointly operate as mediating mechanisms that channel the disruptive effects of natural disasters into pathways of economic recovery and long-term growth. This gap underscores the need for further investigation into the intervening role of insurance and reinsurance in the relationship between natural disasters and economic growth. To address this limitation, the study sets out to test the following:

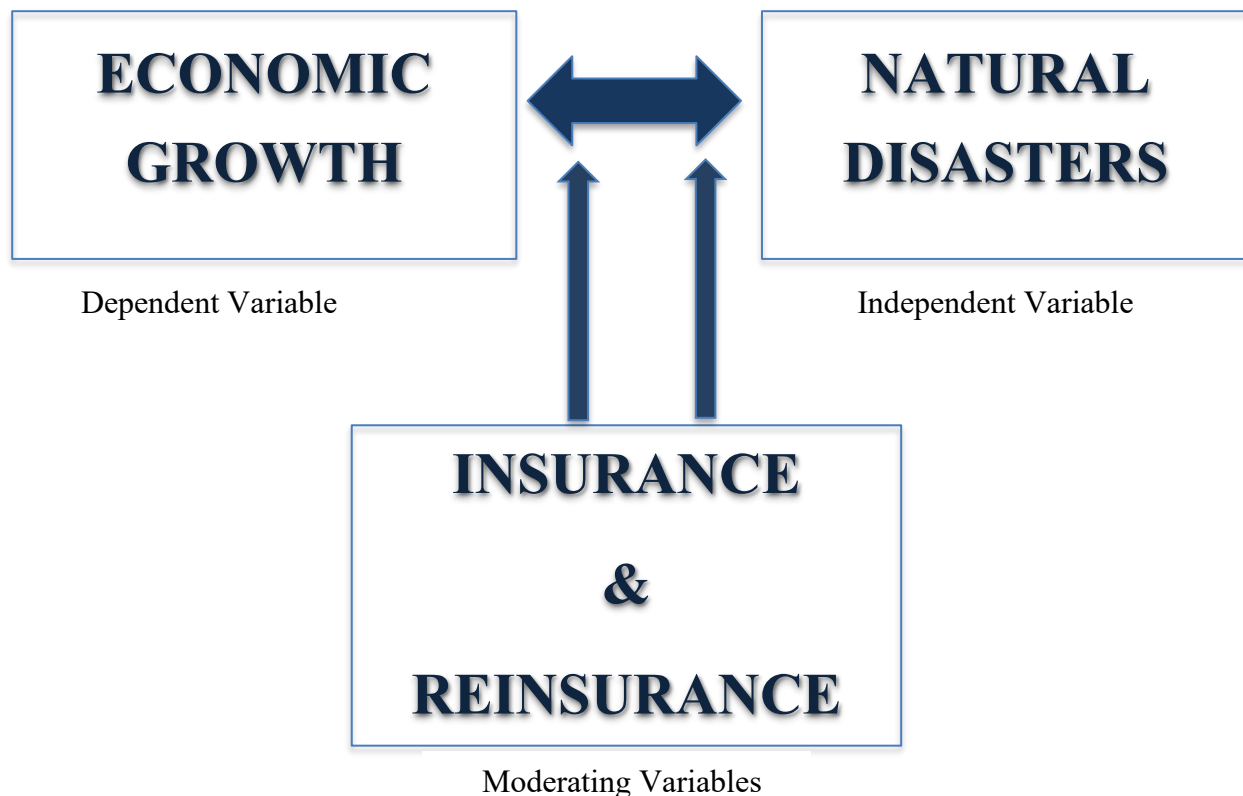
Hypothesis 3 (H3): Insurance and reinsurance positively moderate the relationship between natural disasters and economic growth.

2.7 Conceptual framework

Natural disasters generally exert a negative effect on economic growth and stability, while the growth status of nations also shapes how communities prepare for and respond to such events (Díaz-Fernández, Llorente-Marrón, & Méndez-Rodríguez, 2025; Fateh & Poulin, 2025; Díaz, Paniagua, & Larroulet, 2024; Strulik & Trimborn, 2018; Papageorgiou & Spatafora, 2021). Insurance and reinsurance play a critical role in moderating this relationship by enhancing economic resilience. Insurance provides direct financial support for recovery, mitigating economic shocks and facilitating faster rebuilding (Bah & Abila, 2024; Karagyzova, 2023; Choi & Wang, 2021; Botzen, 2021). Moreover, greater public awareness and institutional support strengthen insurance penetration and its effectiveness (Malambo, 2023). Reinsurance, as emphasized by Bressan (2018) and Cummins and Mahul (2003), distributes risk across multiple entities, thereby ensuring market stability and influencing the affordability of coverage. More recently, Dong and Finlay (2025) highlight the importance of accurate risk modelling in sustaining reinsurance effectiveness amidst evolving risk patterns. Collectively, insurance and reinsurance constitute a crucial buffer that stabilizes economies and promotes resilience and growth in the aftermath of natural disasters.

Below graphically demonstrate the above:

The relationship between economic growth, natural disasters, and mediating variables



Arrows demonstrate the relationship between the variables, according to literature there is bidirectional relationship between economic growth and natural disasters (Find the arrow above illustrating this relationship). Studies further show that there is a relationship between insurance, reinsurance and the dependent variable (Economic growth). This study aims to bridge the gap in understanding the role of insurance and reinsurance in the relationship between natural disasters and economic growth. The arrows pointing towards the relationship between economic growth and natural disasters aim to graphically demonstrate that these moderating variables impact this relationship.

This chapter reviewed Neoclassical growth theory, Endogenous growth theory, and Resilience theory to explain how economies are affected by and recover from natural disasters. Neoclassical models highlight short-run slowdowns with long-run reconvergence through capital accumulation and technology, while endogenous perspectives emphasize innovation, human capital, and institutional quality as drivers that can transform reconstruction into productivity gains. Resilience theory extends these insights by underscoring absorptive capacity, adaptive policies, and preparedness as crucial for sustaining growth. Empirical findings remain mixed across contexts, yet a common theme is that insurance and reinsurance enhance macroeconomic stability and recovery by providing liquidity, spreading risk, and supporting investment. However, few studies consider insurance and reinsurance jointly as mediating variables in the disaster–growth nexus, which underscores the conceptual framework of this study and informs the analysis in the next chapter.

CHAPTER THREE: METHODOLOGY

This section discusses the methodological approach which is used for data collection and analysis. This seeks to address three objectives. Firstly, to investigate the impact of natural catastrophes on economic growth. Secondly, analyse the role of insurance and reinsurance on economic growth lastly analysing the impact of reinsurance and insurance as moderating factors on the relationship between natural catastrophes and economic growth.

3.1 Research Approach

There are different approaches to research. These includes quantitative, qualitative, and mixed methods. Quantitative research involves the systematic collection and analysis of numerical data to identify patterns, assess theories, and make predictions. This approach relies on statistical, mathematical, or computational techniques to measure variables and evaluate relationships between them (Creswell & Creswell, 2017; Meissel & Brown, 2023). The strength of quantitative research lies in its ability to provide precise, objective measurements and generalizable results across larger populations. Techniques commonly used include secondary data analysis, surveys, and experiments (Saunders & Thornhill, 2019; Babbie, 2020). Qualitative research, in contrast, focuses on understanding phenomena through non-numerical data, such as interviews, observations, and textual analysis (Denzin & Lincoln, 2023). It aims to gain deep insights into people's experiences, beliefs, and motivations by exploring contexts and meanings. This approach is particularly useful for developing theories, generating hypotheses, and gaining a comprehensive understanding of complex social processes (Denzin & Lincoln, 2023). Mixed methods research combines both quantitative and qualitative approaches to offer a more comprehensive understanding of a research problem. By integrating numerical data with qualitative insights, this approach provides a fuller picture of complex issues, allowing researchers to validate and enrich findings from one method with insights from the other (Creswell & Creswell, 2017).

This study adopts a quantitative approach to examine how insurance and reinsurance moderate the impact of natural catastrophes on economic growth. Utilizing the quantitative approach allows for systematic measurement of relevant variables, such as the extent of insurance coverage, the level of reinsurance protection, and various economic indicators. By employing statistical methods, quantitative research can objectively assess the strength and nature of relationships between these variables. For example, recent studies have demonstrated that insurance and reinsurance can significantly influence economic resilience and recovery after disasters (Ackomah et al., 2024; Xie et al., 2024; Kalfin et al., 2022). Quantitative methods also enable the identification of patterns and correlations that might not be apparent from qualitative data alone (Djafar et al., 2021). By analysing large datasets, researchers can reveal how various levels of insurance and reinsurance impact economic outcomes in various contexts.

3.2 Research Paradigm

A research paradigm in academic research serves as a foundational framework that guides the entire research process. It encompasses a set of beliefs and practices that influence how a researcher conceptualizes and conducts a study, shaping everything from the formulation of research questions to the methods used for data collection and analysis (Kivunja & Kuyini, 2017;

Creswell & Creswell, 2023). Research paradigms are based on underlying assumptions about the nature of reality (ontology), the nature of knowledge (epistemology), and the methods through which knowledge can be acquired (methodology) (Ugwu et al.; 2021; Kivunja & Kuyini, 2017; Scotland, 2012). Understanding and selecting an appropriate research paradigm is crucial, as it aligns the research approach with the study's objectives and the nature of the inquiry (Creswell & Creswell, 2017).

There are several types of research paradigms, each with distinct characteristics. Positivism assumes an objective, external reality that can be measured and understood through empirical observation and logical reasoning. It is strongly associated with quantitative research methods, where researchers aim to test hypotheses, identify patterns, and establish generalizable laws or theories. Positivism prioritizes objectivity, reliability, and validity in data collection and analysis (Bryman, 2016; Creswell and Poth, 2018). In contrast, interpretivism emphasizes the subjective nature of reality and the importance of understanding the meanings and interpretations individuals or groups assign to their experiences. This paradigm is often associated with qualitative research methods, such as interviews, observations, and case studies, where the goal is to gain a deep understanding of complex social phenomena from the perspective of those being studied. Interpretivism recognizes that knowledge is context-dependent and shaped by the interactions between researchers and participants, aiming to provide rich, detailed descriptions and interpretations rather than generalizable findings (Denzin & Lincoln, 2023; Creswell & Creswell, 2017). This study adopts a positivism/quantitative paradigm, which emphasizes objectivity, measurement, and empirical hypothesis testing, aligning with the need to investigate the moderating role of insurance and reinsurance in the relationship between natural disasters and economic growth.

3.3 Sample size, period, and data source

The study utilizes all OECD countries to investigate the interaction between natural disasters and economic growth in different regions. The study's data is gathered from the period 1990 to 2023. This period provides a detailed perspective of long-term trends and the evolution of insurance and reinsurance practices over time, capturing the effects of numerous natural disasters and economic cycles. The extended period also allows for the examination of structural changes in the insurance industry and economic growth, thus offering a robust analysis of the relationships under investigation.

The study relies on secondary data, collected from reliable sources such as OECD statistics, EM-DAT, and the World Bank dataset. These sources provide extensive, high-quality data that is essential for conducting a thorough quantitative analysis. Utilizing secondary data allows for a broader and more objective analysis, as it is drawn from well-established databases with standardized data collection methods. This approach ensures that the study's findings are grounded in credible and widely accepted information.

3.4 Definition of variables and proxies

3.4.1 Dependent variable:

Economic Growth:

The study measures economic growth using one indicator: Gross Domestic Product (GDP) per capita. This is a crucial indicator used to assess different dimensions of economic growth within countries. GDP per capita serves as a measure of average economic output per person (World Bank, 2023). GDP per capita, is employed as dependent variable in regression models to explore factors influencing growth outcomes across countries (World Bank, 2022). This variable offers perspectives into the complex interplay of economic growth informing policy-making and academic research on global growth (Setiawan, 2023; Sari, 2022).

3.4.2 Independent Variables:

Natural Catastrophes:

This study measures natural disasters utilizing total damage, total death, number of people injured, and number of people affected. Natural disasters/catastrophes data for this paper is collected from EM-DAT. This is an international data set that contains 26 thousand mass disasters since 1988. The data in this site is a collection of data from reinsurers, UN agencies, companies, and research centres. EM-DAT collects data of natural disaster events that have at least 10 fatalities, state of emergency being declared and or having more than 100 people affected. This study utilizes data from 1990 to 2023 (CRED, 2023).

3.4.3 Moderating variables:

Insurance:

For insurance parameters this paper utilizes total insurance density retrieved from World Bank from a period of 1990 to 2023. Insurance density is a critical metric for understanding the insurance market's size, growth, and impact on an economy. Insurance density is the average amount of insurance premiums per capita within a given population. This metric provides insights into the average expenditure on insurance per person, indicating the level of individual financial protection and awareness (Cao & Wang, 202; Chen & Zhang, 2022; Pradhan et al., 2017; Swiss Re 2022).

Reinsurance:

Retention Ratio is the parameter utilized in insurance and particularly reinsurance analysis. It is measured as the net written premium over gross written premium. This ratio provides insights into risk management and financial stability. This ratio serves as a crucial metric for evaluating an insurer's reinsurance strategy and risk exposure management. (OECD, 2024).

3.4.4 Control Variables:

Gross Fixed Capital Formation (GFCF) is defined as the net increase in physical assets, such as buildings and machinery, after accounting for depreciation. It reflects the level of investment in an

economy's productive capacity and is a key indicator of economic growth and development (World Bank, 2019; Pasara and Garidzirai, 2020). The labour force participation rate refers to a proportion of individuals of working age who are either employed or actively seeking employment to population. This measure is crucial as it determines the productive capacity of an economy and its potential for economic expansion (OECD, 2022; Soava et al., 2020). Inflation is defined as the rate at which the overall prices of goods and services increase, which erodes the purchasing power of money. This is a crucial economic metric as it affects value of money, savings, and economic stability. Central banks often target inflation rates to maintain price stability (OECD, 2021; Yang and Shafiq, 2020).

Table 1: Summary of variables and proxies

Variables	Acronym	Definition	Source
Dependent Variables			
GDP per capita	GDP pc	Gross Domestic Product divided by a country's midyear population	World bank database
Independent Variables			
Total Damage (in US\$ billion)	TDA	Economic impact of a disaster including physical damage to infrastructure, property, and assets.	EM-data
Total Death	TD	Officially reported number of fatalities from a disaster, including both confirmed deaths and missing persons presumed dead due to unknown whereabouts since the event.	EM-data
Number of people injured	NI	Includes all individuals reported as "injured" or "hospitalized" due to a disaster.	EM-data
Moderating variables			
Insurance			
Total Life and Non- Life insurance density	TLNID	The average amount of insurance premiums per	OECD stats

		capita within a given population.	
	Reinsurance		
Total Retention Ratio	TLNRet	The net written premium over gross written premium.	OECD stats
	Robust Analysis (Insurance)		
Total Life and Non-Life Penetration	TLNIP	The ratio of total insurance premium and GDP	OECD stats
	Robust Analysis (Reinsurance)		
Total Reinsurance Accepted	TLNRA		OECD stats
	Control Variables		
Gross fixed capital formation	GFCF	Measures the average yearly increase in investments in fixed assets, calculated using constant local currency.	World bank database
Labor Force Participation Rate	LFPR	Annually weighted average that indicates the share of people aged 15 and older who are economically active.	World bank database
Inflation	CPI	Annual changes in the average cost of a fixed basket of goods and services purchased by consumers.	World bank database

3.5 Regressions and Estimation technique

This study employs a panel regression technique to analyse the data, focusing on the role of moderating variables in the relationship between natural disasters and economic growth. Panel data utilized for this study pertains endogeneity in the independent variables of the study. Dynamic panel regression is particularly valuable in this context as it allows for the examination of data across multiple time periods and countries, capturing both temporal and cross-sectional variations. Panel data analysis enhances the robustness of findings by controlling for unobserved heterogeneity and accounting for both within-country and between-country variations (Singhal et al., 2022). This approach provides more accurate estimates of the relationships between variables

by leveraging the richness of longitudinal data. It also helps in identifying causal relationships and assessing the influence of moderating variables on the economic impact of natural catastrophes, leading to more nuanced insights into how insurance and reinsurance mechanisms can mitigate these impacts (Hsiao, 2014; Baltagi, 2013).

The paper further utilizes the Generalized Method of Moments (GMM), a powerful and versatile estimation technique for the analysis. GMM is robust in the presence of endogeneity, a common challenge in econometric modelling where explanatory variables are correlated with the error term. By using instrumental variables that are correlated with the endogenous explanatory variables but uncorrelated with the error term, GMM helps produce consistent and reliable parameter estimates (Dawd and Benlagha, 2023; Ullah, Akhtar, & Zaefarian, 2018). In the model utilized in this study GMM allows the use of instrumental variables that correlate to the moderating variables but not the error term which leads to more consistent and unbiased estimates. GMM further leverages multiple moments conditions which effectively control endogeneity (Ullah, Akhtar, & Zaefarian, 2018).

3.6 Model

Understanding the impact of natural disasters, insurance and reinsurance parameters on economic growth is crucial for effective risk mitigation strategies. The model utilized to estimate the dependent variable is as follows:

$$Z_{it} = \beta_1 Z_{it-1} - \beta_2 N_{it} + \beta_3 C_{it} + \mu_i + \delta_t + \varepsilon_{it} \quad (1)$$

$$Z_{it} = \beta_1 Z_{it-1} + \beta_2 I_{it} + \beta_4 C_{it} + \mu_i + \delta_t + \varepsilon_{it} \quad (2)$$

$$Z_{it} = \beta_1 Z_{it-1} - \beta_2 N_{it} + \beta_3 R_{it} + \beta_4 C_{it} + \mu_i + \delta_t + \varepsilon_{it} \quad (3)$$

$$Z_{it} = \beta_1 Z_{it-1} - \beta_2 N_{it} + \beta_3 I_{it} + \beta_4 (N*I) + \beta_5 R_{it} + \beta_6 C_{it} + \mu_i + \delta_t + \varepsilon_{it} \quad (4)$$

$$Z_{it} = \beta_1 Z_{it-1} - \beta_2 N_{it} + \beta_3 R_{it} + \beta_4 (N*R) + \beta_5 R_{it} + \beta_6 C_{it} + \mu_i + \delta_t + \varepsilon_{it} \quad (5)$$

When Z represents economic growth (i.e., GDP per capita), N represents natural disasters (i.e., Total Damage, total Death, Total Number of people injured and Total Number of people affected), I represents Insurance density, R represents Reinsurance (i.e., Retention ratio) (N*I) and (N*R) represents the interactions terms and finally C represents control variables (i.e., Gross fixed capital formation, Inflation, Labor Force Participation Rate). β represents the parameters that are estimated while μ_i represents country specific fixed effects, δ_t represents time specific fixed effects and ε_{it} represents the error term.

This chapter outlined the methodological framework guiding the study, emphasizing a quantitative, positivist paradigm to objectively examine how insurance and reinsurance moderate the relationship between natural disasters and economic growth. By employing secondary panel data from OECD, EM-DAT, and World Bank sources covering 1990–2023, the study ensures robust cross-country and longitudinal analysis. Key variables include GDP per capita as the dependent variable, multiple measures of natural disasters as independent variables, insurance density and reinsurance retention ratios as moderating variables, and investment, labour participation, and inflation as controls. Panel regression and the Generalized Method of Moments (GMM) are adopted to address endogeneity and enhance consistency, enabling the identification

of causal pathways between disasters, insurance, reinsurance, and growth. The models developed provide the empirical foundation for testing the study's hypotheses, ensuring methodological rigor and alignment with the research objectives discussed in the next chapter.

CHAPTER FOUR: RESULTS

4.1 Descriptive Statistics

Table 2 below presents the descriptive statistics the study utilizes. GDP per Capita (GDP) has an average of \$29,956.5 and standard deviation of \$22,496.1 thus reflecting that OECD countries are developed economies. Natural disaster variables total damage (TDA); total death (TD); number of people injured (NI), and number of people affected (NAP) reflect the following averages \$2,122,135.7; 256.37; 497; 166,491 respectively. The dataset reveals the following standard deviation for TDA; TD; NI; and NAP \$12,789,387.9; 2,067.7; 4,821.4; 2470796.4 respectively. These figures indicate that although natural disasters are frequent, their impacts are highly skewed: most events are moderate in scale, but a small number of outliers produce catastrophic losses. Economically, this skewness implies that households and firms often face manageable disruptions, but governments and insurers must prepare for rare, high-cost events that can destabilize entire markets. Such tail risks underscore the importance of contingency planning, fiscal buffers, and insurance penetration.

The average of Total Life and Non-Life Insurance Density (TLNID) is 2,427.7, indicating strong life insurance uptake across OECD countries. However, the high skewness (6.35) suggests that a few markets, such as Japan and Switzerland, dominate (OECD, 2023). For households and firms, this translates into unequal protection: while some economies benefit from robust insurance safety nets that facilitate quicker recovery, others remain more exposed to economic shocks.

Reinsurance data reflects the average Total Life and Non-Life Reinsurance (TLNRet) of 70.44. While indicating healthy sector profitability, the relatively high standard deviations (35.77) reflect significant volatility, driven by post-pandemic interest rate and market fluctuations (Munich Re, 2023; Cummins & Weiss, 2017). Such volatility matters economically as reinsurers play a systemic stabilizing role: when reinsurance markets are stable, insurers can confidently expand coverage and absorb shocks; when volatility rises, insurers may retrench, premiums may increase, and coverage gaps may emerge, leaving households and businesses more vulnerable to disaster losses.

Variance Inflation Factors (VIFs), serve as a robustness check for multicollinearity among explanatory variables. In this analysis, all VIF values fall well below the commonly accepted thresholds—ranging between 1.02 and 1.18—confirming the absence of significant multicollinearity (O’Brien, 2007; Hair et al., 2010).

Table 2**Descriptive Statistics**

Statistics	GDPpc	GFCF	LFPR	CPI	TDA	TD	NI	NAP	TLNID	TLNRet
Obs	1292	1292	1292	1292	1292	1292	1292	1292	1292	1291
Mean	29956.5	22.565	58.758	8.181	2122135.7	256.37	497.07	166490.8	2427.6	70.44
Std. Dev	22496.1	4.936	12.618	47.254	12789387.9	2067.7	4821.4	2470796.4	5255.7	35.77
Min	1474.8	0.000	0.000	-4.448	0.000	0.000	0.000	0.000	0.000	0.000
p25	13077.3	20.122	56.448	1.413	0.000	0.000	0.000	0.000	218.5	73.08
p50	24897.2	22.436	60.491	2.534	0.000	2.000	0.000	0.000	1209.3	85.34
p75	42560.3	24.957	64.104	4.796	276500.0	28.000	4622.5	3.000	2666.8	91.67
Max	133711.8	53.222	83.847	1020.6	212520000.0	53057.0	85110376.0	107485.0	54329.3	201.52
Skewness	1.360	-0.711	-3.171	16.835	10.972	16.639	15.438	31.820	6.347	-1.176
Kurtosis	2.511	6.718	13.072	317.6	141.074	359.190	277.021	1084.467	47.388	0.467
VIF		1.03	1.18	1.14	1.18	1.18	1.13	1.02	1.04	1.06

Note: Q1, Q2, and Q3 represents the 25th, 50th and 75th percentiles, respectively. | TDA = Total Death Affected TD = Total Death NAP = No. Of Affected NI = No of Injured TLNID = Total Q1, Q2, and Q3 represents the 25th, 50th and 75th percentiles, respectively. | TDA = Total Death Affected TD = Total Death NAP = No. Of Affected NI = No of Injured TLNID=Total Life and Non-Life Insurance TLNRet = Total Life and Non-Life Reinsurance| Cpi = Inflation GFCF = Gross Fixed Capital Formation LFPR =Labour Force Participation Rate

4.2 Correlations:

The correlation results presented in Table 3 show that all independent variables which are natural disaster variables (TDA, TD, NI, NAP), moderating variables which are insurance and or reinsurance variables (TLNID, LID, NLID, TLNRet), and control variables (CPI, GFCF, LFPR), exhibit relatively low to moderate correlation coefficients. Most correlations are below 0.8, indicating that multicollinearity is not a concern among the variables (Gujarati, 2019). This suggests that the independent and moderate variables are sufficiently distinct and appropriate for inclusion in the regression model. Therefore, the analysis can proceed without concerns of bias due to multicollinearity. Correlations between independent variables and dependent variables are mostly negative showing that natural disasters negatively impact GDP per capita. In contrast, the moderating variables (insurance and reinsurance) reflect a positive relationship with GDP per Capita. This emphasises that insurance and reinsurance positively impact GDP per Capita.

Table 3**Correlations**

Variables	GDPpc	TDA	TD	NI	NAP	TLNID	LID	NLID	TLNRet	Lret	Nret	CPI	GFCF	LFPR
GDPpc	1.000													
TDA	0.125***	1.000												
TD	-0.005	0.224**	1.000											
NI	-0.023	0.219**	0.568***	1.000										
NAP	0.020	0.147**	0.131***	0.123***	1.000									
TLNID	0.699***	0.069*	-0.009	-0.016	0.015	1.000								
LID	0.617***	0.022	-0.010	-0.008	-0.0001	0.989***	1.000							
NLID	0.839***	0.286**	0.001	-0.048*	0.091***	0.663***	0.546***	1.000						
TLNRet	0.237***	0.046*	0.045*	0.032	0.010	0.133***	0.098***	0.262***	1.000					
Lret	0.197***	0.039	0.058**	0.041	0.009	0.121***	0.091***	0.228***	0.868***	1.000				
Nret	0.208***	0.058*	0.051*	-0.006	0.010	0.113***	0.071***	0.281***	0.898***	0.822***	1.000			
CPI	-0.169***	-0.015	0.021	0.018	0.002	-0.059**	-0.044*	-0.109***	-0.169***	-0.156***	-0.153***	1.000		
GFCF	-0.051*	-0.004	0.030	0.048*	-0.002	-0.075**	-0.079**	-0.0240	0.0384	0.059**	0.013	-0.248***	1.000	
LFPR	0.352***	0.042	-0.030	-0.005	0.009	0.095***	0.052*	0.281***	0.307***	0.263***	0.270***	-0.342***	0.227***	1.000

Note: (*), (**) and (***) highlights significance at 10 %, 5 % and 1 %, respectively. Source: Results were generated from Stata by authors.

4.3 Graphs

Interpretation of Graphs:

Figures 3 to 6 depict the relationships between dependent variable- GDP per capita (GDPpc) - and independent variables - various disaster-related metrics. Figure 3 shows a positive relationship between Total Damage (TDA) and GDPpc. Similarly, Figure 6 displays a positive relationship between NAP (Number of people affected) and GDPpc, indicating that as TDA and or NAP from disasters increases, GDPpc also tends to rise. Wealthier countries tend to be defined by higher GDPpc thus these countries often face larger absolute damages and or larger populations due to their greater and high value infrastructure, assets, and population densities in high-risk areas. When richer countries experience a natural disaster, they face higher losses. However, this does not necessarily mean that the damage directly increases GDPpc. Rather, it suggests that in more developed economies, higher disaster-related damages are often followed by significant reconstruction efforts, economic stimulus, and recovery activities that contribute to economic growth. Higher negatively affected areas or people may lead to increased investments in rebuilding, increased insurance and or reinsurance payouts, which can drive short-term economic activity and thereby raise GDPpc.

Figure 4 reveals a negative relationship between Number of Injured (NI) and GDPpc. Similarly, Figure 5 has a negative relationship between Total Deaths (TD) and GDPpc, suggesting that higher numbers of people injured in disasters and or total death tend to lower GDPpc. The economic impact of injuries and or increased fatalities is significant because they reduce productivity, increase healthcare costs, and hinder labour force participation. These negative impacts lead to lower economic output. Figures 7 and 8 show positive relationships between Insurance on GDPpc and Reinsurance on GDPpc, meaning that as insurance and reinsurance mechanisms increase, GDPpc tends to rise. Strong insurance and reinsurance markets allow for quicker recovery from disaster-related losses, as they help redistribute financial risk and provide essential capital for rebuilding. The development of these markets in wealthier countries supports the stabilization of the economy, reducing long-term economic disruptions from disasters. These fosters continued growth in GDPpc by ensuring that countries can maintain economic stability and prevent major setbacks following disasters.

Graphs:

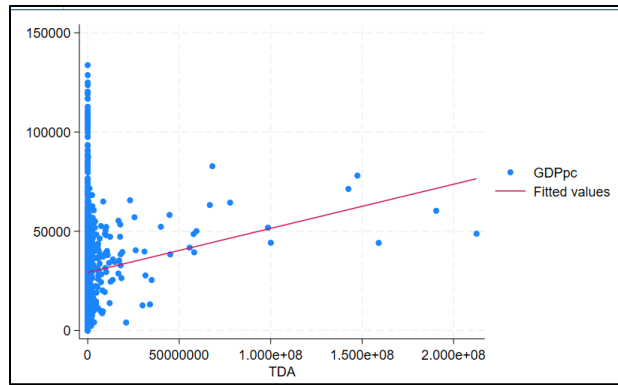


Figure 3: GDP per Capita and Total Damage

Figure 3: shows a positive relationship between Total damage and GDPpc,

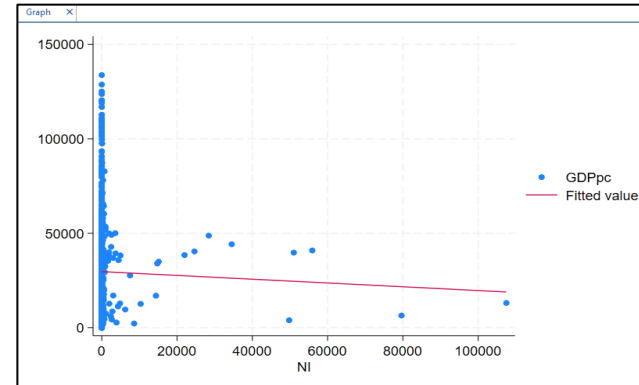


Figure 4: GDP per Capita and Number of people injured.

Figure 4: shows a negative relationship between number of people injured and GDPpc,

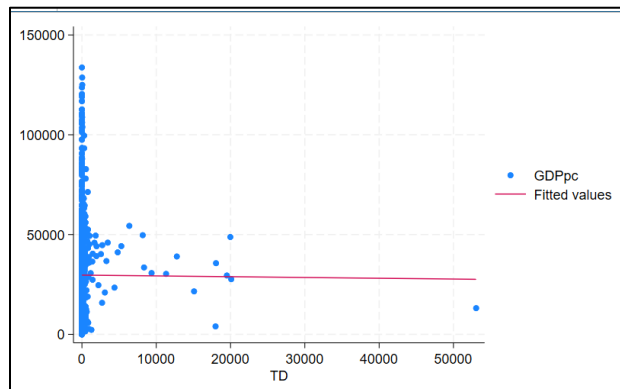


Figure 5: GDP per Capita and Total Death

Figure 5: shows a negative relationship between Total death and GDPpc,

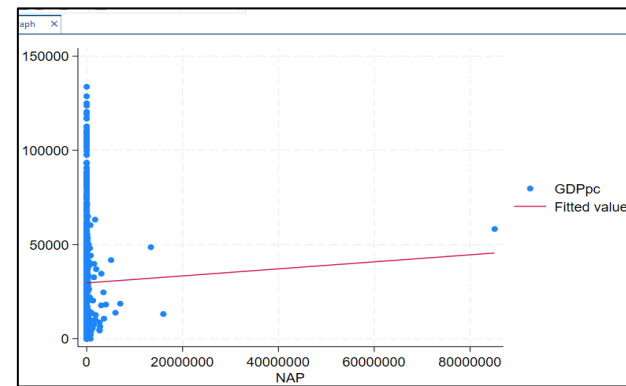


Figure 6: GDP per Capita and Number of people affected.

Figure 6: shows a positive relationship between number of people affect and GDPpc,

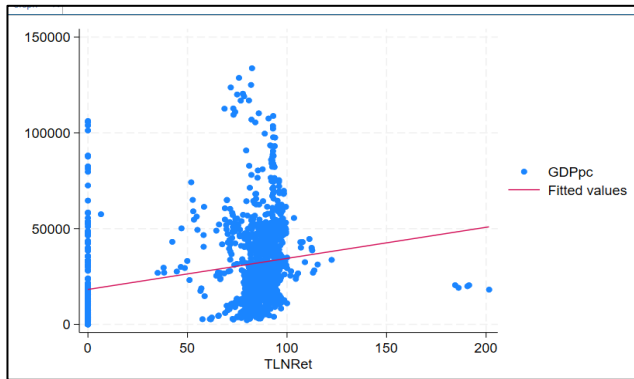


Figure 7: shows a positive relationship between reinsurance utilization and GDPpc,

Figure 7: GDP per Capita and Reinsurance.

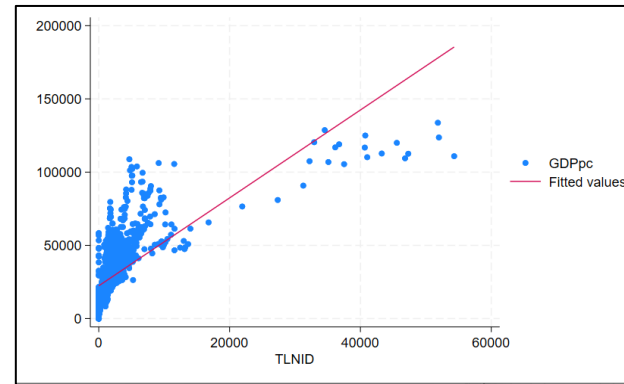


Figure 8: shows a positive relationship between insurance affect and GDPpc,

Figure 8: GDP per Capita and Total Insurance Density

4.4 Regression Results

4.4.1 Direct effects of natural disaster, insurance, and reinsurance on economic growth

The regression results show that natural disaster variables have mixed effects on economic growth. Total damage exhibits a positive and statistically significant relationship with GDP per capita, suggesting that economic activity may increase in the short term as a result of reconstruction and recovery efforts. In contrast, total deaths and the number of people injured both display negative and significant effects on economic growth. This indicates that natural disasters that result in fatalities or injuries reduce productivity and hinder economic performance. The number of people affected by disasters shows a positive and significant relationship with GDP per capita, which may reflect increased resource mobilization, such as aid or emergency funding, in response to disasters.

Insurance-related variables demonstrate a clear positive and statistically significant relationship on economic growth. Total insurance contributes positively to GDP per capita, highlighting the role of insurance in enhancing financial resilience and economic stability. Economically, this reflects insurance's ability to smooth consumption and investment, reduce precautionary savings, and enable households and firms to reallocate resources toward productive activity rather than risk buffers. Similarly, reinsurance variables - total reinsurance - show positive and significant relationships with economic growth. These findings suggest that reinsurance mechanisms support the insurance sector's capacity to absorb large-scale losses, particularly those caused by natural disasters, and thereby contribute to sustained economic growth. In Model 8, the Hansen test records a value of 0.84; while relatively high, the instruments remain valid given the balance with groups and the supporting AR tests, so the results can still be considered robust.

The control variables reflect that the lag of GDP per capita consistently shows a positive and significant relationship across all models, indicating persistent growth patterns over time. Gross fixed capital formation (GFCF) shows mixed results, with both positive and negative coefficients depending on the model, but remains mostly significant, suggesting that its impact varies depending on the context. The labour force participation rate (LFPR) is generally positive and significant, meaning that higher labour market engagement is associated with stronger economic growth. The consumer price index (CPI) also shows a positive and significant relationship in most models, indicating a moderate influence of inflation dynamics on economic activity.

Beyond these ex-post effects, insurance and reinsurance also play critical ex-ante roles by encouraging risk awareness, incentivizing investment in safer infrastructure, and ensuring that insurers remain adequately capitalized prior to shocks. These preventive functions reduce vulnerability and strengthen the foundations of long-term growth.

Table 4**Direct Effects Natural disasters, Insurance and Reinsurance**

Variables	Model One	Model Two	Model Three	Model Four	Model Five	Model Eight
Lag of GDPpc	8.540***	9.180***	8.641***	8.603***	8.467***	8.551***
	(0.006)	(0.004)	(0.002)	(0.002)	(0.005)	(0.007)
GFCF	3.104***	2.444***	-0.740***	-5.371***	3.061***	2.703***
	(0.001)	(0.001)	(0.001)	(0.000)	(0.001)	(0.002)
LFPR	8.565***	3.257***	7.561***	7.400***	1.00***	4.797***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)
CPI	0.640***	3.173***	1.230***	1.240***	1.429***	4.041 *
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Total damage	2.800***					
	(0.000)					
Total Death		-1.280***				
		(0.000)				
Number of people injured			-1.560***			
			(0.000)			
Number of people Affected				1.280**		
				(0.000)		
Total Insurance					3.020***	
					(0.000)	
Total Reinsurance						4.133***
						(0.000)
Year and Country Dummies	Yes	Yes	Yes	Yes	Yes	Yes

Observations	1254	1254	1254	1254	1254	1254
Number of groups	38	38	38	38	38	38
Number of instruments	35	35	35	35	35	35
Prob>F	0.000	0.000	0.000	0.000	0.000	0.000
AR (1)	0.023	0.074	0.065	0.070	0.070	0.000
AR (2)	0.440	0.881	0.444	0.484	0.482	0.067
Hansen	0.145	0.129	0.128	0.126	0.135	0.840

Note: (*), (**) and (***) highlights significance at 10 %, 5 % and 1 %, respectively. Source: Results were generated from Stata by authors.

4.4.2 The interaction effects of natural disasters and insurance on economic growth

The results from Table 5 below reveal that the interaction between total insurance and total damage is positive and significant, suggesting that insurance markets transform potentially destructive shocks into manageable economic events. By mobilizing post-disaster financing, insurance prevents liquidity shortages, supports household consumption, and sustains business continuity. Total insurance consistently shows a positive and significant relationship with economic growth across all models, reinforcing its role as a stabilizing financial tool. In model three and four total death reflects negative relationship with GDPpc while in contrast, the interaction term (insurance* total death) in model four presents a positive and significant relationship with GDP per Capita, indicating that insurance reduces the economic cost of mortality shocks by compensating affected households and easing the fiscal burden on governments.

In models five and six, the number of people injured has a negative and significant impact on GDP per capita, indicating that injuries due to disasters can adversely affect economic productivity. However, insurance maintains a positive and significant effect on economic growth, with the interaction term (insurance* number of people injured) in model six showing a positive and significant with GDP per Capita, emphasizing that insurance plays a vital role in offsetting the economic burden of disasters. These results highlight not only the ex-post stabilizing function of insurance but also its ex-ante contribution, as the availability of insurance products encourages proactive risk management by households and firms. This preparatory role facilitates investment decisions and credit access even before disasters occur, thereby amplifying growth potential.

Control variables show consistent patterns. Lagged GDP per capita remains positive and significant across all models, suggesting economic persistence. Gross fixed capital formation (GFCF) and labour force participation rate (LFPR) also show positive and significant effects, indicating that investment and labour market participation are important for economic growth. Consumer price index (CPI) shows mixed signs, with negative and significant results in some models, particularly where inflation may be destabilizing, and positive in others, suggesting varying inflationary effects depending on the model context.

Table 5**Interaction Effects Natural disasters and Insurance**

Variables	Model One	Model Two	Model Three	Model Four	Model Five	Model Six	Model Seven	Model Eight
Lag of GDPpc	8.343***	8.523***	6.192****	5.828***	8.568***	8.023***	8.469***	8.474***
	(0.007)	(0.006)	(0.011)	(0.009)	(0.007)	(0.011)	(0.006)	(0.007)
GFCF	0.035***	3.103***	1.476***	1.390***	2.770***	4.336***	3.084***	3.067***
	(0.002)	(0.001)	(0.002)	(0.003)	(0.002)	(0.003)	(0.001)	(0.002)
LFPR	8.853***	9.272***	4.873***	2.763***	9.810***	1.235***	9.801****	9.811***
	(0.002)	(0.001)	(0.000)	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)
CPI	0.085***	0.866***	-5.022***	-5.718***	1.226****	1.512***	1.453***	1.446***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Total Damage	2.650***	-4.030***						
	(0.000)	(0.000)						
Total Insurance	1.520***	1.070***	1.235***	1.405***	3.150***	3.580***	3.080***	3.140***

		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Total Insurance * Total Damage		3.150***		2.700***				
		(0.000)		(0.000)				
Total Death			-1.260***	-4.680*				
			(0.000)	(0.000)				
Total insurance * Total Death				2.700***				
				(0.000)				
Number of people injured					-3.080***	-1.930***		
					(0.000)	(0.000)		
Total Insurance * Number of people injured *						4.350***		
						(0.000)		
Number of people affected							0.650	0.640
							(0.000)	(0.000)

Total Insurance* Number of people affected								1.920
								(0.000)
Year and Country Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1254	1254	1254	1216	1254	1254	1254	1254
Number of groups	38	38	38	38	38	38	38	38
Number of instruments	35	35	35	35	35	35	35	35
Prob>F	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AR (1)	0.023	0.036	0.063	0.040	0.047	0.081	0.069	0.069
AR (2)	0.496	0.751	0.143	0.146	0.418	0.232	0.475	0.478
Hansen Test	0.138	0.092	0.119	0.093	0.124	0.098	0.107	0.086

Note: (*), (**) and (***) highlights significance at 10 %, 5 % and 1 %, respectively. Source: Results were generated from Stata by authors.

4.4.3 The interaction effect of natural disasters and reinsurance on economic growth

The findings in Table 6 consistently show that reinsurance has a positive and significant effect on the dependent variable – GDP per Capita- across all models, confirming its vital role in promoting financial resilience. In Model One, reinsurance exhibits a strong positive relationship, which reflects its economic role as an international risk-sharing mechanism: it reduces the domestic cost of disasters by transferring part of the losses to global reinsurers. This stabilizes domestic financial systems and supports sustainable growth. In Model Two, the interaction term (reinsurance* total damage) shows a positive and significant relationship with GDP per Capita, illustrating how reinsurance strengthens the fiscal and financial response to physical damage, enabling faster rebuilding without overwhelming domestic insurers or governments.

Model Three and Four shows total death has negative relations to GDP per capita. However, in model four a positive relationship is observed between the interaction term (total death * reinsurance) and GDP per Capita. This indicates that reinsurance mitigates the adverse economic effects of mortality shocks by softening the financial impact on insurers and the broader economy thus supporting economic growth. Beyond these statistical associations, reinsurance also plays important ex-ante roles. By diversifying risks globally, it attracts foreign capital, stabilizes premiums, and ensures long-term market confidence. These anticipatory roles reinforce economic stability, reduce sovereign fiscal exposure, and enhance resilience to future shocks, making reinsurance a cornerstone of sustainable growth strategies.

In Model Five, the number of people injured shows a negative and significant relationship with the dependent variable (GDP per Capita), suggesting that injuries impose economic costs hindering economic growth. However, in model six the interaction term (injuries * reinsurance) shows a positive and significant impact on GDP per capita, highlighting the effectiveness of reinsurance in buffering against the financial consequences of health-related disaster impacts.

Beyond these statistical associations, reinsurance also plays important ex-ante roles. By diversifying risks globally, it attracts foreign capital, stabilizes premiums, and ensures long-term market confidence. These anticipatory roles reinforce economic stability, reduce sovereign fiscal exposure, and enhance resilience to future shocks, making reinsurance a cornerstone of sustainable growth strategies rebuilding without overwhelming domestic insurers or governments.

Table 6**Interaction Effects Natural disasters and Reinsurance**

Variables	Model One	Model Two	Model Three	Model Four	Model Five	Model Six	Model Seven	Model Eight
Lag of GDPpc	8.477*** (0.006)	8.059*** (0.009)	2.889*** (0.014)	2.879*** (0.021)	8.617*** (0.007)	8.333*** (0.007)	8.551*** (0.007)	8.577*** (0.008)
GFCF	2.872*** (0.002)	3.847*** (0.003)	2.777*** (0.004)	2.876*** (0.004)	2.484*** (0.002)	2.615*** (0.002)	2.707*** (0.002)	2.733*** (0.002)
LFPR	5.226*** (0.000)	4.131*** (0.000)	3.413*** (0.000)	3.549*** (0.003)	5.102*** (0.000)	6.136*** (0.000)	4.807*** (0.000)	3.486** (0.001)
CPI	-3.869* (0.000)	0.418 (0.000)	-6.325*** (0.001)	-6.077*** (0.000)	2.921 (0.000)	1.112 (0.000)	0.405* (0.000)	0.057*** (0.002)
Reinsurance	4.131*** (0.000)	5.312*** (0.000)	1.018*** (0.000)	9.385*** (0.000)	4.087*** (0.000)	4.462*** (0.000)	4.126*** (0.000)	4.288*** (0.000)
Total damage	2.250 (0.000)	-1.160 (0.000)						
Total damage * Reinsurance		3.440*** (0.000)						
Total death			-5.340*** (0.000)	-2.421*** (0.000)				
Total death and Reinsurance				2.660*** (0.000)				
No. of people injured					-3.240*** (0.000)	-2.990*** (0.000)		
No. of people injured * Reinsurance						3.900*** (0.000)		
No. of people affected							2.450 (0.000)	-3.240 (0.000)
No of people Affected * Reinsurance								4.110 (0.000)
Year and Country Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1254	1254	1254	1254	1254	1254	1254	1254

Number of groups	38	38	38	38	38	38	38	38
Number of instruments	35	35	35	35	35	35	35	35
Prob > F	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AR (1)	0.066	0.030	0.011	0.007	0.044	0.017	0.067	0.068
AR (2)	0.863	0.447	0.122	0.188	0.673	0.149	0.838	0.695
Hansen	0.116	0.133	0.119	0.103	0.110	0.094	0.120	0.103

Note: (*), (**) and (***) highlights significance at 10 %, 5 % and 1 %, respectively. Source: Results were generated from Stata by authors.

4.5 Robustness Analysis

4.5.1 Insurance Robust Analysis

For robust analysis, the study introduces insurance penetrations as a measure of insurance instead of insurance density. Insurance penetration -measured as insurance premiums relative to GDP- is an appropriate proxy for insurance as it reflects the size and effectiveness of insurance sector. The regression results below demonstrate that the natural disaster as an independent variable—as measured by; Total Damage, Total Death, and Number of People Injured—have a negative and statistically significant impact on GDP per capita, highlighting the economic toll of natural disasters. This is consistent with the results above in Table 4 and 5 which displays a negative relationship between natural disasters variables and economic growth (GDP per capita). In contrast, the results below also demonstrate positive and significant relationship between the interaction terms (insurance penetration * disaster variables) and GDP per capita. This emphasizes the findings found above in table 5 that insurance effectively mitigates the adverse effects of natural disasters on economic growth i.e. GDP per capita. This reinforces that insurance – moderating variable- contributes to economic resilience by providing financial protection and facilitating recovery in the aftermath of disasters. The consistency of these findings across models underscores the robustness and position of insurance as a reliable mechanism for cushioning economic shocks and accelerating recovery thus promoting economic growth.

Table 7**Insurance Robust Analysis**

Variables	Model One	Model Two	Model Three	Model Four	Model Five	Model Six	Model Seven	Model Eight
Lag of GDPpc	9.054***	8.974***	9.019***	9.027***	9.110***	8.639***	9.056***	9.072***
	(0.004)	(0.004)	(0.004)	(0.005)	(0.004)	(0.005)	(0.003)	(0.004)
GFCF	2.008***	2.185***	2.084***	2.065***	1.771***	2.855***	2.020***	2.054***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)
LFPR	6.871***	7.538***	7.264***	6.338***	7.493***	7.718***	6.509***	6.232***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
CPI	1.375***	1.493***	1.363***	1.424***	1.244***	0.926***	1.377***	1.439***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Total Insurance Penetration	5.104***	4.906***	5.399***	4.690***	3.855***	7.528***	5.258***	5.361***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.000)	(0.000)
Total Damage	-5.651**	-1.270***						
	(0.000)	(0.000)						
Total Insurance Penetration * Total Damage		1.620***						
		(0.000)						
Total Death			-1.111***	-6.380***				
			(0.000)	(0.000)				
Total Insurance Penetration * Total Death				6.430***				
				(0.000)				
Number of people Injured					-3.400***	-2.430***		
					(0.000)	(0.000)		
Number of people injured * Insurance Penetration						1.240***		
						(0.000)		
Number of people affected							1.050	0.090
							(0.000)	(0.000)
Number of people affected * Insurance Penetration								2.530
								(0.000)

Year and Country Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1216	1216	1216	1216	1216	1216	1216	1216
Number of groups	38	38	38	38	38	38	38	38
Number of instruments	35	35	35	35	35	35	35	35
Prob > F	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AR (1)	0.077	0.076	0.077	0.070	0.053	0.034	0.076	0.077
AR (2)	0.321	0.343	0.324	0.318	0.267	0.574	0.321	0.321
Hansen	0.103	0.086	0.107	0.083	0.110	0.087	0.101	0.083

Note: (*), (**) and (***) highlights significance at 10 %, 5 % and 1 %, respectively. Source: Results were generated from Stata by authors.

4.5.2 Reinsurance Robust analysis

The robust analysis for reinsurance as a moderating variable utilizes reinsurance accepted as the new variable used instead of retention ratio. Reinsurance accepted is an appropriate measure of the role of reinsurance as it reflects actual risk transfer, enhances financial resilience post-disaster, and serves as a proxy for economic recovery capacity (Cummins & Weiss, 2009; Froot, 2001; Biener et al., 2015). The results below remain aligned with the primary regression results in table 6 above. The results show that total damage (TDA), total deaths (TD), number of injured (NI), and number of people affected (NAP) have negative effects on economic growth i.e. GDP per capita. However, these negative impacts of natural disaster reflect to be consistently mitigated when observing the relationship between the interaction terms (reinsurance accepted * natural disaster variables) and GDP per capita. Results below demonstrate positive and significant results of the relationships between the interaction terms and GDP per capita. These findings are consistent with the findings above in table 6. This emphasizes the reinsurance offsets the economic losses associated with high damage and fatality levels, helps absorb the long-term burden of injuries, and lessens the adverse effects of widespread displacement. These findings highlight that while disaster-related shocks typically hinder economic growth, reinsurance plays a crucial protective role by providing financial buffers that support recovery and resilience.

Table 8**Reinsurance Robust Analysis**

Variables	Model One	Model Two	Model Three	Model Four	Model Five	Model Six	Model Seven	Model Eight
Lag of GDPpc	8.899***	8.851***	8.965***	8.848***	9.017***	8.835***	8.930***	8.877***
	(0.004)	(0.004)	(0.004)	(0.007)	(0.006)	(0.005)	(0.004)	(0.007)
GFCF	2.391***	2.645***	2.255***	2.400***	2.058***	2.062***	2.345***	2.339***
	(0.001)	(0.001)	(0.000)	(0.001)	(0.001)	(0.000)	(0.001)	(0.002)
LFPR	6.149***	4.567***	5.403***	7.692***	5.832***	7.398***	5.878***	6.805***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
CPI	-1.267	-1.556	-1.914	0.898	-0.348*	-0.281***	-1.552	-1.962
	(0.000)	(0.000)	(0.000)	(0.000)	(0.002)	(0.000)	(0.000)	(0.000)
Reinsurance Accepted	1.744***	1.702***	1.701***	1.192***	1.786***	1.109***	1.768***	1.544***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Total damage	2.080***	-1.660***						
	(0.000)	(0.000)						
Total damage * Reinsurance Accepted		9.710***						
		(0.000)						
Total death			1.780***	-1.605***				
			(0.000)	(0.000)				
Total death and Reinsurance Accepted				2.000***				
				(0.000)				
No. of people injured					-3.190***	-2.900***		
					(0.000)	(0.000)		
No. of people injured * Reinsurance Accepted						4.230***		
						(0.024)		
No. of people affected							0.770	-2.130***
							(0.000)	(0.000)
No of people Affected *								9.920***

Reinsurance Accepted								
								(0.000)
Year and Country Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1254	1254	1254	1254	1254	1254	1254	1254
Number of groups	38	38	38	38	38	38	38	38
Number of instruments	35	35	35	35	35	35	35	35
Prob > F	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AR (1)	0.066	0.043	0.067	0.039	0.046	0.034	0.066	0.064
AR (2)	0.483	0.258	0.263	0.827	0.459	0.535	0.432	0.244
Hansen	0.107	0.087	0.106	0.087	0.107	0.088	0.107	0.084

Note: (*), (**) and (***) highlights significance at 10 %, 5 % and 1 %, respectively. Source: Results were generated from Stata by authors.

This chapter presented the empirical results of the study, beginning with descriptive statistics that confirmed both the developed status of OECD economies and the skewed distribution of disaster impacts, followed by correlation analysis that showed disasters negatively affect GDP per capita while insurance and reinsurance contribute positively. Graphical analysis illustrated how reconstruction and insurance-financed recovery can offset losses, while regression results confirmed that fatalities and injuries reduce growth, but insurance and reinsurance significantly mitigate these effects and enhance resilience. The interaction models further demonstrated that both mechanisms not only buffer ex-post losses but also foster ex-ante preparedness by stabilizing financial systems and encouraging investment in risk management. Robustness tests using alternative proxies for insurance and reinsurance confirmed the consistency of these findings, underscoring their reliability. Overall, the results provide strong evidence that insurance and reinsurance act as critical mediators between natural disasters and economic growth, reinforcing their role in safeguarding stability and promoting recovery.

CHAPTER FIVE: DISCUSSION OF THE RESULTS

5.1 Direct effects of natural disasters, insurance, and reinsurance on economic growth

The regression analysis in Table 4 explores the direct effects of natural disasters, insurance, and reinsurance on economic growth, measured by GDP per capita. The findings reflect the different relationships between the various variables.

Natural disasters are measured using four proxies: total damage, total death, number of people injured, and number of people affected. The results revealed mixed effects, total damage reflects positive and significant relationship with economic growth. This analysis reveals a paradoxical outcome which is attributed to post-disaster reconstruction efforts and inflows of capital such as insurance payouts and foreign aid; government expenditure and donations from NGOs, which can temporarily stimulate economic activity (Ikefuji, Horii, & Masako, 2020; Fomby et al., 2011).

These findings are more prominent in developed countries, including OECD countries as utilized in this study. Wealthier countries tend to have more developed insurance and reinsurance markets and higher levels of preparedness in the event of natural disasters which foster quicker economic recovery and higher levels of income payouts in the attempt to mitigate the losses (Cavallo, Becerra, & Acevedo, 2022). This outcome aligns with Neoclassical growth theory, which predicts that capital replenishment through reconstruction can restore growth paths aftershocks (Barro & Sala-i-Martin, 2004; Hallegatte & Vogt-Schilb, 2019). It also resonates with Endogenous growth theory by suggesting that reconstruction can incorporate new technologies and improved infrastructure, thus enhancing productivity (Onuma, Joo, & Managi, 2021).

In the same vein, Skidmore and Toya (2002) suggest that while disasters disrupt economies initially, they may spur new investments and infrastructure renewal, potentially improving productivity. These findings are also consistent with Onuma, Joo, and Managi (2021) who argue that the presence of a natural disaster can foster reconstruction processes, technological advancement and infrastructure improvement which can lead to enhanced growth. It is important to note that while some disaster variables such as total damage may reflect a positive relationship with economic growth through the reconstruction period, the negative effects of natural disasters outweigh the positives as resources meant for long-term advancement of the country are utilized for the immediate needs of the nation (Strulik & Trimborn, 2018; Felbermayr & Gröschl, 2014; Noy, 2009).

In contrary, the total number of deaths and the number of people injured both show negative and significant effects on GDP per capita. This implies that the loss of human life and increased injury rates negatively affect economic output, primary due to the loss of human capital and higher healthcare burden and costs. The loss of life reduces labour force participation and disrupts productivity. Disaster-related injuries lead to prolonged workforce absenteeism, long-term disabilities and prolonged trauma which increase healthcare expenditures. These outcomes not only stain the healthcare systems, but they also reduce consumer spending and labour market further straining public resources thus impeding overall economic growth (Ackomah et al., 2024).

These negative effects of natural disasters on the economy are consistent with previous empirical studies by Cavallo, Becerra and Acevedo (2021); Berlemann and Wenzel (2015); Ibarrarán et al.

(2007) and Noy (2009) who emphasize that natural disasters hinder economic growth by disrupting infrastructure and economic activities, and the redistribution of resources to mitigate losses. Which is strongly consistent with Endogenous growth theory, which places human capital at the centre of long-term growth. Fatalities and injuries erode the productive workforce, increase welfare and health burdens, and create persistent productivity losses (Ikefuji, Horii & Masako, 2020). OECD economies may offset some physical capital shocks, but human capital shocks are much harder to replace, which explains the robust negative relationship.

Insurance results demonstrate a positive and highly significant relationship with economic growth. Insurance fosters financial resilience, economic stability, strengthening economic landscape which sustain economic growth. By spreading risk and providing financial protection against unexpected losses, insurance reduces economic uncertainty, encourages investment, and fosters consumer and business confidence. Insurance enables quicker recovery facilitating compensation and liquidity. Furthermore, insurance mobilizes long-term savings, which are reinvested in the economy supporting capital market development and infrastructure financing (Bah & Abila, 2024; Choi & Kim, 2023; Dawd & Benlagha, 2023). These findings confirm the “supply-leading” hypothesis by Ajide, Osinubi, and Ojeyinka (2023), whereby insurance markets actively contribute to economic growth by mobilizing savings, enabling investment, and facilitating innovation. This also aligns with Resilience theory, which emphasizes absorptive and adaptive capacity: households and firms are able to maintain consumption and investment in the aftermath of shocks because insurance provides liquidity and reduces vulnerability.

Reinsurance further strengthens economic resilience by allowing primary insurers to manage large scale financial risk more effectively. This allows primary insurers to transfer portions of their financial risk portfolios to reinsurers (Cummins et al., 2021). This plays a crucial role in fostering systemic financial resilience (Huang & Chen, 2022). The empirical analysis of this study indicates that reinsurance has a positive and statistically significant relationship with GDP per capita, supporting the argument that well-functioning reinsurance markets are essential for macroeconomic stability. Bressan (2018) notes that reinsurance spreads the financial burden of disasters across a broader international base, minimizing the risk of insurer insolvency and reducing fiscal shocks. This finding aligns with the work of Nzuza and Msomi (2023); Kajwang (2022) and Huang and Chen (2022), who show that countries with robust reinsurance frameworks recover faster from large-scale catastrophes and are more likely to attract foreign investment, due to lower perceived risks, this fosters positive economic growth. These results also tie back to Neoclassical growth theory: by stabilizing insurers and financial institutions, reinsurance ensures that capital accumulation and technological upgrading can proceed despite shocks. From a Resilience perspective, reinsurance diversifies tail risks globally, protecting sovereign balance sheets and ensuring that no single disaster overwhelms domestic fiscal capacity (Cummins & Mahul, 2003).

The impact of natural disasters on economic growth is multidimensional. While some disaster-related indicators show temporary positive effects due to reconstruction and aid, others—particularly human casualties—have profound negative implications on long-term growth. Due to the reduction in productivity thus negative impact on economic outputs (Strulik & Trimborn, 2018). Insurance and reinsurance mechanisms are shown to significantly mitigate economic disruptions and enhance resilience by enabling efficient recovery and resource allocation. These findings underscore the need for proactive risk financing strategies and investment in disaster preparedness to foster sustainable economic growth.

Overall, this study provides empirical confirmation of what the literature suggests: material damage may sometimes stimulate short-term growth through reconstruction (Skidmore & Toya, 2002), but human capital losses are consistently detrimental (Noy, 2009; Ackomah et al., 2024). Insurance and reinsurance moderate these effects by stabilizing consumption, investment, and fiscal outcomes, which reflects their dual ex-post recovery role and ex-ante risk management function.

5.2 The interaction effects of natural disasters and insurance on economic growth

Table 5 above presents regression results examining the moderating role of insurance in the relationship between natural disasters and economic growth. Across the models in Table 5, a positive and statistically significant relationship is observed between the interaction terms and economic growth (GDP per Capita).

A positive and statistically significant relationship between the interaction term (total damage * insurance) and GDP per capita is observed. This reflects the cornerstone role insurance plays in the event of natural disasters. Insurance facilitates timely reconstruction through payouts which foster recovery, attracts foreign aid and restores investor confidence. An increase in positive prospects post natural disaster accelerates investments, insurance disbursements, which fosters economic stability. This aligns with Cavallo & Noy (2011) and Onuma, Joo, & Managi (2021), who explain that post-disaster reconstruction can lead to temporary economic expansion. This confirms that insurance plays a significant role in managing the economic outcomes in the presence of natural disasters.

In economic terms, this demonstrates that insurance supports consumption smoothing, investment continuity, and the stabilization of credit markets. By ensuring that losses are compensated quickly, insurance reduces the risk of liquidity crises and prevents businesses and households from falling into insolvency. This directly links to Resilience theory's emphasis on absorptive capacity and recovery speed (Crespo Cuaresma, 2020).

The interaction term (total deaths* insurance) yields positive and significant relationship with GDP per Capita. Noting that total death negatively affects economic growth - by reducing labour supply, increasing health burdens and eroding human capital – a positive interaction between the interaction term and economic growth decreases the negative effect. This emphasizes that insurance assists in absorbing income shocks through life and health payouts, supporting negatively impacted households, and reduces the long-term burden and or strain on public systems/resources. According to Ackomah, Mensah and Kuttu (2024), well-structured insurance market reduces the vulnerability and provide affected households with financial continuity, which translates into broader macroeconomic stability which promotes economic growth. This finding also resonates with Endogenous growth theory, as protecting household income and enabling continued investment in education and health prevents the erosion of human capital, which is the foundation of long-term growth.

A positive relationship between the interaction term - number of people injured * insurance – and economic growth (GDP per Capita) is reflected. Noting that number of people injured has a negative impact on economic growth. This suggests that injuries from disasters can impair productivity and increase healthcare burdens and strain public systems. In the presence of insurance losses due to injuries are mitigated through medical coverage and rehabilitation support. The positive interaction term indicates that insurance reduces the adverse productivity loss and enables quicker workforce reintegration. Studies such as Kalfin et al., (2022) argue that inclusive insurance schemes that cover injuries enhance post-disaster recovery and help maintain household income flows thus stabilizing the nation's economy. These further fosters economic growth. This outcome is consistent with Resilience theory, where insurance accelerates labour reintegration and

reduces long-term scarring, while also aligning with Neoclassical growth models that stress the importance of maintaining labour force participation.

The interaction term (number of people affected * insurance) and economic growth (GDP per Capita) exhibits positive relationship. The presence of insurance moderates the negative effects of natural disasters. This suggests that insurance coverage for affected populations (property, health and income protection) fosters resilience by converting humanitarian shocks into managed financial risks. Skidmore and Toya (2002) and Loayza et al. (2012), emphasizes the institutional responses including insurance play a pivotal role in determining whether disaster exposure leads to dependency or recovery driven growth. From the perspective of endogenous growth, widespread insurance coverage encourages entrepreneurship and investment even in high-risk environments, since households and firms are shielded from catastrophic losses.

The interaction terms between insurance and natural disaster variables (total damage, total death, number of people injured, and number of people affected) in Table 5 reveal that insurance positively and significantly moderates the adverse economic effects of natural disasters. This indicates that insurance weakens the negative impact disaster -induced damage, mortality, injuries and disruptions on GDP per capita. This demonstrates that the insurance's role is a stabilizing force that absorbs the negative effects of disasters on economic outcomes. Insurance payouts for damaged assets, income losses, loss of life and or disabilities post disaster facilitates faster recovery and reduces reliance on public aid.

Studies such as Choi and Kim (2023); Cao and Wang (2021) and Zhang and Liu (2020) emphasizes that a well-developed insurance market and increased insurance coverage foster economic stability by improving risk management, capital accumulation and enhancing financial resilience. The positive relationship between the interaction term and GDP per Capita revealed in table 5 show that economies with more robust insurance markets experience less server economic downturns from natural disasters.

This moderating effect of insurance aligns with Bah & Abila (2024) and Dawd & Benlagha (2023) who echo that the presence of insurance being able to absorb disaster downturns improves risk management practices which stimulates business confidence and long-term investments thus enabling a stronger environment for economic growth. These findings also confirm the inverted U-shaped relationship discussed by Dawd & Benlagha (2023), suggesting that OECD countries in this study are operating below the threshold where insurance remains growth-enhancing. Thus, insurance moderates disaster impacts without creating financial-sector distortions.

5.3 The interaction effects of natural disasters and reinsurance on economic growth

Table 6 above presents regression model results examining the moderating role of reinsurance in the relationship between natural disasters and economic growth. Across the models in Table 6, a positive and statistically significant relationship is observed between the interaction terms -natural disaster variables * reinsurance - and economic growth (GDP per Capita).

The relationship between interaction term (total damage * reinsurance) and economic growth is positive. The presence of reinsurance weakens the negative impact of disaster-related physical and financial damage on the economy. Although total damage due to natural disasters could lead to a contraction in GDP per Capita long-term - due to the loss of infrastructure, a decrease in productivity and a halt in economic activity – the presence of reinsurance mitigates these losses by enabling swift capital inflows which fosters efficient economic recovery. This aligns to findings by Kajwang (2022), who emphasises that reinsurance prevents a liquidity crisis in nations due to catastrophic losses. This protects solvency of insurers thus stabilizes the economy post a disaster.

Similarly, the interaction term – total death * reinsurance - and economic growth (GDP per Capita) presents a positive relationship. Reinsurance moderates the negative effects of disaster -induced mortality on GDP per Capita. A high death total leads to a decline in productivity due to a loss of human capital thus a reduction in economic growth. Reinsurance ensures that life insurance and health claims are settled promptly, supporting affected households and easing the fiscal burden on governments, this outcome is consistent with the findings by Huang and Chen (2022) and Cummins and Mahul (2003) emphasizing that reinsurance supports economic growth in the presence of adverse weather events and their consequences thus indicating the essential moderating role it plays. Economically, this prevents secondary shocks to financial institutions and households by ensuring solvency in the face of large-scale mortality claims. From an endogenous growth perspective, this preserves household investment in education and human capital, mitigating long-term scarring.

The interaction term (number of people injured * reinsurance) has a positive impact on GDP per capita. This implies that even though injuries due to a natural disaster can cause an increased cost of health services, broader reliance on public system and a decline in productivity as the labour force is negatively impacted, the presence of reinsurance reduces these effects. Reinsurance enables border financial coverage for injury related claims, facilitating medical treatment and workforce rehabilitations. According to Bressan (2018), reinsurance strengthens social protection systems by allowing insurer to honour claims without default which indirectly sustains labour participation and household consumption. Thus, protecting economic growth.

Lastly the interaction term – number of people affected * reinsurance – and GDP per capita exhibits positive relationship. Reinsurance lessens the economic disruption experienced by large populations during natural disasters. The people affected become displaced, experience loss of income or loss of access to essential services in the aftermath of a natural disaster. Reinsurance acts as a financial shock absorber by enabling insurance payouts (including housing and business interruption claims) which fosters economic resilience and business continuity post disaster. This moderating role resonates with studies such as Nzuza and Msomi (2023), who note that the strength of reinsurance markets lies in its ability to be a solvency protector for insurers, fostering broader

financial and social stability during disaster recovery and acting as a financial and economic buffer for nations.

The regression results for table 5 and table 6 highlight the positive and significant role of insurance and reinsurance in reducing the adverse economic output of natural disasters. The interaction terms between insurance and disaster variables – total damage, total death, number of people injured, and number of people affected – reveal positive and significant effects on economic growth. Indicating that insurance is crucial for faster economic recovery, maintaining household income post disaster and stabilizing the burden on public systems. Insurance payouts support reconstruction, liquidity, foster investor confidence and allows for business continuity. This moderating effect affirms insurance's role as a buffer that sustains economic growth aftermath of disaster.

Similarly, reinsurance enhances economic stability by strengthening insurer's capacity to absorb large losses. Positive relation between interaction term (reinsurance * disaster variables) and economic growth affirms the positive moderating role reinsurance plays post disaster. Reinsurance ensures claim solvency, reduction of fiscal pressure on governments, sustains consumptions and encourages productivity through its payout to insurers post-disaster. Together insurance and reinsurance serve as crucial financial tools to stabilize economies, protect livelihoods and promote sustainable growth following natural disasters.

In summary, the findings show that while natural disasters generally depress growth (particularly through human-capital losses) insurance and reinsurance significantly mitigate these effects, accelerate recovery, and sustain macroeconomic stability. Physical damage can sometimes spur short-term growth via reconstruction, but fatalities and injuries impose lasting costs, highlighting the importance of financial risk-transfer mechanisms. Insurance and reinsurance consistently buffer economies by providing liquidity, ensuring claim solvency, stabilizing consumption and investment, and supporting recovery, while also delivering ex-ante benefits such as risk pricing and resilience investment. These results extend the literature and confirm the relevance of Neoclassical theory (capital replenishment), Endogenous growth theory (human capital and innovation), and Resilience theory (absorptive and adaptive capacity). Taken together, the evidence underscores the importance of deepening insurance penetration, strengthening reinsurance capacity, and promoting effective public-private partnerships to reduce vulnerability and foster sustainable long-term growth.

CHAPTER SIX: CONCLUSION

6.1 Summary and Conclusion

The crucialness of this study lies in its potential to shape policy, research and practice in managing disaster risk while attaining sustainable economic growth. The purpose of the study is to investigate the intervening role of - insurance and reinsurance- in the relationship between natural disaster and economic growth. The study does so by addressing three objectives. Firstly, to examine the impact of natural disasters on economic growth. Secondly, to examine the influence of insurance and reinsurance on economic growth and lastly to explore the intervening role of insurance and reinsurance on the relationship between natural disasters and economic growth.

In addressing the first objective, the study found that natural disasters (utilizing total damage, total death, no. of injuries and no. of people affected as measures of natural disasters) have a negative effect on economic growth. The study observed that total damage from natural disaster can appear to have positive relations with economic growth, which could be attributed to factors such as higher infrastructure costs, greater disaster preparedness, and more developed insurance markets. These characteristics are commonly found in developed economies, such as the OECD- nations, which were utilized in the study. Better equipped countries are able to absorb, recover and innovate in the presence of natural disasters, this can sometimes temporarily boost economic activity through reconstruction effects. The study revealed that total death has negative effects on economic growth as an increase in mortality, decreases human capital, labour participation thus impacts economic productive activities negatively. Number of people injured, and number of people affected have a negative effect on economic growth as disaster related injuries and people affected prolong workforce absenteeism, increases long term disabilities and increasing healthcare expenditure thus straining the public resources. This encourages low productivity impacting economic growth negatively.

To address the second objective the study ran a direct effects regression to observe the impact of insurance and reinsurance on economic growth. The results revealed a positive relationship between insurance and economic growth, similarly to reinsurance and economic growth. Insurance plays a critical role in fostering economic growth by promoting investment confidence, protecting assets, and enhance financial stability. These functions assist to reduce uncertainty and encourage productive economic activities. Reinsurance operates in conjunction with insurance and further strengthens the system by fostering risk diversification and large loss coverage (especially catastrophic events). Reinsurance assists in being a financial buffer for insurance companies thus the economy in the event of catastrophic losses.

The study observes the intervening role of insurance and reinsurance on the relationship between natural disasters and economic growth. The study does this by introducing insurance and reinsurance interaction terms (insurance * natural disaster variables and reinsurance * natural disaster variables). The results reveal that the insurance and reinsurance interaction terms (individually) have positive impact on economic growth in the presence of natural disasters. These results highlight that insurance and reinsurance positively moderate the relationship between

natural disasters and economic growth. The results remain consistent when the different proxies of natural disasters were introduced. These findings suggest that insurance and reinsurance play a crucial role in buffering economies against shocks by offsetting the negative effects of physical damage and human casualties. Thus, insurance and reinsurance significantly contribute to economic resilience and financial stability in wake of natural disasters.

6.2 Theoretical Implications

This study builds upon three central theoretical frameworks: the Neoclassical Growth Theory, Endogenous Growth Theory and Resilience theory to contextualise the moderating role of insurance and reinsurance on the relationship between natural disasters and economic growth. The study empirically investigates how insurance and reinsurance moderates the relationship between natural disaster and economic growth; the study provides theoretical insights that reinforces and nuance these theories.

Neoclassical Growth Theory (primary theory of this study), articulated by Solow (1956) and later expanded by Mankiw, Romer, & Weil (1992), emphasises the main drivers of growth as capital accumulations, labour force expansion and technological progress. Within this theoretical framework natural disasters are viewed as exogenous shocks which destroy capital and disrupt labour markets which cause a short-term decline in economic output. The theory predicts that the economic output will return to a steady state through investments in physical and human capital. The Neoclassical Growth Theory implies that countries that experience natural disasters face setbacks however, with sufficient reinvestments measures these countries eventually resume growth.

The findings of this study support and extend this theoretical framework by revealing that with the presence of well-developed and functioning insurance and reinsurance markets (such as those in OECD countries) enables coverage payouts, foster investor confidence which encourages continued reinvestments and productivity-enhancing measures. This significantly reduces the negative effects of natural disaster on growth, thereby realigning the economy promptly with their long-term growth path. This implies that financial instruments such as insurance and reinsurance are essential inputs in the growth model. These instruments assist in preserving capital, mitigate productivity losses and accelerates re-accumulation of capital post disaster. This ensures recovery and the ability for the economy to return to its steady state.

In contrast, the Endogenous Growth Theory focusses on internal drivers of growth primary human capital development, innovation and knowledge of spillovers (Romer, 1990). The theory argues growth is a cumulative process driven by investment in research, development, education and adoption of technology. In the context of disasters, the theory argues that natural disasters may initially disrupt economic activities and infrastructure, they also create opportunities for technological upgrading and innovation during reconstruction.

The findings of this study reveal that natural disaster have negative effects on economies. The results reveal that natural disasters possess negative outputs that surpass positive effects. The presence of insurance and reinsurance allow for financial risk transfer mechanisms which enables protections of foundational elements of economic developments. Therefore, the theory should be applied with strong emphasis on institutional quality and financial mechanisms that support innovation and recovery as natural disaster led to more adverse effects without insurance and reinsurance.

Lastly, Resilience Theory originally developed in ecological studies and later adopted for other aspects such as economics. The theory emphasises a system's ability to absorb shocks, adapt and reorganize while maintaining core functions (Holling, 1973). In economics, resilience refers to how effectively can an economy withstand and recover from external shocks such as natural disasters. By examining how insurance and reinsurance support economic systems in absorbing natural disasters shocks this study applies the resilience theory. Findings demonstrate that insurance and reinsurance provide an immediate financial buffer that stabilizes consumptions, reduces uncertainty, fosters productivity and encourages reconstruction and restoration of economic productive activities. These results support resilience theory by revealing that countries (such as OECD countries) with more developed and established insurance and reinsurance mechanism exhibits greater economic stability and encourage faster return to pre-disaster growth levels. Insurance and reinsurance act as adaptive mechanisms which reinforces the theoretical argument that resilience involves resistance to shock, capacity to adopt and ability to reorganise while encouraging positive economic outputs. This study demonstrates that this process to absorb shock, adapt and reorganize post-disaster is effectively facilitated by insurance and reinsurance instruments.

6.3 Policy and Practical Recommendations

The findings provide valuable insights for policymakers, financial regulators, and disaster risk management professionals. The study identifies that natural disasters have negative effects on economic growth. Natural disasters damage infrastructure, disrupt productive activities, impede public systems and reduces government resources meant for the advancement of the country by utilizing them to mitigate immediate losses. This leads to economic outputs decline thus negative impact on economic growth. This negative relationship signals that without intentional disaster protection mechanisms, economic progress could be eroded. The wealthier OECD countries (such as United States, United Kingdom and Switzerland) with well-developed insurance and reinsurance markets should continue investing in their insurance and reinsurance systems. This ensures strong financial resilience against natural disasters. Meanwhile, OECD countries with fewer resources such as Costa Rica, Chile and Colombia, need to prioritize the development and strengthening of their insurance and reinsurance frameworks. This would provide fiscal protection and support economic stability in the presence of natural disasters.

Policymakers should implement targeted subsidies and regulatory frameworks that incentivize broader participation in insurance markets, particularly in high-risk areas. For example, in South Africa, introducing a subsidized or discounted flood insurance program in Kwa-Zulu-Natal to mitigate the recently frequent Kwa-Zulu-Natal floods can encourage broader participation and cushion the post-flood recovery period. FONDEN program in Mexico is a relevant example of how such polies can promote insurance uptake and effectively mitigate losses.

Governments should foster public-private partnerships to develop affordable insurance schemes for vulnerable populations, ensuring that financial protection is extended to those most at risk. Turkey recently shared the success story of such partnerships. A Turkish Catastrophe Insurance Pool private-public partnership was founded in 2000. This partnership resulted in playing a significant role in the aftermath of the 2023 earthquakes with insured property payout of approximately \$6.2 billion (Munich Re, 2023). This emphasizes that the partnership between public and private sector can increase insurance penetration, coverage, and economic recovery.

Fostering effective economic recovery and sustainable economic growth in midst of adverse weather patterns.

Financial institutions should focus on developing innovative insurance solutions that integrate climate risk factors and disaster probabilities. Parametric insurance, which triggers payouts based on predefined disaster parameters, should be further explored as a means of providing faster financial relief in disaster-prone areas. In addition, leveraging emerging technologies such as AI and blockchain can enhance underwriting accuracy, customize policies, and streamline claim settlements. These Insurtech innovations will improve efficiency, increase consumer accessibility, and boost insurance penetration, strengthening financial resilience.

Public awareness initiatives should also be strengthened to educate communities about the benefits of insurance and reinsurance. Enhancing financial literacy through targeted educational campaigns can reduce resistance to insurance adoption and encourage proactive financial planning. Governments should consider linking insurance coverage with social protection programs to provide direct financial relief to affected individuals and businesses. For instance, subsidized microinsurance schemes can play a crucial role in shielding low-income households from financial distress caused by natural disasters.

Labor policies should integrate insurance-backed compensation mechanisms for workers in disaster-prone industries, preventing productivity losses from translating into prolonged economic downturns and ensuring job security in affected regions. Moreover, governments should incorporate insurance and reinsurance considerations into broader climate resilience policies. Encouraging sustainable construction practices, improving early warning systems, and reinforcing disaster risk reduction strategies will create a more comprehensive framework for mitigating the economic consequences of natural disasters.

6.4 Limitations and Future Research Directions

Despite its contributions, this study has certain limitations. The dataset used is limited to a time (1990-2023), which may restrict the generalizability of findings across different economic contexts. Future research should incorporate longitudinal analyses to track the long-term impact of insurance and reinsurance on economic resilience. Future studies can consider incorporating life and non-life insurance and reinsurance variables as moderating variables.

Additionally, while this study focuses on quantitative data and factors such as total death, number of people injured and economic growth indicators i.e. GDP per Capita it warrants a further exploration in other research methodology. Qualitative research methods, such as case studies and interviews, can provide deeper insights into how insurance mechanisms influence individual decision-making during crises.

Emerging financial technologies, such as blockchain-based insurance and AI-driven risk assessment models, should also be explored for their potential in disaster risk management. Regional variations in insurance effectiveness should be examined, considering differences in financial inclusion and regulatory environments that affect insurance uptake.

Future research could also investigate the impact of carbon emission reductions on the frequency and severity of natural disasters, thereby assessing the evolving role of insurance in a transitioning global economy. Additionally, extending this research to non-OECD countries would provide a

more inclusive perspective on the role of insurance and reinsurance in mitigating disaster-related economic losses in developing economies.

Finally, future studies should examine the ex-ante roles of insurance and reinsurance, particularly how these mechanisms encourage risk awareness, incentivize preventive investment, and strengthen financial stability before disasters occur. Such research would complement the ex-post focus of existing studies and provide a more comprehensive understanding of the disaster–insurance–growth nexus.

Appendixes

Appendix A – List of OECD Countries (as of 2023)

1. Australia
2. Austria
3. Belgium
4. Canada
5. Chile
6. Colombia
7. Costa Rica
8. Czech Republic
9. Denmark
10. Estonia
11. Finland
12. France
13. Germany
14. Greece
15. Hungary
16. Iceland
17. Ireland
18. Israel
19. Italy
20. Japan
21. Korea
22. Latvia
23. Lithuania
24. Luxembourg
25. Mexico
26. Netherlands
27. New Zealand
28. Norway
29. Poland
30. Portugal
31. Slovak Republic
32. Slovenia
33. Spain
34. Sweden
35. Switzerland
36. Turkey
37. United Kingdom
38. United States

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