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| RESEARCH ARTICLE

An Analysis on the Impact of Natural Disasters on the Economy of the Philippines

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| ABSTRACT
Over the past century, natural disasters have been terrorizing the economy by causing human fatalities and damaging infrastructure and production inputs. The Solow growth model suggests that natural disasters adversely affect gross domestic product (GDP) since these disrupt the production of inputs. On the contrary, the Schumpeterian growth theory provides an explanation behind the positive effect of natural disasters on economic growth. This study analyzed the relationship between natural disasters (i.e. earthquake, flood, and storm), economic activities (i.e. foreign aid and foreign direct investment) and GDP per capita income in the Philippines from 1990 to 2019. This study employed a multivariate analysis, time series regression, and autoregressive distributed lag (ARDL) approach. The results revealed a complex relationship between GDP per capita and the regressors. In the short run, the independent variables have a negative and significant relationship with the country's per capita income. On the contrary, only FDI has a significant long-run relationship with the economy of the Philippines. The results highlight the Philippines' need for comprehensive disaster plans and to lessen its dependence on foreign and external factors.

| KEYWORDS
Natural disasters; per capita income; foreign aid; FDI; time series; the Philippines

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1. Introduction
In this chapter, the reader will have an overview of the background and objectives of the study. It gives an introduction that sheds light on the economy of the Philippines when natural disasters occur. Further, it briefly discusses the effect of investments and foreign aid received by the country when natural disasters take place and connect its relevance to the GDP per capita. Finally, it presents the statement of the problem, hypothesis, scope and limitations, and significance of the study.

1.1 Background of the Study
Natural disasters, such as earthquakes, floods, and storms, have been terrorizing the world economy for the past century. In 2020, a total of 416 natural disasters struck the globe. According to the International Federation of Red Cross and Red Crescent Societies, a global disaster is a sudden event that disrupts society and causes human, material and economic losses. Disasters often happen due to natural reasons but may also be triggered by human actions, such as deforestation and irresponsible mining.

On the other hand, the economic growth of a country can be determined by its Gross Domestic Product (GDP), which is the total value of goods produced and services provided in a country annually. GDP can be measured as the sum of consumption, investment, government spending, and net exports. Net exports are the difference between exports and imports. GDP per capita determines a country's economic output per person. This can be measured by the division of a country's GDP by its population. Another economic indicator is the foreign direct investment (FDI) inflows, which is the net transfer of funds to purchase and acquire physical capital. The World Bank defines FDI as "the sum of equity capital, reinvestment of earnings, other long-term capital, and short-term capital as shown in the balance of payments". Finally, foreign aid is economically defined as one country's voluntary transfer of resources to another country.

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Natural disasters are capable of directly impacting a country's GDP. An example of the direct impact of natural disasters on the economy is the destruction of agricultural production. GDP can also be indirectly affected by natural disasters. For instance, the loss of human life from natural disasters would put an end to the casualties' consumption and income. In effect, these would weaken the country's economic growth or GDP. In the Philippines, the economy has suffered greatly from the impacts of natural disasters. The country is exposed to many natural disasters because of its geographic position. Simultaneously, the country is burdened with limited resources to alleviate the adverse effects of natural disasters.

The Philippines is vulnerable to natural disasters such as earthquakes, floods and storms. During the period 1990 to 2019 (see Figure 1), one of the most disastrous earthquakes in the Philippines was recorded during the 1990 Luzon earthquake. The 7.8-magnitude earthquake collapsed infrastructure, killed many people and ultimately cost the country approximately $369-billion worth of damages. Aside from this, another 7.8-magnitude earthquake caused the volcanic eruption of Mount Pinatubo in 1991. It is known to be the second-largest volcanic eruption of the 20th century. The emission of gas, ash and lava killed over 6,000 people.

Moreover, the country is exposed to several floods and storms since it is a typhoon-prone country. Typhoon Ondoy, known internationally as Typhoon Ketsana, caused widespread flooding in 2009 (see Figure 2). Most of Metro Manila was submerged in floodwater. As a result, people had to evacuate their residences and temporarily relocate to unaffected locations. Super Typhoon Yolanda, known internationally as typhoon Haiyan, caused the Philippines massive economic loss in 2013. Super Typhoon Yolanda produced a large amount of economic loss in the Visayas region as it destroyed many infrastructure and production inputs. The destruction of production inputs, such as coconut trees, resulted in the disruption of livelihood. The estimated overall damage of Super Typhoon Yolanda was $5.8 billion. Super Typhoon Yolanda also caused many fatalities in the Visayas region when it made landfall. More than 6,000 fatalities were recorded, and 30,000 houses were damaged in Tacloban City, Eastern Visayas (see Figure 3). Super Typhoon Yolanda caused a large amount of damage in the Visayas region when it made landfall in 2013 (Tuhkanen et al., 2018).

Over the past decades, the impacts and destruction caused by these natural disasters have become more extreme and intense. The negative impacts of natural disasters resulted in skyrocketing costs for recovery plans by the government in terms of the social, political and economic welfare of their constituents. For instance, the Department of Budget and Management (DBM) reported that 150 billion Philippine pesos were allocated for the Yolanda reconstruction and rehabilitation program. Based on climate trend data, natural disasters are forecasted to continue to adversely affect the economy (Bollettino et al., 2018).

Due to the similarities, the result of this study should either confirm or reject the findings of the earlier research conducted by Qureshi et al. (2019). On that matter, the study has the following research objectives. First, it contributes to the growing economic literature that explains the impacts of natural disasters on the economy. By employing updated data on natural disasters, which include the number of people affected and fatalities that were recorded in the Philippines, the scope of investigation becomes more extensive. Second, the researchers also include foreign aid and foreign direct investment inflows. The subject of the study, which is the Philippines, is a developing country that considers these economic variables as an important source of external finance. Lastly, the study analyzes the relationship between natural disasters, foreign aid and FDI to the country per capita income that can usher sustainability and growth of the local economy.

The rest of the paper is organized as follows: Chapter 2 begins by presenting an overview of the short-run and long-run impacts brought by natural disasters to the economy and information about the case of the Philippines. Following this, it then reviews the insights from the theory and the concept of creative destruction associated with the economy and how it can be applied to natural disasters. Chapter 3 elaborates on the data and the disaster measures used. It also presents the research design, the methodology, and the diagnostic tests deployed in the study. Chapter 4 discusses the empirical results obtained from the estimation methodology, followed by Chapter 5, which concludes the study and recommends policy implications of the findings and put forth a future research consideration on this subject.

1.2 Statement of the Problem

Since the Philippines has a high vulnerability rate to catastrophic events due to its geographical location, this study focuses on the effects of natural disasters on the economy of the Philippines from 1990 to 2019 through the deployment of time-series regression analysis. Specifically, it seeks to answer the following questions:

1. Is there a relationship between natural disasters and the GDP per capita of the Philippines?
2. Is there a relationship between foreign aid and assistance following natural disasters and the GDP per capita income of the Philippines?
3. Is there a relationship between FDI inflows and GDP per capita of the Philippines?

1.3 Research Objectives
In order to answer the aforementioned research questions, the researchers aim to:

1. Identify the effects of natural disasters (e.g., no. of people affected and fatalities caused by disasters such as earthquake, flood, and storm) to the GDP per capita of the Philippines.
2. Examine the impacts of foreign aid and FDI on the GDP per capita of the Philippines.
3. Investigate the relationship between natural disasters, foreign aid, FDI and GDP per capita of the Philippines.
4. Provide information for government agencies to mitigate policies focusing on the impacts of natural disasters on the nation's economy.

1.4 Formulation of the Hypothesis
Hypotheses have been formulated based on the previous studies presented in Chapter 2. Thus, the hypotheses tested in this study are as outlined below:

H_{01}: There is no significant relationship between natural disasters and the country's GDP per capita.
H_{02}: There is no significant relationship between FDI and the country's GDP per capita.
H_{03}: There is no significant relationship between foreign aid and the country's GDP per capita.

The null hypothesis is rejected if the p-value is less than the 5% level of significance. On the contrary, the researchers fail to reject the null hypothesis if the p-value is greater than the 5% level of significance.

1.5 Scope and Limitations
The primary goal of this quantitative study is to determine if there is a significant relationship between natural disasters and economic activities in the Philippines from 1990 to 2019. This study will mainly cover indices that fall under natural disasters and the economy. For economic indicators, gross domestic product (GDP) per capita, foreign assistance and aid, and foreign direct investment (FDI) inflow received by the Philippines are included. On the other hand, natural disaster indicators are the combined number of affected and killed individuals in the top three most recurring disasters in the Philippines, which are earthquake, flood, and storm. Although the EM-DATA database reports natural, technical, and complex disasters, the researchers only focus on natural disasters such as geophysical, meteorological, hydrological, and biological. Moreover, there are two calculations in measuring a country's GDP per capita, foreign aid, and FDI, which are in current US dollars and in constant US dollars; the study only utilizes the computation in current US dollars. Chapter 3 presents a further discussion about the data.

On the other hand, there are several limitations of this study that must be acknowledged. First, there are a lot of factors that can be used to derive the economic performance of a country, in which the researchers selected those factors that are accessible and available for them. Another limitation is that the researchers mainly depend on the data published through online platforms by institutions such as The World Bank and the Center for Research on the Epidemiology of Disasters (CRED). Finally, a limitation that should be noted is that little research has been conducted on the subnational level, especially in the case of the Philippines, and the subject of this research paper is still a comparative niche area, with the limited presence of economic literature.

1.6 Significance of the Study
The Philippines' geographic location makes it exposed to numerous types of natural disasters. The archipelago is vulnerable to floods, landslides, storms, earthquakes and volcanic eruptions since its islands are situated along the boundary of major tectonic plates and at the center of the typhoon belt in the Pacific region (Bollettino et al. 2018). According to the United Nations Population Fund (2019), the Philippines ranked as the third most disastrous-prone country in the 2018 World Risk Index. Furthermore, a higher probability of exposure to disaster risk in developing countries was recorded as the drivers of vulnerability to natural hazards can be attributed to socioeconomic aspects such as poverty, inequality, governance and infrastructure investments (Asian development outlook 2019: 2019). As a developing nation, the Philippines is classified with high vulnerability and exposure to natural calamities with limited resources in assessing and delivering disaster preparedness and relief (Brucal et al., 2020).

Therefore, the findings of this study redound the benefit of Filipinos considering that the country is located in a natural hazard-prone area. Since natural disasters have different short-run and long-run effects on the economic activities of a country and it is the government's primary responsibility to respond and manage disaster operations, the study could be beneficial to the following:

- ***National Disaster Risk Reduction and Management Council (NDRRMC).*** The information presented in this study may enable NDRRMC to develop programs that focus on improving disaster preparedness, relief operations, and rehabilitation efforts following natural disasters of the government.

- ***National Economic and Development Authority (NEDA).*** The outcome of this study can facilitate NEDA to mitigate plans to guide and coordinate the Local Government Units (LGUs) in building disaster-resilient communities. The paper can also help the agency to integrate policies and programs to lessen the impacts and intensity brought by catastrophes to the economy.
- ***Department of Budget and Management (DBM).*** The results may enable DBM to assess and evaluate the budget allocated for the acquisition of disaster response and rescue equipment, supplies and relief packages, training for emergency response teams, and other post-disaster activities.
- ***Department of Social Welfare and Development (DSWD).*** The propositions presented in this study can assist DSWD in upgrading the pre-disaster assessment and post-disaster recovery operations of the department. The study can also help DSWD to ameliorate the delivery of social services they provide following natural disasters.
- ***Department of Science and Technology (DOST).*** The findings of this study can be supplemental to DOST in terms of investment in research and development of technology used for assessing, monitoring, and forecasting natural disasters.
- ***Future Researchers.*** The results of this study can be used as reference data in conducting new research or testing the validity of other related findings. The study will also serve as economic literature that will provide future researchers with an overview of the relationship between natural disasters and economic growth.

2. Literature Review

In this chapter, previous literature about the relationship between economic growth and natural disasters are presented to the reader. Further, the reader will have a better understanding of the short-run and long-run impacts of natural disasters on the economy. Moreover, it provides knowledge about the Solow growth model and Schumpeterian creative destruction theory. Lastly, the chapter ends with the presentation of the conceptual framework of the study.

2.1 Economic Growth and Natural Disasters

2.1.1 Short Run

In the short run, the direct impacts of natural disasters are death, casualties and destruction of property. Natural disasters disrupt economic activities such as the flow of goods, services and money. For instance, the production of goods in disaster-affected regions becomes stagnant because natural disasters destroy physical capital such as manufacturing facilities. In addition, human casualties from natural disasters would lower labor. Thus, the cessation of production output would cause a reduction in revenue. Natural disasters also cause financial shocks. The destruction of residential infrastructures increases financial hardship and risk aversion (Johar et al., 2020). Results of the study conducted by Tang et al. (2019) showed that the short-term economic effects of natural disasters mainly depended on development levels and disaster types.

The production possibilities frontier (PPF) is an illustration of economic output if all the resources are used. Natural disasters lessen the available resources, resulting in the PPF curve shrinking. Natural disasters likewise cause loss of wages and a decrease in output, which are both significant components of the country's GDP. Total production falls as a result of the damages to labor, capital and other resources—the decrease in economic output increases scarcity.

Developing countries, such as the Philippines, are not entirely equipped to withstand the short-term economic consequences of natural disasters. Relatively frequent tropical cyclones generate about a 1-2% decrease in short-run economic activity in the country (Strobl, 2019). Studies such as Yonson et al. (2017) and Jha et al. (2018) provide empirical data showing the positive correlation of natural disasters with poverty. In fact, natural disasters increase poverty rates and push households into deeper poverty (Boustan et al., 2020; Jha et al., 2018). Poverty pushes people to give up investments in human capital to survive the effects of natural disasters (Yonson et al., 2017). A positive consequence is a post-disaster reinvestment in capital and technology, which may be a catalyst of economic growth. However, the government and private investors have a small incentive to rebuild physical capital because of the probability that it will be damaged again in the future (Samphantharak, 2019).

2.1.2 Long Run

Research on the long-term effects of natural disasters on economic growth has been scant due to the challenges encountered in data collection and methodology. There has been no sufficient theoretical and empirical evidence to determine the precise impact of natural disasters on long-term economic growth. In the long run, natural disasters may have beneficial, adverse or even no effect on economic growth (Noy & DuPont, 2016). The present study aims to close this research gap and provide more information about the long-term effects of natural disasters on economic growth.

Destruction of human and physical capital can cause a negative impact on long-term economic growth permanently. Eventually, these damages can bring the country's economic growth to a lower-level equilibrium. The effects of natural disasters on long-term economic growth have been more noticeable in developing countries, such as the Philippines. Studies such as Marin & Modica (2017), Batten (2018) and Tuhkanen et al. (2018) have shown that natural disasters are correlated with GDP growth, total factor productivity growth and human capital accumulation. Natural disasters may have a positive impact on economic mobility because the government would spend on recovery and mitigation plans (Jha et al., 2018). Dynamic resilience or the use of more advanced technology in reconstruction is an example of a positive impact of natural disasters (Xie et al., 2018).

The difficulty of measuring the long-term effects of natural disasters on economic growth has hindered some research on the topic. The absence of a standardized method of data collection has resulted in different estimations of the economic impacts of natural disasters (Ladds et al., 2017). Endogenous growth models, such as the Schumpeterian Growth Theory, can justify the beneficial long-term effects of natural disasters on the economy. Jha et al. (2018) provide evidence of the Schumpeterian *creative destruction hypothesis* in the context of the Philippines through the use of synthetic panel data regressions. There will be a more in-depth discussion of the Schumpeterian creative destruction theory in the next section.

2.2 Theoretical Background

2.2.1 Solow Growth Model

There is a wide literature available on fields that focus on natural disasters and growth theories. However, most of these studies shed light on the empirical relationship between natural disasters and economic growth. Thus, growth literature focusing on natural disasters is scarce (Shabnam, 2014). Additionally, there is a dearth of literature available in the context of the Philippines, which motivated the researchers to conduct a study based solely on a country level. In this section, existing literature about economic growth theories is discussed in order to explain the causal relationship between natural disasters and economic growth. Dealing with the subject of environmental economics, one of the most applied neoclassical growth theories is the Solow Growth Model.

The Solow growth model states that economic growth is the outcome of three factors of production. According to neoclassical economics, these three factors of production are land or natural resources, labor and capital stock. As stated by London (2017), the incorporation of the environment into the analysis of economic growth recognizes the transition from a closed system to a complex system. In line with that, absolute substitution between natural capital, human and physical capital, and non-natural capital can take place. One of the two main components of the Solow Growth Model is the production function, which defines the combination of factors of production to produce the economy's output (Halkos & Psarianos, 2016). The Cobb-Douglas Production Function below shows the relationship between the output produced and the inputs, which are capital and labor. Y represents the total production or output, A represents the total factor productivity, K represents the capital input, α represents the output elasticity of capital, L represents the labor input, and β represents the output elasticity of labor.

$$Y = AK^{\alpha}L^{\beta} \quad (1)$$

Natural disasters serve as exogenous factors to production. Furthermore, natural disasters impact the production inputs in the function. Land or natural resources used in production are destroyed by natural disasters. Labor is likewise affected because of human fatalities caused by natural disasters. Finally, natural disasters damage capital stock such as machinery and equipment used in production. The Solow Growth Model states that the destruction of capital would steer the economy away from its balanced path and reduce income per capita in the short term (Fatouros & Sun, 2020). Thus, natural disasters have an indirect effect on the country's output and GDP.

Theoretically, natural disasters have an adverse effect on GDP since these disrupt the production of inputs (Mohan et al., 2019). Following a natural disaster's economic shock to production inputs, the output will fall. The lesser the stock of production inputs, the greater the effect of the shock on total production or output, ceteris paribus. The poorer the economy, the greater the effect of the natural disaster on GDP, ceteris paribus. Natural disasters also function as economic shocks to the labor market. The deaths caused by natural disasters directly impact the supply and demand of labor (Kirchberger, 2016). Thus, affecting labor productivity, which measures the number of goods and services produced in a given period of time.

2.2.2 Schumpeterian Creative Destruction Theory

Schumpeterian *creative destruction theory* promotes that natural disasters might have a positive effect on economic growth as physical destruction caused by these events may stimulate large investments in rebuilding and enhancing the damaged physical and human capital. The theory of *Schumpeterian creative destruction* can explain the long-term impacts of natural disasters through its endogenous growth models. These models predict that in a disaster-prone and affected environment, negative shocks will be followed by growth mainly because of the reconstruction, enhancement of infrastructures, and investment in the latest technology, which will boost productivity and opportunities for the economy in the long term. In an instance, purchasing and investing in new machinery and equipment would be cost-effective rather than repairing the damaged ones. A number of scholarly works are widely available on the study topic of *creative destruction*, wherein economic growth is intertwined with a natural disaster.

The Schumpeterian growth theory consists of three main ideas (Aghion, 2018). The first idea states that innovation can be a catalyst for long-term growth. The second idea explores how innovation is a result of the investments and responses of entrepreneurs to economic policies and incentives. The third idea is the concept of *creative destruction* wherein old technologies and processes will be replaced by new innovations.

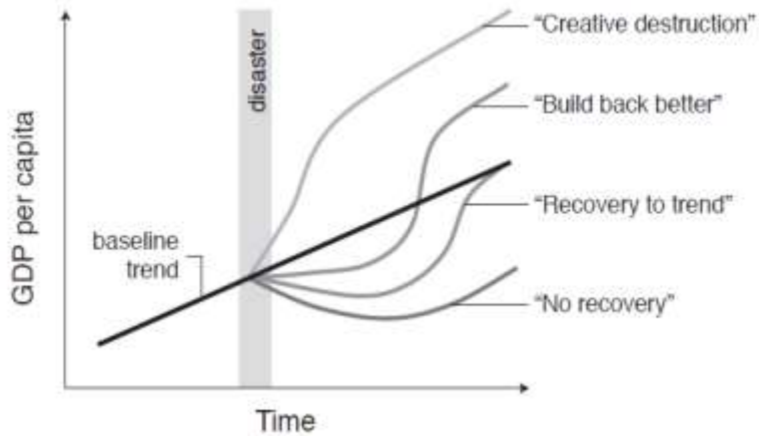

Figure 4. Four hypotheses on the long-term effects of natural disasters on GDP per capita
Source: The Causal Effect of Environmental Catastrophe on Long-Run Economic Growth: Evidence from 6,700 Cyclones (Hsiang & Jina, 2014)

Hsiang and Jina (2014) plotted a graph that features four hypotheses, which are *creative destruction*, *build back better*, *recovery to trend* and *no recovery*. Prior studies have extensively disputed these four hypotheses regarding the long-term effects of natural disasters on GDP per capita. However, no study has yet to disprove any of these hypotheses. The graph features Schumpeter's *creative destruction* hypothesis with having the largest growth in GDP per capita post-disaster. Schumpeter's *creative destruction* hypothesis explains that natural disasters cause innovation, which is the replacement and improvement of lost capital stock. Although disasters disrupt existing economic activities, they also create new opportunities for improvement (Deakins & Scott, 2020). Schumpeter further argues that disasters may temporarily accelerate economic growth because the replacement of lost capital increases the demand for goods and services. Innovation would then increase GDP per capita post-disaster in the long run. The inflows of foreign direct investment and foreign aid post-disaster likewise promote economic growth since natural catastrophes invigorate innovation.

A number of studies using panel data sources have presented the different impacts of natural disasters on economic growth. Lackner (2018), in her study, stated that creative destruction causes positive impacts following disasters. By utilizing a panel dataset of the earthquake ground shaking from the period 1973-2015 on country levels, the study investigated the relationship between earthquake and GDP per capita. The findings of the study revealed that only high-income countries could take advantage of creative destruction following a disaster as these nations can invest in infrastructure that can prevent major damage by catastrophes. As mentioned by Fang et al. (2018) in their study, the Schumpeterian creative destruction hypothesis shows that short-term economic losses from natural disasters may contribute to long-term economic growth as catastrophes can stimulate the replacement of damaged capital stock. However, by examining G20 countries through the employment of panel data for the years 1990-2010, the study revealed that FDI, economic growth, climate change, and the number of individuals affected by natural disasters are not conducive to natural capital. Jha et al. (2018) explored the impact of typhoons in the Philippines by applying synthetic panel estimation to the Family, Income, and Expenditure Survey (FIES) and finance data per municipality for the years 2009 and 2012 and found out that disasters can drive non-poor households into poverty while poor families can be pushed down into deeper poverty. Moreover, the study revealed that disasters have positive impacts on economic mobility through the government's post-disaster recovery and reconstruction projects, an effect modelled by creative destruction. Panwar and Sen (2019) analyzed the effects of floods, droughts, storms, and earthquakes on economic growth in 102 countries by using panel data for the period 1981-2015 and found out that the effects vary depending on the specific economic sector and disaster type and its intensity. Additionally, the study affirmed that the impacts of natural disasters are stronger in developing countries.

The creative destruction effect may also vary depending on the type of disaster that occurred during a certain period. For example, Hornbeck and Keniston (2017) investigated the creative destruction caused by the Great Boston Fire of 1872 by deploying the Cobb-Douglas function and discovered that the reconstruction of burned buildings substantially increased the value of land in the area due to road widening, owners of nearby buildings were motivated to also upgrade their properties, and some buildings were transformed from residential into commercial spaces that led to the urban growth of the area. By using firm-level data from Yokohama City in Japan, Okazaki et al. (2019) measured the damages caused by the Great Kanto Earthquake of 1923 to the different firms and plants in the prefecture. The study revealed that the earthquake paved the way for the expansion of firms in terms of higher quality machinery and equipment, higher electricity consumption, and higher bank loan offers supported by Japanese policies. These results indicated that creative destruction was present due to the Great Kanto Earthquake, which boosted the local economies of the affected regions. Heger and Neumeyer (2019) indicated on one of its trajectories that creative destruction does predict not only the certainty of economic productivity gain but also the permanent higher growth trajectory of the economy. Their study focused on the impacts brought by the 2004 Indian Ocean tsunami in the flooded districts of Aceh Province in Indonesia using a quasi-experimental difference which found out that the province only experienced growth depression in the first year following the tsunami, but during the subsequent years, the local economy became stronger. This is due to the efficient administration of foreign aid, effective reconstruction efforts, and the migration of productive individuals to Aceh that partly replaced the population of those residents who were killed by the disaster.

Qureshi et al. (2019) evaluated the effects of flood, storm, epidemic, foreign aid, and FDI on the economic growth of Malaysia for the period of 1965-2016 by employing the Autoregressive Distributed Lag (ARDL) model and discovered that natural disasters decrease the economic output of the country due to destruction of human and physical capital. However, the study also mentioned that cyclical floods and storms have a positive influence on economic growth in the long run through the implementation of new investment in the country, which supports the idea of Schumpeter's creative destruction.

2.3 Conceptual Framework

According to Tabuena (2021), a conceptual framework is used as a guide for researchers to have a clear direction as it presents the central ideas of their study, wherein the statement of the problem appears as its backbone. Based on the proposed framework, the researchers suggest three categories of analysis.

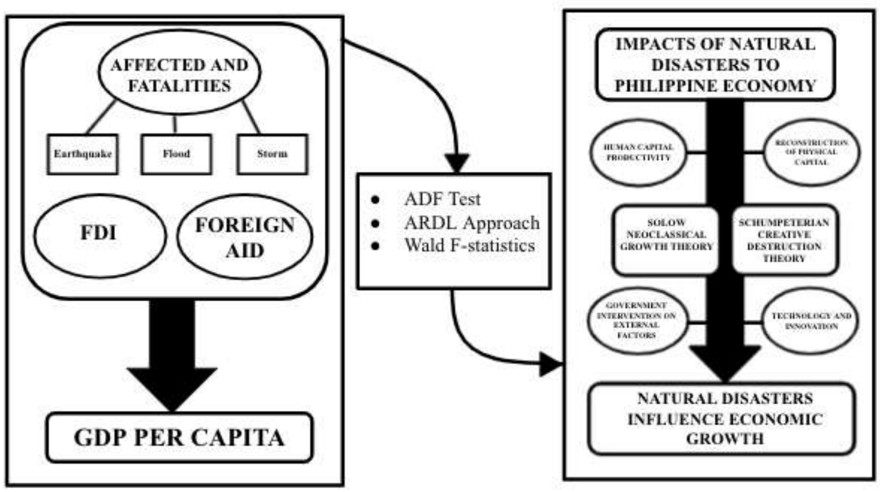

Figure 5. Conceptual framework of the study

The first category of analysis is composed of the independent and dependent variables. The independent variables are natural disasters, FDI, and foreign aid, while GDP per capita is the dependent variable. Natural disaster indicators are collected from EM-DAT. The combined total number of affected and killed individuals of the three most recurring disasters in the country, namely earthquake, flood, and storm are included, respectively. Hence, three independent variables fall under the category of natural disasters. Another independent variable is foreign aid refers to any type of assistance given by another country to the Philippines. Moreover, FDI represents the investments made by a firm from another country to the Philippines. Finally, GDP per capita is the dependent variable which is the output of the Philippines divided by its total population within a specific period. Non-monetary variables can give emphasis to the damaging effects of natural disasters on human capital stock, which can be transformed into severe macroeconomic losses (Panwar & Sen, 2019). Meanwhile, foreign aid can create sustainable growth through the recovery and reconstruction of destroyed human and physical capital as long as it is efficiently administered and properly coordinated (Heger & Neumeyer, 2019). According to Fang et al. (2018), FDI is correlated with the production and consumption of natural capital. It can help in reducing the exposure to vulnerabilities of a country through the funds generated from foreign investment (Qureshi et al., 2019).

For the second category, the methodological process of the study is presented in order to find out if there is a significant relationship between the independent and dependent variables. Following Heger and Neumeyer (2019), quasi-experimental design is exploited to establish the cause-and-effect relationship between the variables. The researchers conduct several diagnostic tests in order to confirm if any of the independent variables have a significant relationship with GDP per capita. After employing the statistical treatments, the researchers run the Autoregressive Distributed Lag (ARDL) model to estimate the short-run and long-run effects of the independent variables to the dependent variable. The creative destruction hypothesis suggests the economic process of destroying and replacing old units with updated ones (Schumpeter, 1942). In the third category of analysis, the Solow growth model and Schumpeterian creative destruction theory will be applied in evaluating the empirical results of the multiple regression and other diagnostics tests utilized in this paper. The core of this research paper is that creative destruction is evident in the economic activities led by natural disasters in the Philippine context. This points out that natural disasters can stimulate economic growth.

3. Methodology

In this chapter, the reader will be introduced to the methodological approaches that are being utilized in the study. The chapter also discusses the data gathering procedure and describes the choice of the regression model. Finally, the possible errors and biases that could take place in the study are emphasized.

3.1 Research Design

Quantitative research tests theories and hypotheses. According to Tabuena (2021), quantitative research stems from positivism and can be used in analyzing both long-term and short-term studies. Quantitative methods are often applied in studies about environmental economics. In the present study, the researchers use a quantitative strategy in order to test the Solow growth model and Schumpeterian creative destruction theory. The quantitative strategy involves the collection and analysis of numerical data. Furthermore, this will be used to determine if there are causal relationships between the variables.

The present study follows a multivariate analysis, which measures the five independent variables' degree of relationship with the dependent variable. The study used secondary data obtained from the Emergency Events Database (EM-DAT) and the World Bank. The autoregressive distributed lag (ARDL) approach was implemented to determine the relationship between the independent and dependent variables. The technique applied in the study was a time series analysis, which is a vital statistical tool in modelling the systematic patterns over time and understanding the causes of these trends. The researchers use a quantitative approach and economic analysis in this study. The focus of the study is to explain the effect of EQK, FLD, STM, FDI and AID on GDPPC in the Philippines using time series data. Comparative and cross-sectional designs were not used because the present analysis is limited to one country only. Rather, the present thesis uses a time series design, which is a type of quasi-experimental design. A series of periodic measurements will be taken from a group of test units. This will be followed by treatment before having another series of measurements. The purpose of this study is to test how a change in the independent variables would affect the dependent variable.

3.2 Data and Variables

A time-series data set will be constructed in order to test the hypothesis of creative destruction in the case of the Philippines over the period of 1990 to 2019. Following Qureshi et al. (2019), the researchers organized the data and used five regressors and one *response* variable in order to assess the relationship between natural disasters and the economic growth of the Philippines. The sample includes 30 observations of GDP per capita income (current US$), Foreign Direct Investment net inflows (BoP, current US$), net official development assistance and official aid received (current US$), and the combined total number of people affected and a number of fatalities per natural disaster annually. The dependent variable is per capita income (represented by GDPPC) in current US dollars, which will be obtained from World Development Indicators taken from the World Bank (2019) database.

For the indices under natural disasters, the researchers have listed the top three most recurring disasters in the Philippines, which are earthquake (represented by EQK), flood (represented by FLD), and storm (represented by STM). In line with this, the total number of people affected and a total number of fatalities are combined in order to come up with natural disaster indicators. The data points were taken from the Emergency Events Database (EM-DAT), which is monitored by the Centre for Research on Epidemiology of Disasters (CRED) of the University of Louvin in Brussels, Belgium. The database released by EM-DAT continues to provide worldwide information regarding the impacts and occurrences of more than 20,000 natural and technological disasters since 1900 up to the present day. Furthermore, EM-DAT has specified certain criteria in order for an event to be classified as a disaster, such as 1) ten or more people are reported killed; 2) 100 or more individuals are affected; 3) there is a declaration of a state of emergency and; 4) call for international assistance.

However, according to Panwar and Sen (2018), using a natural disaster as an independent variable might result in a spurious regression. Following other disaster literature, few researchers have used a natural disaster as their dependent variable as it might be endogenous and can be highly correlated to economic growth. Additionally, a few shortcomings associated with disaster-related data obtained from EM-DAT must be acknowledged as it can greatly impede the robustness of the econometric analysis. First, it is difficult to validate whether a certain event is missing, no damages, or there is zero economic losses (be it human or property losses) as some events are not fully reported. Second, due to the increased occurrence of natural disasters and improved reporting methods by EM-DAT throughout the years, there might be a presence of time bias. Lastly, the accuracy of the data related to disasters is mainly dependent on the data collected and provided by primary sources of each country (Panwar & Sen, 2018). Due to the deficiency of overtime variables that fall under natural disasters, the researchers have decided to fill the missing values with zero to generate time-series data.

The other independent variables include net official development assistance and official aid received in current US dollars (represented by AID) and Foreign Direct Investment, net inflows (represented by FDI) in current US dollars, which were obtained from the World Bank (2019).

3.3 Estimation Methodology

The researchers use a time series regression to analyze and forecast values based on the observed data. Time-series is used for growth theories since it is able to display patterns such as trends. Compared to other statistical methods, time series analysis makes use of only one historical sample. To determine the relationship between natural disasters, foreign aid, and foreign direct investments with GDP per capita, the following specification has been formulated:

$$GDPPC = \beta_0 + \beta_1 EQK + \beta_2 FLD + \beta_3 STM + \beta_4 AID + \beta_5 FDI + \varepsilon_i \tag{2}$$

Equation (2) shows the main regression equation. The model specification is based on the study conducted by Qureshi et al. *GDPPC* is GDP per capita in current US$, β_0 is the y-intercept, *EQK* is the total number of people affected/killed by earthquakes, *FLD* is the total number of people affected/killed by floods, *STM* is the total number of people affected/killed by storms, *AID* is the foreign aid receipt, FDI is the inflows of foreign direct investment, and ε_i is the random error term.

The study of Qureshi et al. (2019) used the Solow growth model, more specifically the production function, to explore the impact of natural disasters on economic growth. Data regarding natural disasters has not been consistent over time since this is based on events data. As a result, missing values will be filled with "zero" to generate the time series data.

$$y_t = Af(k_t, l_t) \tag{3}$$

Equation (2) shows the dependence of the country's output on capital stock and labor inputs. It is assumed that technology is constant.

$$\begin{aligned} k_t &= f(d_t, AID_t, FDI_t) \\ l_t &= f(d_t, AID_t, FDI_t) \\ AID_t &= f(d_t) \text{ and } FDI_t = f(d_t) \end{aligned} \tag{4}$$

Equation (4) is an extension of Equation (3). This shows the function of natural disasters, foreign aid and FDI inflows. *d* represents natural disasters, AID represents foreign aid receipt, and FDI represents FDI inflows.

$$y_t = Af(k_t, l_t d_t, AID_t, FDI_t) \tag{5}$$

In line with this, several issues may surface from the use of time-series data. An issue that may arise in time series data is the sample size. In addition, a problem with time series data is the use of incomplete or partial observations. The time series sampling records only a finite sample path and not the entire sample-path. The issues of normality, heteroscedasticity and autocorrelation may also arise in time series data. Hence, the researchers conducted a series of diagnostic tests to meet the assumptions of normality, no heteroscedasticity, and no serial correlation by exploiting the statistical tests such as the Jarque-Bera test, Breusch-Pagan test and Lagrange Multiplier (LM) test. The assumptions mentioned above are going to be checked using the Eviews software.

3.4 Diagnostic Tests

The researchers conducted a series of diagnostic tests in order to derive consistent, statistically significant and robust results. The researchers started by satisfying the classical assumptions in running linear regression, namely normality, no serial correlation, and no heteroscedasticity. Since the study focuses on time series data with a 30-year time frame, the researchers examined the properties of the time-series data they have gathered. Following Qureshi et al. (2019), the study utilizes the Dickey-Fuller Unit Root

Test (1979), which is mainly used to assess the stationary trend of variable series. However, if an autocorrelation problem arises in the study, the test will be augmented with the autoregressive properties of GDPPC and Akaike Information Criteria (AIC) serves as the basis for the number of lags used. Thus, it is now referred to as Augmented Dickey Fuller Test, which is used to determine a possible non-stationary problem in the variables. If the p-value is greater than 5%, the null hypothesis will be accepted, and the series will be labelled as non-stationary. The ADF test formula is:

$$\Delta y_t = (\rho - 1)y_{t-1} + \alpha_i \sum_{i=1}^{m} \Delta y_{t-1} + \mu_t \tag{6}$$

Where y_t is the dependent variable at the current time period, y_{t-1} represents the lagged dependent variable, ρ represents the autoregressive component, m represents the number of lags of the dependent variable, and μ_t represents the error term at the current time period. On the other hand, to examine the short-run and long-run relationship of the variables, the paper will be applying the Autoregressive Distributed Lag (ARDL) bounds testing approach. The ARDL formula is as follows:

$$\begin{aligned}\Delta (GDPPC)_t = {} & \alpha_0 + \sum_{i=1}^{p} \phi\Delta(GDPPC)_{t-1} + \sum_{i=0}^{q} \theta_i\Delta(EQK)_{t-1} + \sum_{i=0}^{r} \lambda_i(FLD)_{t-1} + \sum_{i=0}^{s} \phi_i\Delta(STM) \\ & + \sum_{i=0}^{s} \phi_i\Delta(AID)_{t-1} + \sum_{i=0}^{s} \phi_i\Delta(FDI)_{t-1} + \delta_1(GDPPC)_{t-1} + \delta_2(EQK)_{t-1} + \; + \delta_3(FLD)_{t-1} \\ & + \delta_4(STM)_{t-1} + \delta_5(AID)_{t-1} + \delta_5(FDI)_{t-1}\end{aligned} \tag{7}$$

Where Δ represents the operator of first difference, p represents the optimal lag length, and GDPPC, EQK, FLD, STM, FDI, and AID are per capita income, the total number of people affected/killed by earthquakes, total number of people affected/killed by floods, the total number of people affected/killed by the storm, FDI net inflows, and aid received by the Philippines, respectively. Since the Philippines substantially depends on international aid in order to recover and rebuild infrastructures following natural disasters, it is expected that the lag of AID would have a positive relationship with GDPPC. Moreover, Wald F-test will be employed in the estimation of Equation (7) to assess the cointegration relationship between the regressors and the regressand. By applying Wald F-statistics, the alternative hypothesis of cointegration is tested. The hypothesis of cointegration evaluation is:

$$H_0: \delta_1 = \delta_2 = \delta_3 = \delta_4 = \delta_5 = \delta_6 = 0$$
$$H_1: \delta_1 \neq \delta_2 \neq \delta_3 \neq \delta_4 \neq \delta_5 \neq \delta_6 \neq 0$$

Qureshi et al. (2019) utilized the critical values based on finite sample sizes between the range of 30 to 80. The first order integration *I*(1) variables will be referred to the upper bound value, while zero order integration *I*(0) variables will be referred to the lower bound critical values. If the results of the Wald F-statistics are significant, then the researchers could draw the conclusion that a long-run cointegration relationship is present between the variables, while the reverse is true for no cointegration relationship. Furthermore, a tentative model will be identified by calculating the ARDL lag length of the model using Least Squares. The formula for the ARDL model is as follows:

$$GDPPC_t = c + \alpha_1 GDPPC_{t-1} + \beta_1 EQK_t + \beta_2 FLD_t + \beta_3 STM_t + \beta_4 STM_{t-1} + \beta_5 AID_t + \beta_6 FDI_t \tag{8}$$

In order to determine the long-run regression coefficients, short-run and long-run elasticity ARDL-bounds testing approaches will be calculated based on Akaike Information Criterion. Diagnostic tests such as the LM test, stability test, Jarque-Bera normality test, Breusch-Pagan test for heteroscedasticity, and Ramsey REST test will be exploited. Moreover, the long-run coefficients will be determined by identifying the long-run elasticity of each independent variable. These methods will generate the long-run relation model (see Equation 2). After obtaining the long-run relation model, estimation of the short-run Error correction model (ECM) will be implemented by calculating the Error-correction term (ECT), which represents the residuals from the long-run cointegration model. The short-run dynamic model can be transformed by utilizing Equation (8) into:

$$\begin{aligned}\Delta GDPPC_t = {} & c - (1 - \alpha_1)\, GDPPC_{t-1} + \beta_1 EQK_{t-1} + \beta_2 FLD_{t-1} + (\beta_3 + \beta_4) STM_{t-1} \\ & + \beta_5 AID_{t-1} + \beta_6 FDI_{t-1} + \beta_1 \Delta EQK_t + \beta_2 \Delta FLD_t + \beta_3 \Delta STM_t + \beta_5 \Delta AID_t + \beta_6 \Delta FDI_t + \varepsilon_t\end{aligned} \tag{9}$$

Equation (9) will be transformed into an Error correction model in order to restore the normal equilibrium position of the regressors and regressand. ECM was used to explain the short-run and long-run relationship between the variables. The ECM formula is as follows:

$$\Delta GDPPC_t = c - (1-\alpha_1)\left(GDPPC_{t-1} - \frac{\beta_1}{1-\alpha_1}EQK_{t-1} - \frac{\beta_2}{1-\alpha_1}FLD_{t-1} - \frac{\beta_3+\beta_4}{1-\alpha_1}STM_{t-1} - \frac{\beta_5}{1-\alpha_1}AID_{t-1} - \frac{\beta_6}{1-\alpha_1}FDI_{t-1}\right)$$
$$+ \beta_1\Delta EQK_t + \beta_2\Delta FLD_t + \beta_3\Delta STM_t + \beta_5\Delta AID_t + \beta_6\Delta FDI_t + \varepsilon_t \quad (10)$$

where $c-(1-\alpha_1)$ represents the speed of adjustment and the formula for ECT, which is the error correlation term is as follows:

$$ECT_{t-1} = GDPPC_{t-1} - \frac{\beta_1}{1-\alpha_1}EQK_{t-1} - \frac{\beta_2}{1-\alpha_1}FLD_{t-1} - \frac{\beta_3+\beta_4}{1-\alpha_1}STM_{t-1} - \frac{\beta_5}{1-\alpha_1}AID_{t-1} - \frac{\beta_6}{1-\alpha_1}FDI_{t-1} \quad (11)$$

Hence, the short run dynamic model can be written on the following ECT model:

$$\Delta GDPPC_t = c - (1-\alpha_1)ECT_{t-1} + \beta_1\Delta EQK_t + \beta_2\Delta FLD_t + \beta_3\Delta STM_t$$
$$+ \beta_5\Delta AID_t + \beta_6\Delta FDI_t + \varepsilon_t \quad (12)$$

Furthermore, the Wald test will be employed in order to compute the short-run coefficients based on the ARDL model found in Equation (8). Wald F-Statistics will also be utilized in the study to evaluate the Granger causality relationship between natural disasters (e.g., the total number of people affected, the total number of fatalities, and total damages) and GDP per capita. Restriction on independent variables such as EQK, FLD, and STM was imposed in order to find the causality of the relationship with the dependent variable. The results of the study will provide a more in-depth analysis of the relationship between economic growth and natural disasters in the context of the Philippines.

4. Results and Discussion

In this chapter, the reader will be presented with results and a discussion of the data analysis in four sections. The first section presents the descriptive statistics. Followed by the results of the Augmented Dickey Fuller (ADF) test based on the Akaike Information Criterion. The third section consists of the results of the Autoregressive Distribution Lag (ARDL) bound test. Finally, the last section shows the results of the Wald test to determine the granger causality of the variables.

4.1 Descriptive Statistics

The descriptive statistics are presented in Table 1. Disaster episodes of earthquake, flood, and storm can be found in the form of the combined number of individuals who were affected and killed during the period of time. For earthquakes, the minimum value is 0 individuals affected/killed for the periods 1995-1998, 2000-2001, 2005-2010, 2014-2015, and 2018 while the maximum value is 3221478 individuals affected/killed for the period of 2013. The minimum value affected/killed by flood is 0 in the years 1996 and 1998, while the maximum value who were victims of the flood is 18420020 for the year 2017. Storm shows a minimum value of 20045 individuals who were affected/killed for the period of 2005, while the maximum value is about 64847207 for the period of 2008. The GDP per capita has an average value of US$ 1738.113 with a minimum value of US$ 715.7468 and a maximum value of US$ 3485.084. Meanwhile, foreign aid shows a minimum value of US$ -1.36E+08 and a maximum value of US$ 1.64E+08 with a mean value of US$ 6.18+08. The FDI has an average value of US$ 2.86E+09 with a minimum value of US$ 2.28E+09 and a maximum value of US$ 1.03E+10. The following statistics present an analysis of the dependent and independent variables which are utilized in this study following disasters in the Philippines.

Table 1. Descriptive Statistics

Statistics	EQK	FLD	STM	GDPPC	AID	FDI
Mean	210514.3	1481604	6755707	1738.113	6.18E+08	2.86E+09
Median	0	186531.0	3283391	1202.329	5.90E+08	1.72E+09
Maximum	3221478	18420020	64847207	3485.084	1.64E+09	1.03E+10
Minimum	0	0	20045	715.7468	-1.36E+08	2.28E+09
Std. Dev.	654400.5	3448688	11816814	918.1901	3.84E+09	2.28E+09
Skewness	3.763404	4.167325	4.155395	0.591597	0.457995	1.513493
Kurtosis	16.80033	20.82081	20.89307	1.767679	3.629204	4.111670
Obs.	30	30	30	30	30	30

Note: EQK indicates the number of people affected/killed by the earthquake, FLD indicates the number of people affected/killed by a flood, STM indicates the number of people affected/killed by the storm, GDPPC indicates the GDP per capita income, AID indicates foreign aid, and FDI indicates foreign direct investment inflows

4.2 Results of Augmented Dickey Fuller (ADF) Test

Table 2 shows the results of the Augmented Dickey Fuller (ADF) test wherein the H_0 states that the model is non-stationary while the H_a states that the model is stationary. The null hypothesis is rejected if the p-value is less than a 5% level of significance and vice versa. In line with this, the summary of the ADF unit root test indicates that only EQK and STM exhibit stationary series at the level. Variables such as GDPPC, FLD, AID, and FDI show non-stationary series at the level. By employing the first difference operator, all variables become stationary. Furthermore, the results of the ADF unit root test confirm that the model contains mixed variables. This is enough evidence to implement the ARDL-bounds testing approach in the study, which can be applied to a sample with a finite number of observations.

Table 2. Estimates of ADF unit root test

Variables	Level			First Difference			Decision
	ADF	P-value	Lag Length	ADF	P-value	Lag Length	
EQK	-5.5306*	0.0001	0	-10.1499*	0.0156	4	*I*(0)
FLD	-0.4703	0.8833	0	-10.7802*	0.0313	5	*I*(1)
STM	-4.8011*	0.0006	0	-10.6907*	0.0089	4	*I*(0)
GDPPC	1.6119	0.9992	0	-7.5517*	0.0013	1	*I*(1)
AID	-2.4112	0.1474	0	-8.6415*	0.004	3	*I*(1)
FDI	-0.4703	0.8833	0	-7.987*	0	0	*I*(1)

Note: EQK indicates the number of people affected/killed by the earthquake, FLD indicates the number of people affected/killed by a flood, STM indicates the number of people affected/killed by the storm, GDPPC indicates the GDP per capita income, AID indicates foreign aid, and FDI indicates foreign direct investment inflows

Test critical values at level, i.e., *1% level of significance at -3.679; **5% level of significance at -2.968; and ***10% level of significance at -2.623. Test critical values at first difference, i.e., *1% level of significance at -4.356; **5% level of significance at -3.595; and ***10% level of significance at -3.233

4.3 Results of the Autoregressive Distributed Lag (ARDL) Bound Test

Table 3 presents the results of the Autoregressive Distributed Lag (ARDL) bound test wherein the H_0 states that there is no cointegration in the model while the H_a states that there is a cointegration in the model. The null hypothesis is rejected if the absolute value of F-statistics is greater than the *I*(0) bound and vice versa. As seen in Table 4, the results confirmed that except for the GDPPC model, the remaining five models indicate cointegrated and long-run relationships between the variables. The results of Wald F-statistics show that only the GDPPC model, which happens to be the main model of the study, has insignificant F-statistics. Moreover, the ARDL lag length is based on the Akaike Information Criterion (AIC).

Table 4 presents the results of the diagnostic tests. The diagnostic tests utilized in this study are the Jarque-Bera test for normality, the Breusch-Pagan test for detecting the presence of heteroscedasticity, and the LM test for serial correlation. The results of the diagnostic tests confirm that only GDPPC and FDI models do not have normality issues, no presence of heteroscedasticity, and no serial correlation.

Table 3. Results of ARDL cointegration test

Models	**ARDL Lag Length**	**F-statistics**
GDPPC = f(EQK, FLD, STM, AID, FDI)	(1, 0, 0, 1, 0, 0)	0.98315
EQK = f(GDPPC, FLD, STM, AID, FDI)	(1,0, 0, 0, 0, 0)	6.014903*
FLD = f(GDPPC, EQK, STM, AID, FDI)	(1,0, 0, 0, 0, 0)	7.863309*
STM = f(GDPPC, EQK, FLD, AID, FDI)	(1, 0, 0, 0, 0, 1)	5.201557*
AID = f(GDPPC, EQK, FLD, STM, FDI)	(1, 1, 1, 0, 1, 1)	2.68908***
FDI = f(GDPPC, EQK, FLD, STM, AID)	(1, 1, 0, 1, 1, 0)	3.297162**
Level of Significance	**F-statistics**	
	Lower bounds *I*(0)	**Upper bounds *I*(1)**
1%	3.41	4.68
5%	2.62	3.79
10%	2.26	3.35

*1% level of significance; **5% level of significance; ***10% level of significance

Table 4. Results of diagnostic tests

Models	**JB Normality Test**	**Heteroscedasticity**	**LM Test**
GDPPC = f(EQK, FLD, STM, AID, FDI)	0.954949	0.9092	0.2084
EQK = f(GDPPC, FLD, STM, AID, FDI)	0	0.4504	0.4933
FLD = f(GDPPC, EQK, STM, AID, FDI)	0	0.038	0.3436
STM = f(GDPPC, EQK, FLD, AID, FDI)	0	0.2731	0.5572
AID = f(GDPPC, EQK, FLD, STM, FDI)	0	0.9464	0.1582

FDI = f(GDPPC, EQK, FLD, STM, AID)	0.969844	0.5069	0.9762

Table 5 shows the results of short-run and long-run estimates. In the short run, all the independent variables are considered to have a negative and significant relationship with GDP per capita at a 5% level of significance. The results of the short-run calculation conclude that the more occurrences of natural disasters, the lower the GDP per capita of the Philippines. The results for the short-run is consistent with the previous study of Fang et al. (2018). Additionally, the effect of earthquakes, floods, and storms on the economy varies negatively. The results are congruent with the studies conducted by Panwar and Sen(2019) and Tang et al. (2019) as short-run economic effects of natural disasters mainly depend on the type of the disaster event, and its impacts are greater in developing nations. The results also imply that natural disasters can hamper economic growth, which does not support the Schumpeterian creative destruction theory in the Philippine context in the short run.

The results confirm that foreign aid has a negative impact on the economic growth of the Philippines in the short run. According to Thapa (2020), foreign aid does not promote economic growth in developing nations as it increases the inequality between the rich and the poor, increases inflation when foreign aid is allocated to an unproductive sector, and donor countries will most likely get involved in the economic and political activities of the receiving country. The Philippines is still a developing nation and often depends on the assistance given by other countries during calamities. Furthermore, the efficient allocation of foreign aid and assistance mainly depends on how the government manages the funds for its recovery and rehabilitation programs post-disasters. Foreign aid has been interlinked with major challenges such as corruption, wherein the latter impedes the implementation of efficient budgetary and monetary policy that mutilate growth (Quibria, 2017). In addition, disaster mitigation programs implemented in developing nations are not focused on improving capital and technology. As eloquently stated by Alcayna et al. (2016), short-term recovery such as immediate relief is prioritized as opposed to long-term recovery such as disaster risk reduction.

On the other hand, the results found out that only FDI inflows have a positive and significant relationship with the country's per capita income in the long run with a coefficient value of 0.000000223, $p < 0.0012$ (refer to Table 6). In addition, FDI is one of the main sources of income and finance for developing nations like the Philippines. Following natural disasters, Doytch (2019) states that the reconstruction of infrastructure, replacing the intangible capital, and upgrade of technology in the economy can attract FDI to bring external capital to make rebuilding possible. Furthermore, the upgrade can be beneficial for local firms through technology spillover wherein they could produce goods and services at a much lower cost. This would intensify the relationship between local suppliers and parties involved in FDI inflows like multinational companies (Kato & Okubo, 2018).

Table 5. Results of ARDL-bound testing approach

Variables	Short-run coefficients	Variables	Long-run coefficients
C	-71.35825	EQK	0.0000339
ECT_{t-1}	0.150373	FLD	-0.0000193
ΔEQK_t	-1.000005	STM	0.0000169
ΔFLD_t	-0.999997	AID	-0.000000299
ΔSTM_t	-0.999999	FDI	0.000000223
ΔSTM_{t-1}	-1.000004	Constant	474.542
ΔAID_t	-1	**Diagnostic Tests**	
ΔFDI_t	-1	F-statistics	0
		Jarque-Bera test	0.954949
		LM (2) test	0.2084
		Heteroscedasticity test	0.9092
		Ramsey RESET test	10.47

Dependent variable: $\Delta GDPPC_t$;EQK indicates the number of people affected/killed by the earthquake, FLD indicates the number of people affected/killed by a flood, STM indicates the number of people affected/killed by the storm, GDPPC indicates the GDP per capita income, AID indicates foreign aid, and FDI indicates foreign direct investment inflows.

The diagnostic results confirm that the model is normally distributed, no presence of serial correlation up to 2 lags, no heteroscedasticity, and model stability, which obtained insignificant statistical values of Jarque-Bera test, LM test, Breusch-Pagan test, and Ramsey RESET test, respectively. Table 6 presents the result of the long-run cointegration through the deployment of Wald F-statistics with a value of 3.76, which lies in *I*(1) upper critical boundaries at a 5% level of significance. The result indicates that long-run cointegration between the variables is present.

Table 6. ARDL-bounds test of cointegration

Test statistic		Value	k
F-statistic		3.76003	5
Critical value bounds			
Significance	*I*(0) bound	*I*(1) bound	
10%	2.08	3	
5%	2.39	3.38	
2.5%	2.7	3.73	
1%	3.06	4.15	

4.4 Results of the Wald Test for Granger Causality

Table 7 presents the results of the Wald test for Granger causality. The Granger causality test is applied to test whether a bidirectional, unidirectional or no causal relationship exists between two variables. Only two variables, which are both independent and dependent, will be considered at a time in a causality test. The H_0 states that the X variable does not Granger cause the Y variable. If the p-value > 0.05, the H_0 is accepted, thereby indicating that no causality exists between the two variables. Conversely, if the p-value <0.05, the H_0 is rejected, thereby indicating that causality exists between the two variables.

Table 7. Results of short-run Granger causality

Variables	Wald F-statistics	P-value	Short-run causality
GDPPC → AID	0.4313	0.5171	No causal relationship
AID → GDPPC	0.04257	0.8382	
GDPPC → FDI	7.26182	0.0122	Unidirectional causality
FDI → GDPPC	0.12027	0.7315	
GDPPC → EQK	2.60207	0.1188	No causal relationship
EQK → GDPPC	0.38474	0.5405	
GDPPC → FLD	6.16871	0.0198	Unidirectional causality
FLD → GDPPC	0.02847	0.8673	
GDPPC → STM	1.1528	0.2928	No causal relationship
STM → GDPPC	1.78388	0.1932	

The p-values confirm that there is no causal relationship between GDPPC and AID, GDPPC and EQK, and GDPPC and STM in the short-run. On the contrary, the p-values indicate that GDPPC Granger Causes both FDI and FLD in the short-run. This implies that unidirectional short-run causality exists running from per capita income to foreign direct investment but not vice versa. Similarly, unidirectional short-run causality exists running from per capita income to flood but not vice versa. The results imply that both foreign direct investment and flood are influenced by per capita income. The rest of the variables do not manifest the patterns of causality between the variables. Thus, the presence of Schumpeterian creative destruction cannot be supported as disaster-led economic growth is not evident in the Granger causality test.

5. Conclusion and Recommendation

This chapter concludes the study and discusses the findings based on its objectives which analyzed the impacts of natural disasters on the economy of the Philippines. Furthermore, the researchers prepared recommendations that could be applied in further studies about the topic.

5.1 Conclusion

The relationship between economic growth and natural disasters is complex. In the case of the Philippines, the effect of natural disasters on the economy varies. This research investigated the impact of natural disasters (i.e. earthquake, flood, and storm), foreign aid, and foreign direct investment to the economy of the Philippines by using ADF unit root test, short-run and long-run elasticity ARDL-bounds testing approaches and Wald-F Statistics for causality estimates set from the period of 1990 to 2019. For the short run, the independent variables have a negative and significant relationship with the country's per capita income. The result indicates that the higher the number of disaster events, the lower the per capita income of the Philippines. On the other hand, the results of this study found out that only FDI has a significant relationship to the economy of the Philippines in the long run. The results imply that foreign direct investment inflows influence economic growth and can be a confirmation of the Schumpeterian creative destruction theory in the context of the Philippines. The results also indicated no causal relationship between per capita income, foreign aid, earthquake and storms in the short-run. However, there is unidirectional short-run causality between per capita income and foreign direct investment and per capita income and flood.

Accordingly, mitigation of a comprehensive disaster plan is essential in order to reduce the number of affected individuals, lessen the damage to infrastructure, and promote resiliency among the people. The Philippines must implement policies that boost different local and economic sectors with the aim to lessen the nation’s dependency on foreign and external factors such as foreign aid. Moreover, the government should mitigate disaster-focused policies offering fiscal and non-fiscal incentives to encourage foreign direct investments despite the occurrences of natural disasters as well as empowering the local economy. On top of that, proper communication and information dissemination among local communities is one of the key factors that could help in assessing and mitigating the appropriate national disaster plan. With minimal effects, natural disasters can still be considered as a factor that could affect the country’s progress and development.

5.2 Recommendation

Based on the results, the researchers recommend further work to the following:

a. Future researchers may utilize a longer time frame, longer data collection period, and longer modelling period.
b. Future researchers may include additional variables that focus on the classification of natural disasters (e.g. geophysical, meteorological, hydrological, climatological, biological, and epidemiological); based on other economic indicators that can be attributed to disasters such as government expenditure, openness to trading, and literacy rate; and sector-focused variables namely agriculture, manufacturing, industry, and service sectors.
c. Future researchers may incorporate socioeconomic indicators (e.g. gender, income, poverty rate), which are rarely studied.
d. Future researchers could explore other economic growth theories as theoretical background in order to lessen the complexity in analyzing the impact of natural disasters on the economy.

References

[1] Aghion, P. (2018). Innovation and growth from a SCHUMPETERIAN PERSPECTIVE. *Revue D'économie Politique, 128*(5), 693. doi:10.3917/redp.285.0693
[2] Alcayna, T., Bollettino, V., Dy, P., & Vinck, P. (2016). Resilience and Disaster Trends in the Philippines: Opportunities for National and Local Capacity Building. https://dx.doi.org/10.1371%2Fcurrents.dis.4a0bc960866e53bd6357ac135d740846
[3] Asian development outlook 2019. (2019). *Asian Development Outlook*. doi:10.22617/fls190070-3
[4] Batten, S. (2018). Climate change and the Macro-economy: A critical review. *SSRN Electronic Journal*. doi:10.2139/ssrn.3104554

[5] Bollettino, V., Alcayna, T., Enriquez, K., & Vinck, P. (2018). Perceptions of Disaster Resilience and preparedness in the Philippines. Retrieved May 23, 2021, from https://hhi.harvard.edu/publications/perceptions-disaster-resilience-and-preparedness-philippines

[6] Boustan, L. P., Kahn, M. E., Rhode, P. W., & Yanguas, M. L. (2020). The effect of natural disasters on economic activity in US counties: A century of data. *Journal of Urban Economics, 118*, 103257. doi:10.1016/j.jue.2020.103257

[7] Brucal, A., Roezer, V., Dookie, D., Byrnes, R., Ravago, M., Cruz, F., & Narisma, G. (2020). *Disaster impacts and financing: Local insights from the Philippines* (Rep.). Retrieved March 19, 2021, from Centre for Climate Change, Economics and Policy website: https://www.lse.ac.uk/granthaminstitute/wp-content/uploads/2020/06/GRI_policy_report_Disaster-impacts-and-financing_Local-insights-from-the-Philippines.pdf.

[8] Canonizado, I. (2021). Input-process-output model. Retrieved May 21, 2021, from https://discover.hubpages.com/education/IPO-Model-of-Research

[9] Doytch, N. (2019). Upgrading destruction? *International Journal of Climate Change Strategies and Management*, *12*(2), 182–200. https://doi.org/10.1108/ijccsm-07-2019-0044

[10] Fang, J., Lau, C. K., Lu, Z., Wu, W., & Zhu, L. (2018). Natural disasters, climate change, and their impact on inclusive wealth In G20 countries. *Environmental Science and Pollution Research, 26*(2), 1455-1463. doi:10.1007/s11356-018-3634-2

[11] Fatouros, N., & Sun, Y. (2020). Natural Disasters and Economic Growth: A Semiparametric Smooth Coefficient Model Approach. *Journal of Risk and Financial Management*, *13*(12), 1-9. MDPI. http://dx.doi.org/10.3390/jrfm13120320

[12] Halkos, G., & Psarianos, I. (2016). Exploring the effect of including the environment in the neoclassical growth model. *Environmental economics and policy studies*, *18*(3), 339-358. ECONIS. 10.1007/s10018-016-0146-5

[13] Heger, M. P., & Neumayer, E. (2019). The impact of the Indian Ocean tsunami on Aceh's long-term economic growth. *Journal of Development Economics, 141*, 102365. doi:10.1016/j.jdeveco.2019.06.008

[14] Hornbeck, R., & Keniston, D. (2017). Creative destruction: Barriers to urban growth and the Great Boston Fire of 1872. *American Economic Review, 107*(6), 1365-1398. doi:10.1257/aer.20141707

[15] Hsiang, S., & Jina, A. (2014). The causal effect of environmental catastrophe on long-run Economic Growth: Evidence From 6,700 cyclones. doi:10.3386/w20352

[16] International Federation of Red Cross and Red Crescent Societies. (n.d.). *What is a disaster?* IFRC. Retrieved November 26, 2021, from https://www.ifrc.org/what-disaster

[17] Jha, S., Martinez, Jr., A., Quising, P., Ardaniel, Z., & Wang, L. (2018). Natural disasters, public spending, and Creative Destruction: A case study of the Philippines. *SSRN Electronic Journal*. doi:10.2139/ssrn.3204166

[18] Johar, M., Johnston, D., Shields, M., Siminski, P., & Stavrunova, O. (2020). The Economic Impacts of Direct Natural Disaster Exposure. *IZA Discussion Paper No. 13616*. Retrieved April 18, 2021, from https://ssrn.com/abstract=3679022

[19] Kato, H., & Okubo, T. (2018). The impact of a natural disaster on foreign direct investment and vertical linkages. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.2983835

[20] Kirchberger, M. (2017). Natural Disasters and Labor Markets. *Journal of Development Economics*, *125*, 40-58. http://dx.doi.org/10.1016/j.jdeveco.2016.11.002

[21] Lackner, S. (2018). Earthquakes and economic growth. *FIW Working Paper*. Retrieved April 30, 2021, from http://hdl.handle.net/10419/194225

[22] Ladds, M., Keating, A., Handmer, J., & Magee, L. (2017). How much do disasters cost? A comparison of Disaster cost estimates in Australia. *International Journal of Disaster Risk Reduction, 21*, 419-429. doi:10.1016/j.ijdrr.2017.01.004

[23] London, S. (2017). A methodological note about the analysis of the economic growth and environment. *MOJ Ecology & Environmental Sciences*, *2*(8). https://doi.org/10.15406/mojes.2017.02.00053

[24] Marin, G., & Modica, M. (2017). Socioeconomic exposure to natural disasters. *Environmental Impact Assessment Review, 64*, 57-66. doi:10.1016/j.eiar.2017.03.002

[25] Mohan, P. S., Spencer, N., & Strobl, E. (2019). Natural Hazard-Induced Disasters and Production Efficiency: Moving Closer to or Further from the Frontier? *Int J Disaster Risk Sci*, *10*, 166-178. https://doi.org/10.1007/s13753-019-0218-9

[26] Noy, I., & DuPont, W. (2016). Long-term consequences of natural disasters. *Oxford Research Encyclopedia of Natural Hazard Science*. doi:10.1093/acre for/9780199389407.013.72

[27] Okazaki, T., Okubo, T., & Strobl, E. (2019). The creative destruction of Industries: Yokohama city in the Great Kanto Earthquake, 1923. *The Journal of Economic History, 79*(1), 1-31. doi:10.1017/s0022050718000748

[28] Padagdag, J. M. (2018). *The Philippine Disaster Risk Reduction and Management System* (Rep.). Retrieved March 23, 2021, from ADRC Visiting Researcher Program 2018B website: https://www.adrc.asia/countryreport/PHL/2018/Philippines_CR2018B.pdf

[29] Panwar, V., & Sen, S. (2018). The economic impact of natural disasters: An empirical re-examination. *Margin: The Journal of Applied Economic Research, 13*(1), 109-139. doi:10.1177/0973801018800087

[30] Quibria, M. G. (2017). Foreign Aid and Corruption: Anti-Corruption Strategies Need Greater Alignment with the Objective of Aid Effectiveness. *Georgetown Journal of International Affairs*, *18*(2), 10–17. http://www.jstor.org/stable/26396014

[31] Qureshi, M. I., Yusoff, R. M., Hishan, S. S., Alam, A. F., Zaman, K., & Rasli, A. M. (2019). Natural disasters and MALAYSIAN economic Growth: Policy reforms for DISASTERS MANAGEMENT. *Environmental Science and Pollution Research, 26*(15), 15496-15509. doi:10.1007/s11356-019-04866-z

[32] Samphantharak, K. (2019). Natural disaster and economic development in Southeast Asia. *SSRN Electronic Journal*. doi:10.2139/ssrn.3388396

[33] Shabnam, N. (2014). Natural disasters and economic growth: A Review. *International Journal of Disaster Risk Science*, *5*(2), 157–163. https://doi.org/10.1007/s13753-014-0022-5

[34] Strobl, E. (2019). The impact of typhoons on economic activity in the Philippines: Evidence From Nightlight Intensity. *SSRN Electronic Journal*. doi:10.2139/ssrn.3590202

[35] Tabuena, A. C. (2021). Preliminary Methods and Illustrative Examples in Formulating the Research Frameworks on the Research Writing Process for Senior High School Students. *International Journal of Advance Research and Innovative Ideas in Education, 7*(1), 8-15. Retrieved May 20, 2021, from https://ssrn.com/abstract=3759290

[36] Tang, R., Wu, J., Ye, M., & Liu, W. (2019). Impact of economic development levels and Disaster types on the SHORT-TERM Macroeconomic consequences of Natural Hazard-induced disasters in China. *International Journal of Disaster Risk Science, 10*(3), 371-385. doi:10.1007/s13753-019-00234-0

[37] Thapa, I. (2020). Foreign Aid: Positive and Negative Impact in Developing Countries. 10.13140/RG.2.2.19155.81448.

[38] Tuhkanen, H., Boyland, M., Han, G., Patel, A., Johnson, K., Rosemarin, A., & Lim Mangada, L. (2018). A typology framework for trade-offs in development and disaster risk REDUCTION: A case study of Typhoon Haiyan recovery in TACLOBAN, PHILIPPINES. *Sustainability, 10*(6), 1924. doi:10.3390/su10061924

[39] Tuhkanen, H., Boyland, M., Han, G., Patel, A., Johnson, K., Rosemarin, A., & Lim Mangada, L. (2018). A typology framework for trade-offs in development and disaster risk REDUCTION: A case study of Typhoon Haiyan recovery in TACLOBAN, PHILIPPINES. *Sustainability, 10*(6), 1924. doi:10.3390/su10061924

[40] World Bank. (n.d.). *Glossary*. Glossary | DataBank. Retrieved November 26, 2021, from https://databank.worldbank.org/metadataglossary/jobs/series/BX.KLT.DINV.WD.GD.ZS

[41] Xie, W., Rose, A., Li, S., He, J., Li, N., & Ali, T. (2018). Dynamic economic resilience and economic recovery from disasters: A quantitative assessment. *Risk Analysis, 38*(6), 1306-1318. doi:10.1111/risa.12948

[42] Yonson, R., Noy, I., & Gaillard, J. (2017). The measurement of disaster Risk: An example from tropical cyclones in the Philippines. *Review of Development Economics, 22*(2), 736-765. doi:10.1111/rode.12365

Appendices:

Appendix A

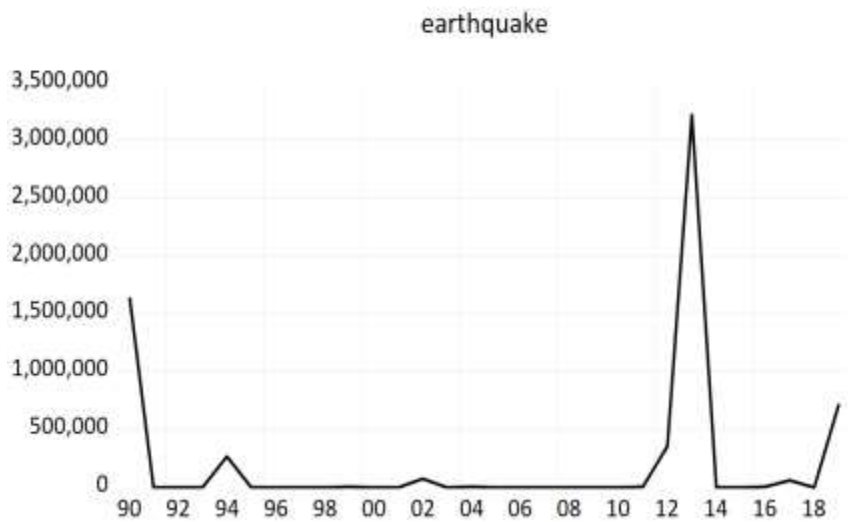

Figure 1. Total number of people affected/ killed by earthquakes in the Philippines

Source: Emergency Events Database (EM-DAT, 2021)

Appendix B

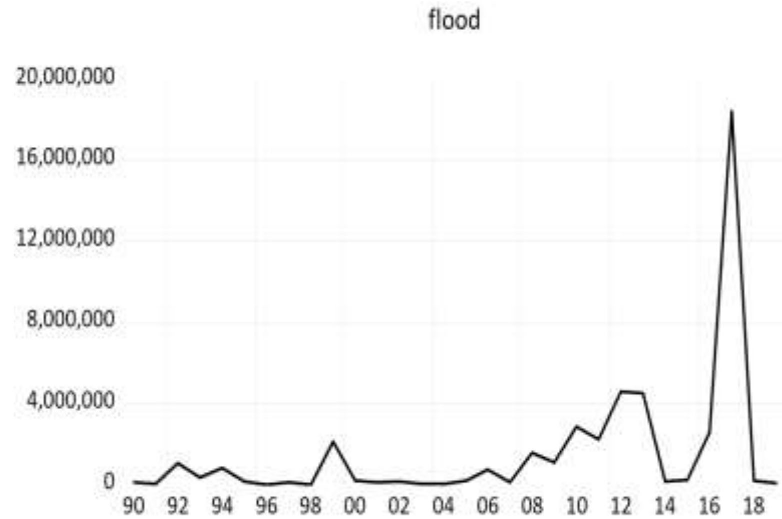

Figure 2. Total number of people affected/ killed by floods in the Philippines

Source: Emergency Events Database (EM-DAT, 2021)

Appendix C

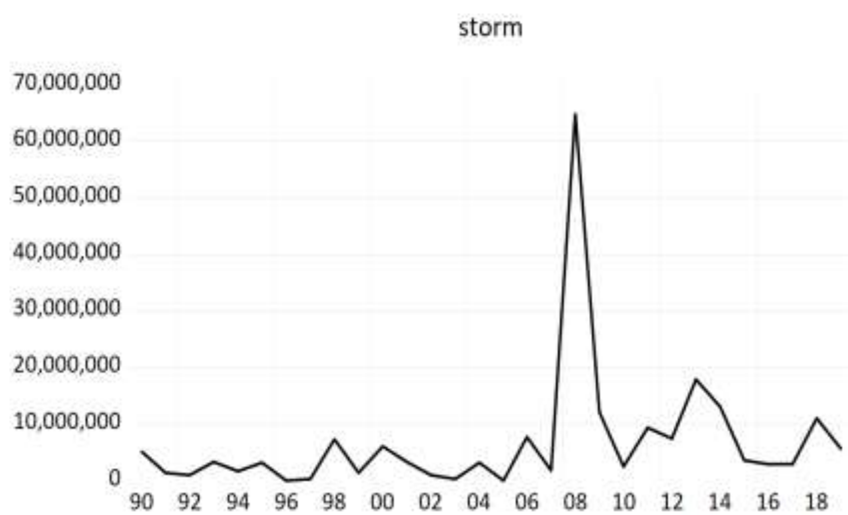

Figure 3. Total number of people affected/ killed by storms in the Philippines

Source: Emergency Events Database (EM-DAT, 2021)

Appendix D

	Natural Disasters			Economic Variables		
Year	EQK	STM	FLD	GDP	FDI	AID
1990	1630957	5209012	116662	715.913712	530000000	1143089966
1991	0	1500589	70	715.74682	544000000	949719970.7
1992	0	1037212	1053736	814.768539	228000000	1636449951

1993	0	3332157	348129	816.412324	1238000000	1390089966
1994	267006	1659506	794591	939.918638	1591000000	1008820007
1995	0	3169621	119654	1062.13306	1478000000	857570007.3
1996	0	37653	0	1160.30968	1517000000	860909973.1
1997	0	366814	105182	1127.52655	1222000000	630840026.9
1998	0	7322727	0	966.989169	2287000000	592719970.7
1999	156	1382243	2100414	1087.37816	1829000000	662549987.8
2000	0	6067470	160445	1072.80906	1487000000	552799987.8
2001	0	3350544	91343	990.563896	760000000	553179992.7
2002	73366	979343	155590	1036.15931	1769000000	553179992.7
2003	0	383132	3500	1048.00819	492000000	724770019.5
2004	380	3234624	20243	1121.48963	592000000	465010009.8
2005	0	20045	193051	1244.34904	1664000000	587760009.8
2006	0	7820954	732545	1452.43866	2707414997	595010009.8
2007	0	1922374	86787	1744.64031	2918724841	636289978
2008	0	64847207	1552964	1991.23154	1340027563	66879997.25
2009	0	12221938	1083316	1905.89471	2064620678	339690002.4
2010	0	2595624	2847075	2217.47401	1070386940	582450012.2
2011	25	9464167	2218760	2450.73366	2007150725	-135869995.1
2012	353148	7559795	4579007	2694.30547	3215415155	-3369999.886
2013	3221478	17923128	4500384	2871.4309	3737371740	192059997.6
2014	0	13067040	145135	2959.64845	5739574024	677440002.4
2015	0	3602922	231362	3001.04037	5639155962	514950012.2
2016	8	2971544	2563143	3073.65361	8279548275	283649993.9

2017	57718	2912515	18420022	3123.23423	1.03E+10	160479995.7
2018	0	11026930	180011	3252.09232	9948598824	547340026.9
2019	711188	5682374	45000	3485.08422	7685339334	905380004.9

Table 8. Raw Data of Natural Disasters and Economic Variables

Source: Emergency Events Database (EM-DAT, 2021); World Development Indicators (World Bank, 2019)

Appendix E

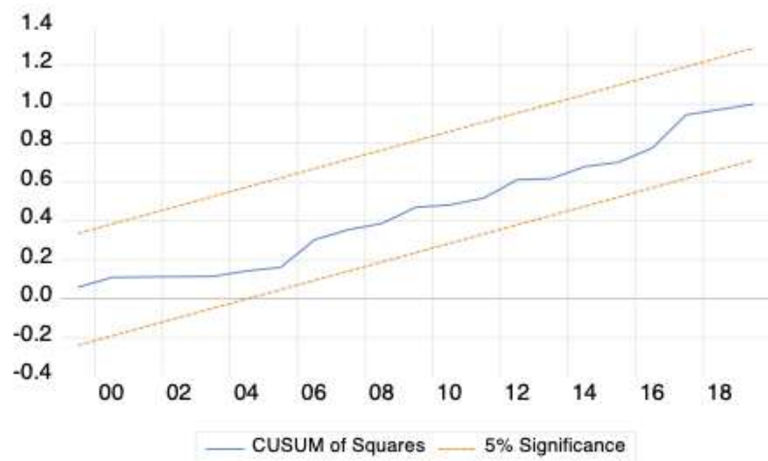

Figure 4. Results of the stability test

Appendix F

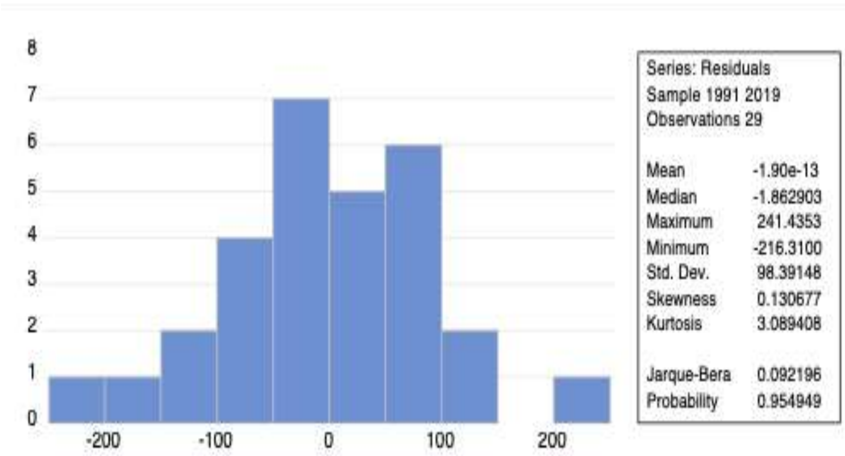

Figure 5. Results of the Jarque-Bera test