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The Short, Medium, and Long-Term Growth Effects of a Natural Disaster on Economies within the Ring of Fire

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By

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Abstract:

This paper investigates the economic impacts that natural disasters cause on countries located in the region of the Ring of Fire. Using information from 1960 to 2016, this paper adds to the current literature on the impacts that earthquakes have on economies in the short run, mid-term and long run. Furthermore, this paper investigates specifically developed and developing economies located within this region. The results indicate that overall natural disasters only impact developed economies located within the Ring of Fire in the short run and that only *ECONOMIC* and *SOCIAL* factors are the main drivers and hinderers of economic growth overall.

I. Introduction:

Whether it is meteorological, such as extreme temperature changes and storms, hydrological such as major floods and landslides, climatological such as, droughts and wildfires or geophysical such as, earthquakes and volcanic activities; all of these types of disasters affect communities in a myriad of ways. Loss of life, wiped out infrastructure, and spreading disease are some of the major issues at hand when these events hit communities. It is our responsibility as economists to assess the damages and measure the potential risks associated with natural disasters. With this information, economists seek to develop new policies to stimulate growth in lieu of these disasters. This paper's primary focus is to assess if geophysical natural disasters have an impact on economic growth. Furthermore, this paper will also look at the short, mid, and long term effects on countries' economies in the aftermath of a geophysical natural disaster. It will analyze whether or not the countries' economy is growing at a faster rate than before due to new post-disaster infrastructure and policies which help mitigate the future risks and damages associated with a subsequent natural disaster. The countries that were selected for study are located around the border of the Ring of Fire, specifically, Chile, Mexico, The United States of America, Russia, Japan, the Philippines, New Zealand, Papa New Guinea, Indonesia, Canada, Peru, China, and Guatemala. The Ring of Fire is a large area in the basin of the Pacific Ocean in which volcanic and seismic activity occur. These countries were selected due to their proximity to the Ring of Fire therefore, they tend to experience the greatest amount of seismic activity and its aftereffects thus, they bear the greatest adversities when it comes to combating economic losses.

This study investigated the effects of earthquakes on GDP per Capita growth in order to understand the impact of such an exogenous shock to a country in the short, mid, and long run. Furthermore, this paper examines the impact that earthquakes have on both developing and

developed countries in the short and long run. It was expected that a shock such as an earthquake would have severe negative effects to GDP per Capita growth within a country, however, only in the short run for developed countries did this occur; overall from this investigation no such significance appeared. For the countries selected, only social and economic factors seemed to be the main stimulators and hinderers of economic growth. Specifically, in the short run, only how democratic a country is suggested a positive and significant correlation to short run growth. In the mid-term, no factors seem to be the main drivers of economic growth. In the long-run, electric power consumption and having a high capital to GDP ratio showed to stimulate economic growth, while, trade and democracy showed to hinder economic growth. For developing countries specifically, in the short run, only electric power consumption seemed to stimulate growth while having a high private credit to GDP ratio seemed to hinder economic growth. In the long run for developing countries only social and economic factors seemed to aid and hinder growth. Both high democracy levels and high levels of trade showed to hinder economic growth while electric power consumption showed to aid in economic growth. For developed countries in the short run, disaster factors and economic factors did show mixed results in both hindering and stimulating economic growth. Furthermore, intensity factors did show to hinder economic growth severely, while social factors displayed positive results in aiding economic growth. Lastly, for developing countries in the long run, only economic factors showed to hinder economic growth.

This paper will be structured in the following fashion. Section one which has already been read will provide a brief introduction to the topic and a brief summary of results. Section two will incorporate an in depth review of past literature on the topics of growth theory, effects of natural disasters, and growth after a disaster event. Section three will discuss the methodology and analysis. Section four, five, six and seven will describe the data sources used, the results, the discussion and

the policy implications respectively. Lastly, section eight will summarize and draw an overarching conclusion

II. Literature Review:

Before investigating literature on the economic impacts on growth after a natural disaster occurs, it is important to first investigate how economic growth and development of a country operate without such exogenous shocks.

Economic Growth:

Economists have been interested in determining the exact factors that play a role in economic growth. Early development economists dating back to the mid-1900s resorted to the Harrod-Domar model as a measure of economic growth. This model suggested that economic growth was hindered due to an insufficient investment in capital that could be rectified by either investing in capital or by satisfying the inefficiencies with foreign aid (Easterly 1998). Theory on the Harrod-Domar model suggests that investment will respond to incentives to invest in the future. However, foreign aid does not change incentives to invest therefore it does not necessarily increase investments. This is due to Milton Friedman's permanent income hypothesis theory, which states that people (in this case countries) that receive a "permeant flow of aid" will not invest it (Friedman 1957). Furthermore, when the Harold-Domar model was tested there was little empirical evidence due to the fact that many countries with a large inflow of foreign aid and high initial investment showed little growth (Easterly 1998).

As an alternate model, the Solow growth model was created. The Solow model suggests that production is a function of capital accumulation, labor/human capital growth and technological progress. However, it slowly became true that it was total factor productivity (TFP)

that was the deciding factor towards economic growth. When Klenow et al. (1997) challenged the claim, they found that a majority of the countries' differences in growth rates were due to TFP growth and not capital growth. Moreover, various other economists who used cross-country and cross-time variation in growth rates found that TFP was the deciding factor on growth not the accumulation of human or physical capital (Easterly 1998).

Other economists such as Richard Easterlin believed that other factors contributed towards economic growth, such as education. Easterlin (1998) suggested that modern economic growth has depended primarily on distribution of knowledge pertaining to new production techniques. These techniques are supposedly acquired by populations that have acquired traits and motivations associated through formal schooling. Easterlin suggests this by looking at primary school enrollment rates towards formal schooling as enrollment rates have proved to be increasing in countries at a remarkable rate between the years 1830-1975. However, he seems to be missing out on numerous variables and policies that could have affected economic growth. For example, Easterlin has not looked at the factors of globalization such as, increased volume of trades between countries and improvement in the financial services and technology which can aid in growth. Education and growth might be a correlated with one another, but correlation does not imply causation.

Kenny and Williams (2001) decided to run cross country economic studies on growth. From their select review of the studies on economic growth they concluded that no model: the Harrod-Domar Model, Rostow's Stages of Growth Model, Nurkse Balanced Growth Model, or the Lewis' Unlimited Labor Model was suggested to be robust. This was due to the fact that they found these models to be ahistorical and over simplified.

Durusu-Ciftci et al. (2016) found strong evidence to believe that financial development within a country's economy promotes economic growth. From using the Solow-Swan growth model augmented with financial markets they found both debt from credit markets and equity from stock markets to be two long term determinates of GDP-per capita. Though overall all credit market had a much greater effect towards income growth there was a discrepancy between developed and developing countries. Developing countries fared better from improved credit marked developments while in highly developed countries development of the stock market is suggested to be a more powerful factor contributing to economic growth.

Overall, when assessing economic growth in countries all theories point towards investments playing a major role in stimulating economic growth. Even though the Harrod-Domar model and the Solow model have been proven to not hold completely true in robustness checks, new endogenous growth theories have suggested to be more robust when assessing economic growth. For example, countries investing in their own private financial markets and institutions, pose the greatest returns. Therefore, similar variables such as, private credit to gross domestic product (GDP), foreign direct investment (FDI), and fixed capital to GDP will be considered in the economic model of this paper.

Natural Disasters:

Over the past decade, literature on epidemics, especially natural disasters and their effects towards industries, international trade, communities' behavior and the economic growth of a country have been expanding. Natural disasters have been deemed by Governments, nongovernmental organizations (NGOs), and multilateral trading agencies as a significant barrier to economic development (Barry et al., 2014). Various studies show that natural disasters hinder

growth and trade within the country itself and towards neighboring countries while other studies show that disasters could potentially stimulate growth and cause a country to be better off than it once was (Hayakawa et al. 2015). To better understand the subject at hand a select number of papers and reports were chosen.

i. International Aid and Growth:

Kazyoshi and Hirokazu (2009), whom looked at the reconstruction costs and their effect towards long term growth after a disaster struck, found that more developed countries fared better than developing countries. Though overall, countries where a disaster did occur accumulated more external debt, countries that were in the lower income group portrayed to have higher levels of external debt on average than higher income countries. This is shown to be significant due to the fact that if lower income countries are struck by a disaster, GDP growth can be hindered due to countries having to pay back large amounts of accumulated external debt instead of being able to invest within their own economy. In addition, the study also examined how international aid and remittances affect an economy's growth after a disaster has occurred. Kazyoshi and Hirokazu (2009) concluded that countries that received daily remittances and international aid fared better than countries that did not. This can be explained because countries could have reallocated their remittances and international aid towards financing reconstruction costs. When assessing a country's growth after an earthquake occurs, international aid and remittances can likely play a major factor in the recovery process, thus, these variables will be considered within the empirical model of this paper.

Though credit constrained economies and economies that do not receive any sort of financial aid have revealed to be worse off, the role of government and government stability have also shown to mitigate risk and aid in faster recoveries. Stromberg's (2007) study, which

researched economic development, social factors and how international aid was given to disaster victims, portrayed numerous findings when it came to growth and aid. Stromberg used variables such as government efficiencies indexes produced by the World Bank to determine the quality of public services, infrastructure, and civil services. Furthermore, he used the University of Maryland's democracy index, and the Gini coefficient from the Un-Wider World Income Inequality Database. The study concluded that more established governments gave better care to the individuals that were affected and had faster recoveries. In addition, Stromberg found that economic inequality can be a significant factor when it comes to economic growth. Countries that were shown to have higher income inequality had a harder time recovering and tended to be worse off when a disaster did strike. Lastly, when looking at international aid, there seemed to be a bias towards those that did and did not receive aid. Aid typically was given to countries that have similar interests, backgrounds, and a strong trade value. Depending on the severity of the disaster, more aid was given to those that needed it most and were affected the most by a disaster. Compared to other studies, Stromberg's approach was unique for utilizing the news variable, which measured whether a disaster was covered by one of the major U.S. television networks. It showed that more news coverage on certain disasters has a direct positive correlation between whether or not the U.S. Office of Foreign Disaster Assistance (OFDA) provided aid relief. One drawback of using the news variable within the disaster relief regression is that both media coverage of natural disasters and disaster relief efforts tend to trend towards more serious disasters causing some bias. Furthermore, news coverage could potentially be affected by both similarities in culture and geographic location of the country where the disaster was being covered, thus showing another potential bias; therefore, the news variable will not be used in this paper.

ii. Financing, Education, and Infrastructure:

Access to credit has shown to play a major role in countries and their ability to grow and recover from natural disasters. Barry (2014) used a two-period model of economies that were struck by a disaster and compared the recovery differences between economies that were credit constrained to economies that were unconstrained. From comparing and contrasting the two types of economies the study concluded that economic output could be hindered due to the side effects of the disaster. The economies that were given access to credit investments were able to fully compensate for any losses to capital stock. Thus, the post-disaster economy was able to bounce back to its pre-shock and long-term growth path.

Other studies such as Toya and Skidmore (2007) suggest that this quicker recovery is because of a more highly developed financial sector which may reduce impacts due to the fact that an efficient, information based financial system is less likely to finance projects that are located in potentially risky locations. Furthermore, both authors suggest that more informed investors require more rigorous safety standards for their projects. This suggestion seems to hold true, because Horwich (2000) suggests that affordability and demand for safety rises with income, and the greater a society's income per capita the more likely it is to be correlated with a higher level of safety and disaster preparedness. This means that societies with higher incomes are already more prepared to recover from such an exogenous shock. On the other hand, economies that did have credit constraints suggested to be worse off when a disaster did occur. The economies would not be fully compensated by investment. Thus, the investment effects in credit constrained economies, usually economies that were undeveloped or developing, were permanently worse off in terms of output in the medium and long term. These results have held consistent with other papers: Kazyoshi and Hirokazu (2009), Fomby et al. (2013), and Benali and Saidi (2017). Compared to

previous literature, this study had numerous control variables such as, political stability, government size, and agriculture to GDP variables, which could have played a factor in the growth of economies thus making the results more robust. Overall, the more developed economies have shown to be better off or showed little change in output.

Although there is a better understanding of natural disasters and economic growth, Fomby et al. (2013) suggest that economic growth after a disaster is still ambiguous. Their study, which explored the effects on growth separated by disaster category, found that specific disasters and the severity of the disaster can have an effect on future growth. In their study, in which they covered 94 countries in total, 68 developing and 24 developed countries, using the Generalized Method of Moments procedure, results suggest that some disasters can have effects on the country as a whole. Disasters, in general, can be found to cause shocks on human capital and education within the communities that were affected due to infrastructure problems. For example, schools and roads being destroyed or the displacement of people due to loss of home or livelihood. Furthermore, they found that damages from earthquakes tend to have the strongest effects on physical capital. What differentiated this study compared to its preceding papers was that they used the GDP per capita for each specific segment that contributed to the economy. For example, the industries segment, the agricultural industry and the services industry were each individually regressed using a modified standard empirical growth model. Furthermore, they also controlled for educational achievement since education could play a factor in growth; the more educated individuals are in a country the more developed and faster they could recover from a disaster. Lastly, what differentiated this study from others was that they used the consumer price index (CPI) inflation rate as a proxy for macroeconomic stabilization in which countries with high inflation are deemed countries with bad macroeconomic policies. Empirical analysis concluded that natural disasters do

affect economic growth but not always negatively. This is mainly due to the fact that the less severe disasters that occurred in more developed countries or countries that were well prepared had little to no effect or increase in output. Other studies such as, Toya and Skidmore (2002) found similar findings where disasters lead to an increase in total factor productivity resulting in potential increases in output. Additionally, it was concluded that droughts and storms did have a significant impact on the agricultural industry while earthquakes overall lowered growth rates but increased industrial growth and floods, if moderate, suggest to have positive effects on growth. However, if any of the disasters were deemed severe, (meaning if the number of people affected times 0.3 plus the number of casualties is greater than 0.01% of the population) they always suggested to hinder economic growth with all the industries or have little to no effect depending on how developed the country was.

Benali and Saidi (2017) took a different approach towards economic growth after a natural disaster struck. The authors compared and contrasted electricity consumption rates in countries where a natural disaster had occurred. Using panel data from 1990-2014 of 41 countries in the European, American, and African regions they ran numerous tests consisting of a unit root test, a Pedroni Cointergration Test, a Kao Panel Cointergration Test, and a causality panel test. From their analysis they concluded that there was a direct positive correlation between economic growth and electrical consumption throughout the country. The more electricity that was consumed after a disaster occurred the greater the economic growth. The results in this paper are similar to previous studies (Barry et al. 2014, Fomby et al. 2013) because they show that less developed countries, particularly African countries, faced a much greater negative shock to their economies. This is inferred due to the fact that these countries tend to have aging infrastructure, and are poorly

prepared or informed. Thus, the variable, electrical consumption will be added to this paper's empirical model.

iii. Positive Effects of Natural Disasters:

In Toya and Skidmore's study (2002) which looked at natural disasters' effects on long-term growth and total factor productivity (TFP) where the disaster had occurred differed significantly from previous studies. They suggest that a disaster can have positive impacts to a country's economy. From their empirical analysis using cross sectional data of 89 countries and ordinary least squares (OLS) procedure, they found that climatic disasters did provide opportunities to update capital stock and adopt new technologies. This is significant for future research due to the fact that if capital stock can be updated after a natural disaster does occur, countries affected by disasters have the potential to expand and increase output within the economy. However, the drawbacks from this study were that they did not use inflation as a proxy for economic stability as suggested by Christiaensen et. al (2012) which can be a factor of growth and recovery. Furthermore, they did not consider the access to credit for individual countries as a potential variable which Barry (2014) suggests can aid in recovery and investments into new technologies which can result in greater TFP.

iv. Behavioral Effects of Natural Disasters:

It can be inferred that once a community has been struck by a natural disaster, behavioral traits of individuals change due to the new economic and community shocks. Studies conducted by Alessandra Cassar, Andrew Healy, and Carl Con Kessler (2017) have shown this to be true. In a series of various behavioral games - a trust game, a risk game and a time game - that were

organized within a small village in Thailand where a tsunami hit, individuals that were strongly affected were shown to be more risk adverse compared to those that weren't affected by the tsunami. Furthermore, from these behavioral games it was concluded that tsunamis made individuals more impatient. This potentially shows a major paradoxical dilemma and breakthrough. In areas where natural disasters are more frequent, insurance premiums tend to be higher because these areas are taking more risks. However, individuals in these same areas wish to take on less risky loans with smaller interests (Samphantharak, 2014). This can be problematic towards economic expansion due to the fact that if individuals have less access to credit and are frightened to take out loans they are less likely to rebuild new infrastructure due to the higher costs of living. Lastly, the study has also shown that when a disaster does strike, community ties become stronger. It has been shown that stronger community ties, especially the ones established pre-disaster, help reduce the negative consequences of disasters and speed up the recovery process (Aldrich et al. 2015). This is due to the fact that, in these type of communities, they have moderated focus groups that meet regularly to dialogue and discuss issues. Moreover, these communities have community currencies, time banking, and local festivals, which have shown to deepen bonding and bridge social capital. Although behavioral factors could possibly aid in faster reconstruction and help stimulate quicker economic growth these factors will not be the focus of this paper.

Contributions:

From previous literature it is clear that natural disasters' effect on economic growth or reduction is still ambiguous. When assessing a country's recovery after a disaster, results portray positive, no change, or a reduction to economic output within a county's economy. This paper's primary focus will be to expand on previous literature's models and variables in order to truly

assess whether earthquakes can promote faster GDP-growth within specific economies in order to compare and contrast which factors matter most when combatting the exogenous shock to an economy. Furthermore, this paper will be assessing all, short-term, mid-term, and long-term growth effects of earthquakes which have yet to be determined.

III. Methodology:

Current research shows that there are numerous models and variables that can be used to determine economic growth and factors that can aid in the recovery process of a disaster's economic shock. For this paper I decided to use three specific factors as the base of my regression analysis: severity factors, social factors, and economic factors. Each group has specific variables that were derived from previous literature on economic growth and economic growth after a natural disaster in order to make the model as accurate as possible.

Severity Variables:

Fomby et al. (2013) suggests that the intensity of an earthquake in a given country has a significant effect on the country's ability to grow and recover quickly. Therefore, the variable intensity must be considered when looking at the effects to economic growth. This variable falls under the severity factor of the model. Similar to the Fomby et al. (2013) study I expect that the more severe a disaster is the greater the negative impact it will have on a country's GDP per Capita.

Social Variables:

A democracy variable will also be added to the model. Stromberg (2007) and Aldrich et al. (2015) suggest that the democratic level a country of can be significant towards a country's growth. The Democracy indicator is an additive eleven-point scale (0-10). The operational indicator of democracy is derived from the coding of the competitiveness of political participation, the

openness and competitiveness of executive recruitment, and constraints on the chief executive. The higher the number, the more democratic the country acts.

Economic Variables:

Benali and Saidi (2017) found a causality between electrical consumption, economic growth, and natural disasters in their analysis. They suggested that electricity consumption increases with technological progress and industrialization. Further, an increase in economic growth leads to an increase in electrical consumption and increased electrical consumption increases economic growth. Natural disasters, specifically earthquakes, can destroy various types of power system equipment, thus, hindering economic growth. Therefore, electrical consumption must be considered when examining the model of economic growth and will be added to the economic factors.

Durusu-Ciftci et al. (2016) used the variable Bank Credit as a control for credit market development. Previous literature, Barry et al. (2014), also used this variable Credit (as a percent of GDP) to be used as a proxy for the level of financial development within a country. This variable will take into account credit issued to the private sector, not to governments, and will be computed as the ratio of domestic credit to private sector to GDP.

Lastly, control variables such as government spending to GDP, capital to GDP, labor force to population, and net exports to GDP, will be considered to examine the role of structural and stabilization polices as well as institutions. Government spending to GDP will be used to show the government's burden on the country. Capital to GDP and labor force to population will be used to control for the productivity of a country. Openness of a country will be proxied by the volume of trade within a country (exports plus imports) to GDP. Each economic factor variable will be in logs when running regressions in order to normalize skewed variables.

The Model

The basic population model is:

$$GDPPC_{i,t} = \beta_0 + \beta_1 DISASTERS_{i,t} + \omega_i + T_t + LAGEDDIFFER_{i,t} + \varepsilon_{i,t}$$

The model illustrates the relationship between the Gross Domestic Product per Capita (GDPPC in natural log form) and the disaster variables regressed using country and time fixed affects. Within the *DISASTERS* factors there are: the number of earthquake occurrences, total number of deaths caused by the earthquake, total number of individuals injured from the earthquake, the total number of individuals left homeless due to the earthquake, the total number of individuals affected by the earthquake, the total damage caused by the earthquake (in hundreds of dollars). ω represents country fixed effects, T for time fixed effects, *LAGGEDDIFFER* shows growth which is current minus lagged GDPPC and *DISASTER* factors (used in later regressions) and ε is the unknown stochastic error which captures other factors affecting gross domestic product per capita and the disaster variables. Moreover, i stands for the country that the disaster took place during year t. All future models will be regressed using fixed affects. The purpose of this paper is to test natural disasters, specifically earthquakes' impact on Gross Domestic Product per Capita, in the short run, mid-term, and long-run.

The first model will include the basic population model with the *SEVERITY* factors derived from Fomby (2013). There will be one *SEVERITY* factor that will act as a dummy variable: intensity. For each earthquake I create a dummy variable $intensity_{i,t}$ measuring the magnitude of the event relative to the size of the economy, such that the variable is 1 if the sum total number of deaths

and 30% of the total number of people affected is greater than 0.01% of the population and 0 otherwise.

Model 1:

$$GDPPC_{i,t} = \beta_0 + \beta_1 DISASTERS_{i,t} + \beta_2 SEVERITY_{i,t} + \omega_i + T_t + LAGEDDIFFER_{i,t} + \varepsilon_{i,t}$$

Model number two will add in the *SOCIAL* factors of a country. The variable that was chosen for the *SOCIAL* factors is the democracy index (explained in detail below).

Model 2:

$$GDPPC_{i,t} = \beta_0 + \beta_1 DISASTERS_{i,t} + \beta_2 SEVERITY_{i,t} + \beta_3 SOCIAL_{i,t} + \omega_i + T_t + LAGEDDIFFER_{i,t} + \varepsilon_{i,t}$$

Model three will add in *ECONOMIC* factors of an economy to model two. The variables that will be considered in the *ECONOMIC* factors are: capital to GDP, the ratio of domestic credit to private sector as a percentage of GDP, electric power consumption (in kWh per capita), government expenditures to GDP, labor force to population, and trade (exports plus imports) to GDP. All economic variables have been taken in natural logs to scale down the variation between variables.

Model 3:

$$GDPPC_{i,t} = \beta_0 + \beta_1 DISASTERS_{i,t} + \beta_2 SEVERITY_{i,t} + \beta_3 SOCIAL_{i,t} + \beta_4 ECONOMIC_{i,t} + \omega_i + T_t + LAGEDDIFFER_{i,t} + \varepsilon_{i,t}$$

The democracy index taken from the Center for Systemic Peace Polity IV Project which is used in model two and model three is an additive eleven-point scale (0-10). The operational indicator of democracy is derived from coding of the competitiveness of political participation, the openness and competitiveness of executive recruitment, and constraints on the chief executive. The higher the number on the scale the more democratic a country is considered to be (Polity IV Project Manual).

IV. DATA:

To assess the economic and community impacts of these disasters, I used the Emergency Events Database, one of the most premier databases on natural disasters, maintained by the Centre for Research on Epidemiology of Disasters (CRED) at the University of Louvain (Belgium) for the years 1960 to 2016. The selected countries are: Chile, Mexico, The United States of America, Russia, Japan, the Philippines, New Zealand, Papa New Guinea, Indonesia, Canada, Peru, China, and Guatemala. In order for a disaster to be registered on the CRED database, it must fulfill and act in accordance with one of the following criteria: (1) ten or more people were killed; (2) 100 or more people were affected; (3) a state of emergency was declared; or (4) a call for international assistance was made. The CRED database contains disasters of all types including, natural disasters, famines, epidemics, industrial, and transport accidents. One drawback from the CRED database is that only immediate fatalities are recorded. Thus, the number of deaths does not include those indirectly caused by the disasters. This is because it is vastly more difficult to estimate indirect fatalities with accuracy. A second drawback, is that it is extremely difficult to estimate human losses and monetary damages that occur. Although the database does have its limitations when it comes to accuracy of its estimations, it is still the best database available when tracking

these specific types of events. CRED complies its data from numerous sources such as, UN agencies, NGOs, insurance companies, research institutes and press agencies (Centre for Research on the Epidemiology of Disasters). Priority is given to data from the UN agencies, governments, and the international Federation of Red Cross and the Red Crescent Societies while entries are consistently reviewed for inconsistencies, redundancy and incompleteness. Lastly, CRED consolidates and updates its data on a daily basis and checks are made at monthly intervals while revisions are made at the end of each calendar year, which makes this database one of the most premier databases when accessing natural disasters.

All the information on *ECONOMIC* factors along with percent of the population with access to electricity was gathered from the World Bank Indicators of the World Bank (2017). One drawback from the using the World Bank database was there were small gaps in the data for variables of countries which could affect results. In addition to the World Bank database, I also used the International Statistical Institute in order to rank countries in the developing or developed categories. The final database that was used was the Center for Systemic Peace Polity IV Project. This database was used to gather information on political regime characteristics and transitions, specially, the Democracy Index which was used to look at the differences in democracy levels between countries.

Looking at the summary statistics (seen in Table 1), countries can differ considerably. For example, the difference between GDP per Capita between the min and the max are enormous. Ergo, there are some big discrepancies between countries that are more developed compared to countries which could be deemed undeveloped or developing. Additionally, there is a large distribution between the occurrences of earthquakes that happened in a county in a given year. Some countries received no disastrous events while other countries received up to 11 earthquakes in one year

which could be a major shock to GDP per Capita. However, though there seems to be numerous earthquakes between the years 1960-2016 that were registered on the CRED database, out of the 684 earthquakes that occurred only 217 of the earthquakes resulted in deaths, injuries, individuals being displaced, individuals affected, and damages. The reason for this is likely due to the limitations of the database when it comes to accurately estimating the effects of earthquakes. Lastly, most of the countries that were selected for this paper could fall under the category of being a developed country thus, making the results less reliable. More limitations to the model and data will be seen below in the conclusion section.

VARIABLES	(1) N	(2) mean	(3) min	(4) max
occ	684	0.547	0	11
totdeath	217	2,439	0	242,000
injured	217	4,781	0	368,412
homeless	217	36,229	0	1.824e+06
totaffect	217	505,098	0	4.737e+07
totdam	217	2.774e+06	0	2.100e+08
capgdp	654	0.368	0	100
credpriv	599	59.63	6.062	221.3
epower	509	4,715	119.4	17,235
gdp	654	8,540	70.91	57,638
govgpd	631	0.207	0.0500	41
laborpop	324	0.477	0.337	1.262
nxgdp	654	0.387	0	1.310

Comparing the summary statistics between the developing countries (seen in table 2) and the developing countries (seen in table 3) there are large variations in the data. For example, the sizes of the economies of the developed countries are much larger than the developing countries. Looking at the average sizes between the two developed countries, they are almost eight times as large as the developing countries. Additionally, the disaster variables differ considerably as well. On average, the developing countries experience double the amount of earthquakes that developed countries do. Furthermore, looking at the *DISASTER* factors between the two tables, on average

developing countries experience more deaths, injuries, individuals left homeless, and more individuals affected from earthquakes than developed countries. However, developed economies do have considerably higher cost of damages from earthquakes than developing countries; the cost of damages from an earthquake on average in a developed country are approximately eight times greater than the damages caused from an earthquake in a developing country. This is because more developed countries have costlier infrastructure.

VARIABLES	(1) N	(2) mean	(3) min	(4) max
occ	399	0.684	0	11
totdeath	144	3,434	0	242,000
injured	144	6,591	0	368,412
homeless	144	43,085	0	1.824e+06
totaffect	144	676,592	0	4.737e+07
totdam	144	837,084	0	8.549e+07
capgdp	370	0.210	0	0.455
credpriv	329	31.25	9.162	156.7
epower	245	1,285	119.4	6,673
gdp	370	2,097	70.91	16,007
govgpd	357	0.127	0.0500	0.358
laborpop	189	0.453	0.337	0.588
nxgdp	370	0.428	0	1.310

VARIABLES	(1) N	(2) mean	(3) min	(4) max
occ	285	0.354	0	3
totdeath	73	475.7	0	19,848
injured	73	1,211	0	34,531
homeless	73	22,704	0	800,000
totaffect	73	166,808	0	2.672e+06
totdam	73	6.595e+06	0	2.100e+08
capgdp	284	0.575	0	100
credpriv	270	94.20	6.062	221.3
epower	264	7,898	742.2	17,235
gdp	284	16,934	479.0	57,638
govgpd	274	0.310	0.0873	41
laborpop	135	0.509	0.377	1.262
nxgdp	284	0.334	0	0.828

V. RESULTS:

Contemporaneous Effects

Regressions demonstrated contemporaneous effects; overall it seemed that *DISASTERS* do not have a significant impact on GDP per Capita. Though simplified models do show *DISASTER, INTENSITY,* and *SOCIAL* factors had varying levels of significance, once all factors were incorporated into the model, only economic factors seemed to hinder or stimulate GDP per Capita growth.

Preliminary regressions on the basic model estimated the coefficient on occurrence and total damage were both positive and significant. Occurrence of an earthquake was significant at the 1% level, while total damage was significant at the 5% level. This suggests that there is a strong correlation between occurrences of an earthquake to GDP per capita as well as a strong correlation between total damage caused from the earthquake and GDP per capita (see Table 2). The positive coefficients imply that both occurrence and total damage have a positive impact on GDP per Capita meaning that the more earthquakes that occur and the more damage sustained from an earthquake the better off a country would be. Other *DISASTER* factors; total death, homeless, and total affected, showed the expected negative coefficients. This suggests that the more deaths caused from an earthquake, the more individuals left homeless and the more individuals affected all had a negative effect on GDP per Capita. Lastly, the number of individuals injured showed a positive coefficient, which suggests that the more individuals injured from an earthquake, the higher the GDP per Capita.

Results from more sophisticated models, models 2 and 3, where *INTENSITY* and *SOCIAL* factors were respectively added into the model, show similar coefficients in the results. Occurrence and total damage yielded positive coefficients and levels of significance. Occurrence was

significant at the 1% level in models 2 and 3 which indicates that the occurrence of an earthquake stimulates economic growth. Total damage was significant at the 10% level for both models 2 and 3 suggesting that higher levels of damages stimulate economic growth. All other disaster factors demonstrated similar significance levels and magnitudes from the basic regression. The intensity variable showed a positive but not significant coefficient and magnitude in both models 2 and 3. This contradicts previous literature, as other scholars have found that earthquakes that affect more than 10% of the population tend to have negative and significant effects to GDP per Capita. The democracy variable seen in model 3 yielded the expected positive coefficient and was significant at the 1% level. These results are similar to the Barry et al. (2014) study as they found that the more democratic a country is the better its GDP per Capita growth should be.

Results from the most advanced model, model 4, illustrated that all *DISASTER, INTENSITY,* and *SOCIAL FACTORS*, showed no signs of significance. Only *ECONOMIC* factors showed signs of significance. Occurrence, total death, number of individuals injured, and number of individuals left homeless yielded the expected coefficients suggesting that the more earthquakes, deaths, injured individuals, and individuals left homeless, the worse off a country's GDP per Capita will be. Total affected and total damage showed unexpected negative coefficients. This suggests that the more individuals affected and the more damage sustained from an earthquake, the better a country's GDP per Capita.

Intensity demonstrated the expected negative coefficient suggesting that earthquakes that affect more than 10% of the population have a negative impact on GDP per Capita. However, the intensity variable showed no level of significance, meaning that its impact on GDP per Capita is minute. Furthermore, the democracy variable had flipped its coefficient from positive to negative,

contradicting previous scholars (Barry et al., 2014). These results suggest that the more democratic a country is the worse off its GDP per Capita will be.

Results from the *ECONOMIC* factors, the main drivers and hinderers of the results showed that capital to GDP, private credit to GDP and electricity consumption yielded positive coefficients with high levels of significance. Capital to GDP, which was significant at the 1% level suggests that for every one percent increase in capital to GDP, GDP per Capita was expected to grow by approximately 0.05 percentage points. Additionally, the ratio of private credit to GDP was significant at the 1% level, suggesting that more developed markets help stimulate economic growth. For every one percentage point increase in private credit to GDP, GDP per Capita was expected to grow by 0.57 percentage points. These results are similar to previous studies (Durusu-Ciftci et al., 2016; Barry et al., 2014) in which more developed financial markets have been suggested to increase economic growth within a country. Electricity consumption, which was positive at the 1% level, shows similar findings to the Benali and Saidi (2017) study, in which they found that more electricity consumption in a country would increase economic growth. Results suggested that for every one percent increase in electricity consumption, GDP per Capita will increase by approximately 1.42 percentage points. Furthermore, labor force to population showed the expected positive coefficient but no levels of significance, suggesting that its impact is miniscule within the selected countries.

Contrary to economic growth theories, government spending to GDP was significant at the 1% level and trade portrayed no levels of significance. Both values yielded unexpected negative coefficients. This suggests that both trade and high ratios of government spending to GDP could hinder GDP per Capita growth. Specifically, government spending, which was found to be

significant at the 1% level, suggests that for every one percent increase in government spending to GDP, GDP per Capita is expected to decrease by 0.51 percentage points.

Table 4: Empirical Results Contemporaneous (Overall)

VARIABLES	(1) basic	(2) model 2	(3) model 3	(4) model 4
occ	0.330***	0.312***	0.303***	-0.00741
	(0.0593)	(0.0626)	(0.0572)	(0.0151)
totdeath	-8.08e-06	-8.76e-06	-1.48e-05*	-8.16e-06
	(8.23e-06)	(8.27e-06)	(7.61e-06)	(1.78e-05)
injured	1.76e-06	1.94e-06	1.22e-05	-2.41e-06
	(9.42e-06)	(9.43e-06)	(8.75e-06)	(3.20e-06)
homeless	-3.19e-07	-3.91e-07	-1.47e-07	-1.01e-08
	(4.31e-07)	(4.39e-07)	(4.04e-07)	(1.16e-07)
totaffect	-5.90e-09	-6.25e-09	-7.21e-08	3.30e-08
	(6.53e-08)	(6.53e-08)	(6.05e-08)	(3.05e-08)
totdam	8.61e-09**	7.94e-09*	7.75e-09*	2.41e-09
	(4.30e-09)	(4.37e-09)	(3.99e-09)	(1.71e-09)
intensity		0.152	0.0442	-0.00528
		(0.175)	(0.162)	(0.0483)
dem			0.181***	-0.0278
			(0.0277)	(0.0188)
capgdpln				0.0499*
				(0.0296)
credprivln				0.572***
				(0.124)
epowerln				1.416***
				(0.0761)
govgpdln				-0.511**
				(0.209)
laborpopln				0.158
				(0.427)
nxgdpln				-0.0569
				(0.0721)
Constant	7.311***	7.296***	6.387***	-5.399***
	(0.120)	(0.121)	(0.181)	(0.939)
Observations	217	217	214	104
R-squared	0.182	0.185	0.331	0.942
Number of country1	11	11	11	10

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Lagged Effects - 2 Years:

In my two-year lagged regression analysis there was a significant difference from the previous regressions analysis. I lagged the independent variable GDPPC and the *DISASTER* factors by two years and subtracted the lagged years from the current years while keeping the rest of the models as is in order to look at the short run impact of an earthquake. In the two year lagged models throughout all 4 regressions only the democracy variable was deemed significant and

positive (at the 5% level) in model 4 (See Table 5). Private credit to GDP (significant at the 10% level) and government spending to GDP (significant at the 10% level) showed negative coefficients. Though occurrence, total affected and total damage showed negative coefficients none were deemed significant across all level. Ergo, these results overall suggest that in the short run disasters do not have an impact on GDP growth.

However, the democracy variable showed a positive coefficient, suggesting that the more democratic countries are in the short run the better off their GDP per Capita growth. However, the more developed the financial markets are and the more government spending in the short run, the worse off GDP per Capita. Results show that for every one percentage point increase in private credit to GDP, GDP per Capita is expected to decrease by approximately 0.25 percentage points. Additionally, for every one percentage point increase in government spending to GDP, GDP per Capita is expected to decrease by slightly more than 0.72 percentage points.

Table 5: Empirical Results (Lag 2 Years, Overall)

VARIABLES	(1) basic	(2) model 2	(3) model 3	(4) model 4
occdif	0.00611	0.00524	0.00519	-0.00206
	(0.0109)	(0.0111)	(0.0111)	(0.00691)
totdeathdif	-1.90e-06	-1.97e-06	-1.97e-06	1.10e-05
	(1.53e-06)	(1.54e-06)	(1.55e-06)	(8.49e-06)
injureddif	1.36e-06	1.40e-06	1.40e-06	2.43e-07
	(1.43e-06)	(1.44e-06)	(1.45e-06)	(1.51e-06)
homelessdif	2.54e-08	2.46e-08	2.52e-08	8.12e-08
	(6.74e-08)	(6.78e-08)	(6.82e-08)	(5.01e-08)
totaffectdif	-6.18e-09	-6.46e-09	-6.50e-09	-1.94e-08
	(9.41e-09)	(9.48e-09)	(9.53e-09)	(1.41e-08)
totdamdif	8.14e-10	7.60e-10	7.64e-10	-3.18e-10
	(5.87e-10)	(6.02e-10)	(6.05e-10)	(8.31e-10)
intensity		0.0206	0.0198	0.000197
		(0.0447)	(0.0450)	(0.0330)
dem			0.00197	0.0585**
			(0.00859)	(0.0286)
capgdpln				0.0369
				(0.144)
credprivln				-0.247*
				(0.132)
epowerln				0.0976
				(0.0624)
govgpdln				-0.724***
				(0.225)
laborpopln				0.517
				(0.576)

nxgdpln				0.000844
				(0.0584)
Constant	0.130***	0.122***	0.113**	-0.842
	(0.0180)	(0.0257)	(0.0459)	(1.056)
Observations	103	103	103	61
R-squared	0.050	0.052	0.053	0.612
Number of country1	11	11	11	9

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Lagged Effects - 5 Years:

In my five-year lagged regression analysis (seen in Table 5) no factors showed any significance across all levels. Though the occurrence, number of individuals injured, and total affected variables showed negative coefficients hinting that disaster could have an effect GDP per Capita growth in the mid-term, no affect was found. Overall, in the mid-term it seems that *DISASTER, INTENSITY, SOCIAL,* and *ECONOMIC* factors did not stimulate or hinder economic grow.

Table 5: Empirical Results (Lag 5 Years, Overall)

VARIABLES	(1) basic	(2) model 2	(3) model 3	(4) model 4
occdif	0.00263	-0.00167	-0.000945	-0.0189
	(0.0245)	(0.0266)	(0.0270)	(0.0244)
totdeathdif	-5.04e-08	-8.76e-10	3.22e-08	2.76e-05
	(3.66e-06)	(3.68e-06)	(3.73e-06)	(3.44e-05)
injureddif	2.36e-06	2.20e-06	2.17e-06	-2.22e-06
	(5.01e-06)	(5.06e-06)	(5.12e-06)	(6.46e-06)
homelessdif	1.25e-07	1.21e-07	1.21e-07	2.93e-07
	(1.42e-07)	(1.43e-07)	(1.45e-07)	(1.89e-07)
totaffectdif	-2.12e-08	-2.05e-08	-2.03e-08	-3.55e-08
	(3.44e-08)	(3.46e-08)	(3.51e-08)	(5.02e-08)
totdamdif	2.61e-09	2.79e-09	2.75e-09	2.11e-09
	(1.75e-09)	(1.81e-09)	(1.84e-09)	(3.38e-09)
intensity		0.0465	0.0361	0.0442
		(0.107)	(0.111)	(0.120)
dem			-0.00137	0.0249
			(0.0236)	(0.0666)
capgdpln				0.726
				(0.656)
credprivln				0.416
				(0.302)
epowerln				0.212
				(0.186)
govgpdln				-0.0694
				(0.783)
laborpopln				-1.675
				(1.369)
nxgdpln				-0.315
				(0.201)
Constant	0.351***	0.335***	0.348***	-3.705

	(0.0381)	(0.0527)	(0.117)	(2.908)
Observations	88	88	87	52
R-squared	0.068	0.071	0.070	0.494
Number of country1	11	11	11	9

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Lagged Effects - 10 Years:

After lagging GDPPC and the *DISASTER* factors by ten years, results (seen in Table 7) showed that disaster factors in the long run have minuscule to no impact on economic growth. However, looking at the disaster variables throughout all four models the occurrence variable and the damage variable demonstrated positive coefficients, suggesting that earthquakes and damage could potentially promote economic growth from reconstruction. In support of this theory Capital to GDP and electric power consumption both showed positive coefficients and significances at the 1% level. As Benali and Saidi (2017) found and economic growth theory suggests that the more investment into capital and the more electric power consumed from a country the greater the increase towards technological progress and industrialization. The greater the increase in technological progress and industrialization the greater the increase in electrical power consumption. However, the intensity variable does show a negative coefficient throughout all models 2, 3, and 4 suggesting that this theory might not hold true in these countries.

Overall it seems that only *SOCIAL and ECONOMIC* factors seem to mitigate or stimulate economic growth in the long run. The democracy variable which yielded the unexpected negative coefficient is significant at the 1% level. This suggests the more democratic a country is in the long run the worse off its economic growth will be. Furthermore, the trade variable also showed an unexpected negative coefficient suggesting that trade actually hinders economic growth. Results showed for every one percentage point increase in trade, GDP per Capita is expected to decrease by 0.7 percentage points. Capital to GDP and electric power consumption demonstrated

the expected positive coefficients and were both significant at the 1% level suggesting that for every one percentage point increase in capital to GDP, GDP per Capita is expected to grow by 1.2 percentage points. Furthermore, for every one percentage point increase in electric power consumption, GDP per Capita is expected to increase by approximately 0.48 percentage points.

Table 7: Empirical Results (Lag 10 Years, Overall)

VARIABLES	(1) basic	(2) model 2	(3) model 3	(4) model 4
occdif	0.0158	0.0186	0.0182	0.0150
	(0.0313)	(0.0323)	(0.0328)	(0.0167)
totdeathdif	-4.47e-06	-4.40e-06	-4.17e-06	3.56e-06
	(2.92e-06)	(2.94e-06)	(3.02e-06)	(2.06e-05)
injureddif	5.79e-06	5.81e-06	5.45e-06	2.85e-07
	(3.48e-06)	(3.50e-06)	(3.63e-06)	(3.89e-06)
homelessdif	-8.48e-08	-7.17e-08	-6.67e-08	5.06e-08
	(1.70e-07)	(1.74e-07)	(1.77e-07)	(1.15e-07)
totaffectdif	-2.92e-08	-2.91e-08	-2.69e-08	-7.58e-09
	(2.46e-08)	(2.47e-08)	(2.55e-08)	(3.62e-08)
totdamdif	9.21e-10	1.11e-09	1.13e-09	1.81e-09
	(1.83e-09)	(1.91e-09)	(1.94e-09)	(1.88e-09)
intensity		-0.0489	-0.0467	-0.0669
		(0.130)	(0.134)	(0.0886)
dem			-0.0149	-0.0943***
			(0.0317)	(0.0334)
capgdpln				1.200***
				(0.317)
credprivln				-0.131
				(0.264)
epowerln				0.482***
				(0.130)
govgpdln				0.408
				(0.475)
laborpopln				1.074
				(0.826)
nxgdpln				-0.700***
				(0.126)
Constant	0.751***	0.769***	0.841***	0.607
	(0.0527)	(0.0710)	(0.167)	(1.895)
Observations	84	84	83	60
R-squared	0.061	0.063	0.066	0.818
Number of country1	10	10	10	9

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Developing vs. Developed Countries:

In order to see how the exogenous shock from an earthquake would affect developing countries and developed countries I decided to do a further investigation by splitting the countries into two categories, developing countries and developed countries. I ranked these countries as developing or developed by using the World Bank Country Classifications from the International Statistical Institute. Furthermore, due to multicollinearity between variables in the developed countries, I decided to take out the 5 year lags.

Lagged Effects - 2 Years Developing:

In my 2-year lagged regression analysis, the basic model showed no significance across all levels. Occurrence, injured, homeless, and total damage all showed positive coefficients while total deaths and total affected caused from an earthquake showed negative coefficients. Total deaths and total affected negative yielded the expected negative coefficients as more people affected and more deaths caused from an earthquake correlated with a decrease in productivity and GDP per Capita. Contrary to what some scholars have seen occurrence and total damage were positive suggesting that earthquakes can benefit GDP per Capita.

Looking at models 2 and 3, where the intensity and the democracy variables are added into the model, the disaster factor results were consistent. Occurrence, number of individuals injured, number of individuals left homeless, and total damage showed positive and insignificant coefficients while, total deaths and total affected showed negative and insignificant coefficients. Furthermore, in models 2 and 3, the intensity variable resulted in a positive and insignificant result suggesting that smaller earthquakes that only affect 10% of the population do not hinder GDP per Capita but could help stimulate it. The democracy variable, which is not significant and negative,

suggests that the more democratic the developing countries are the more it hinders economic growth.

In model 4 where economic variables are introduced, the coefficients on occurrence and total damaged were flipped and were negative coefficients as predicted. However, they were still both seen to be insignificant in the short run. Total deaths also flipped its coefficient from negative to positive, suggesting that deaths from an earthquake can increase GDP per Capita. The homeless and injured variable coefficients and magnitude remain consistent with the basic regression, which showed positive and insignificant results. Additionally, the intensity coefficients have stayed consistent throughout, which suggests that earthquakes that affect only 10% of the population have minimal effects to GDP per Capita. Results from the economic factors demonstrated that, private credit to GDP and electric power consumption were both significant at the 5% level. Private credit to GDP showed a negative coefficient, suggesting that the more developed the financial markets are in developing countries the more they would hinder economic growth. For every one percentage point increase in private credit to GDP, GDP per Capita would decrease by approximately 0.54 percentage points. Electric power consumption showed a positive coefficient; suggesting that the more electricity a developing country consumed the more the developing country's economy will be able to grow. These results are consistent with Benali and Saidi's (2017) study, in which they found that electrical consumption increases GDP per Capita growth. For every one percentage point increase in electric power consumption, GDP per Capita is expected to grow by approximately 0.2 percentage points.

Table 8: Empirical Results (Lag 2 Years, Developing)				
VARIABLES	(1) basic	(2) model 2	(3) model 3	(4) model 4
occdif	0.00739	0.00568	0.00567	-0.00116
	(0.0124)	(0.0126)	(0.0127)	(0.00780)
totdeathdif	-2.25e-06	-2.50e-06	-2.49e-06	1.51e-05
	(1.81e-06)	(1.83e-06)	(1.84e-06)	(1.49e-05)
injureddif	1.63e-06	1.80e-06	1.79e-06	1.61e-06
	(1.67e-06)	(1.68e-06)	(1.69e-06)	(1.90e-06)
homelessdif	1.02e-07	1.05e-07	1.04e-07	3.95e-08
	(1.04e-07)	(1.04e-07)	(1.05e-07)	(5.95e-08)
totaffectdif	-1.97e-08	-2.25e-08	-2.19e-08	-6.98e-10
	(3.02e-08)	(3.04e-08)	(3.07e-08)	(1.83e-08)
totdamdif	7.32e-09	8.10e-09	7.78e-09	-2.08e-08
	(1.44e-08)	(1.44e-08)	(1.46e-08)	(1.70e-08)
intensity		0.0486	0.0499	0.00524
		(0.0515)	(0.0521)	(0.0379)
dem			-0.00333	0.0390
			(0.0110)	(0.0334)
capgdpln				0.0754
				(0.210)
credprivln				-0.544**
				(0.249)
epowerln				0.195**
				(0.0924)
govgpdln				-0.488
				(0.379)
laborpopln				1.338
				(0.782)
nxgdpln				-0.107
				(0.139)
Constant	0.149***	0.129***	0.137***	0.833
	(0.0236)	(0.0319)	(0.0420)	(1.657)
Observations	72	72	72	42
R-squared	0.054	0.068	0.070	0.674
Number of country1	7	7	7	6

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Lagged Effects - 2 Years Developed:

For the developed countries, the basic regression model showed that all variables were insignificant. Occurrence, total death, and injured showed positive signs which is contradictory to what scholars would think because the more disastrous events, the more deaths caused and the more injuries sustained from an earthquake, which should reduce productivity and hinder economic growth. However, number of individuals left homeless, total affected, and total damage all yielded the expected negative coefficients as these variables should hinder economic growth.

Model 2 and model 3 illustrated similar results for the *DISASTER* factors, where occurrence and number of individuals injured showed positive signs. However, the magnitude decreased slightly for both variables and both variables were shown to still be insignificant. The total deaths variable switched its sign to the expected negative coefficient, suggesting that the more deaths from an earthquake the more it should hinder economic growth. Additionally, total damage switched its coefficient from negative to positive, suggesting that the more damage caused from an earthquake the better off a country's economy should be. However, the variable still proved insignificant in both models. Intensity was significant and negative in both model 2 and model 3, suggesting that an earthquake that affects more than 10% of the population of a developed nation greatly hinders economic growth. For both models, a one percentage point increase in intensity decreases GDP per Capita by approximately 0.24 percentage points. Lastly, the democracy variable showed its expected positive coefficient but is insignificant; suggesting that the more democratic a developed country is the better off it will be economically.

Model 4 demonstrated the biggest differences between developed countries and developing countries in the short run. All *DISASTER* factors were significant. Occurrence of an earthquake showed the expected negative coefficient and was significant at the 1% level. This suggests that for every one percentage point increase in the occurrence of an earthquake GDP per Capita is expected to decrease by 0.03 percentage points. Furthermore, total deaths, number of individuals injured, and number of individuals left homeless all yielded positive and significant coefficients. Total deaths, which flipped its coefficient from models 2 and 3 from negative back to positive and was significant at the 1% level suggests that the more deaths that occur the better off an economy will be. Additionally, number of individuals injured and number of individuals left homeless both showed positive coefficients, suggesting that the more people injured from an earthquake and the

more individuals left homeless after an earthquake the better off the economy will be. Lastly, both total affected and total damage showed the expected negative coefficients and were both significant; total affected significant at the 5% level, and total damage significant at the 1% level. These results suggest that the more individuals affected and the more damages caused from an earthquake hinder economic growth. The intensity variable's coefficient remained significant throughout all regressions and showed the expected negative coefficient. Furthermore, it was significant at the 1% level, suggesting that earthquakes that affected more than 10% of the population hinder economic growth. Democracy, which was insignificant in model 3, was significant at the 1% level and positive, suggesting that the more democratic a country is the more it will be able to stimulate economic growth in the short run.

The economic variables, Capital to GDP, electric power consumption, and government expenditures, all showed negative coefficients and significance at the 1% level. These results contradict Benali and Saidi's (2017) study because they found that the more electricity consumed by a country the greater the economic output was. Furthermore, these results contradict the Solow Growth model as capital is needed to grow GDP. The coefficients on the Capital to GDP suggested that for every one percentage point increase in Capital to GDP, GDP per capita is expected to decrease by approximately 0.56 percentage points. Additionally, for every one percentage point increase in electric power consumption, GDP per Capita is expected to decrease by approximately 2.3 percentage points and for every one percentage point increase in government expenditures to GDP, GDP per Capita is expected to decrease by approximately 1.7 percentage points. However, trade, private credit to GDP, and labor to population all yielded the expected positive coefficients and were significant at 1% level. These results are consistent with previous studies (Durusu-Ciftci et al., 2016; Barry et al, 2014)) as the openness of a country should promote shared technologies

and methods towards combatting disastrous events. Furthermore, more developed financial markets have shown to stimulate economic growth and help mitigate the effects of a disaster while a larger labor force should contribute to greater economic output. Trade, which showed a positive coefficient and significance at the 1% level, suggests that for every one percentage point increase in trade, GDP per Capita should increase by approximately 0.29 percentage points. Furthermore, for every one percentage point increase in private credit to GDP, GDP per Capita is suggested to increase by 0.23 percentage points. Lastly, labor force to population, which demonstrated a positive value and significance at the 1% level, suggests that for every one percentage point increase in labor force to population, GDP per Capita is expected to increase by approximately 4.5 percentage points.

Table 9: Empirical Results (Lag 2 Years, Developed)

VARIABLES	(1) basic	(2) model 2	(3) model 3	(4) model 4
occdif	0.00343	0.0212	0.0193	-0.0305***
	(0.0313)	(0.0304)	(0.0306)	(0.000566)
totdeathdif	3.40e-05	-7.20e-06	-1.36e-05	4.90e-05***
	(4.92e-05)	(4.98e-05)	(5.07e-05)	(1.13e-06)
injureddif	8.11e-06	5.99e-06	4.34e-06	2.75e-06**
	(1.01e-05)	(9.46e-06)	(9.71e-06)	(4.84e-07)
homelessdif	-1.93e-07	-1.89e-07	-9.65e-09	6.22e-07**
	(7.66e-07)	(7.12e-07)	(7.46e-07)	(1.08e-07)
totaffectdif	-3.22e-08	-4.70e-08	-9.29e-08	-1.89e-07**
	(2.31e-07)	(2.14e-07)	(2.22e-07)	(2.73e-08)
totdamdif	-2.61e-09	1.87e-09	2.62e-09	-3.10e-09***
	(5.02e-09)	(5.14e-09)	(5.24e-09)	(1.14e-10)
intensity		-0.240*	-0.245**	-0.0866***
		(0.116)	(0.117)	(0.00409)
dem			0.0107	0.202***
			(0.0124)	(0.00847)
capgdpln				-0.564***
				(0.0305)
credprivln				0.232***
				(0.00900)
epowerln				-2.363***
				(0.0717)
govgpdln				-1.676***
				(0.0300)
laborpopln				4.532***
				(0.274)
nxgdpln				0.294***
				(0.00964)
Constant	0.0820***	0.168***	0.0731	17.71***
	(0.0259)	(0.0479)	(0.119)	(0.756)
Observations	31	31	31	19
R-squared	0.264	0.395	0.418	1.000
Number of country1	4	4	4	3

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Lagged Effects - 10 Years Developing:

In the long run, it appears that disasters do not have any impact towards GDP per Capita once all factors are considered. Results from Table 10 show that for developing countries, in the long run, only social and economic factors stimulate or mitigate economic growth. In the basic regression model occurrence, number of individuals injured, and number of individuals left homeless showed unexpected positive coefficients. However, all variables were insignificant. Total damage was significant and positive at the 10% level; suggesting that the more damage caused from an earthquake the better off a country will be in the long run. Total death, and total affected yielded the expected negative coefficients. Total affected was significant at the 10% level. This suggests that the more individuals affected by a natural disaster the worse off a country's economy will be in the long run.

Models 2 and 3, in which *SEVERITY* and *SOCIAL* factors were added, the coefficients and the significance levels of the *DISASTER* factors were consistent throughout both models. However, in model 2 total deaths was significant at the 10% level, suggesting that the more deaths caused by an earthquake hinders economic growth in the long run. The intensity variable had a positive and insignificant coefficient, suggesting that earthquakes that affect more than 10% of the population could potentially increase economic growth. However, once again the democracy variable for developing countries was an unexpected negative coefficient, suggesting that the more democratic a country is the more its economic growth will be hindered.

In model 4, where all factors are considered, no disaster factors showed significance across all levels nor does intensity; suggesting that in the long run only economic and social factors play a role in stimulating and hindering economic growth. The democracy variable was significant at the 1% level which a negative coefficient, suggesting that the more democratic the developing

countries are the worse off they will be economically. Furthermore, trade which was significant at the 5% level was also a negative coefficient, suggesting that trade hinders economic growth for developing countries. For every one percentage point increase in trade, GDP per Capita is expected to decrease by approximately 0.54 percentage points. Lastly, electric power consumption was positive and significant at the 1% level. These results suggest that for every one percent increase in electricity consumption, GDP per Capita is expected to growth by approximately, 0.52 percentage points. These results also back Benali and Saidi's (2017) results in which they found electricity consumption increased economic output.

Table 10: Empirical Results (Lag 10 Years, Developing)

VARIABLES	(1) basic	(2) model 2	(3) model 3	(4) model 4
occdif	0.0213	0.0144	0.0143	0.00271
	(0.0295)	(0.0301)	(0.0305)	(0.0180)
totdeathdif	-4.89e-06	-5.40e-06*	-5.21e-06	3.77e-05
	(3.02e-06)	(3.05e-06)	(3.10e-06)	(3.09e-05)
injureddif	5.32e-06	5.51e-06	5.04e-06	-5.49e-07
	(3.42e-06)	(3.42e-06)	(3.51e-06)	(5.57e-06)
homelessdif	1.64e-07	1.71e-07	1.99e-07	5.89e-09
	(2.19e-07)	(2.19e-07)	(2.23e-07)	(1.40e-07)
totaffectdif	-1.13e-07*	-1.27e-07*	-1.32e-07*	1.31e-08
	(6.43e-08)	(6.55e-08)	(6.65e-08)	(4.32e-08)
totdamdif	4.96e-08*	5.57e-08*	6.00e-08*	-4.22e-08
	(2.91e-08)	(2.96e-08)	(3.04e-08)	(3.13e-08)
intensity		0.133	0.145	0.0577
		(0.124)	(0.128)	(0.0953)
dem			-0.0245	-0.0961***
			(0.0281)	(0.0324)
capgdpln				0.434
				(0.456)
credprivln				0.549
				(0.441)
epowerln				0.524***
				(0.156)
govgpdln				-0.383
				(0.787)
laborpopln				0.680
				(0.886)
nxgdpln				-0.535**
				(0.239)
Constant	0.778***	0.721***	0.781***	-4.938
	(0.0570)	(0.0773)	(0.106)	(3.126)
Observations	59	59	58	40
R-squared	0.105	0.127	0.145	0.827
Number of country1	7	7	7	6

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Lagged Effects - 10 Years Developed:

Similar to the 10 year lagged developing countries, once all factors were considered it seems that earthquakes do not effect economic growth in the long run but trade can impact economic growth. Results from Table 10 show that in the basic regression model occurrence, total death, and total number of individuals injured were the unexpected positive coefficients. However, none of the variables show any level of significance. Furthermore, number of individuals left homeless, total affected and total damage were negative coefficients, as expected, suggesting that the more individuals left homeless, the more individuals affected and the more damages sustained from the disastrous shock could hinder economic growth, but all the variables show no levels of significance.

In models 2 and 3, where severity and social factors are introduced into the model coefficients signs changes from negative to positive and vice versa are seen. Total deaths and individuals injured changed from a positive coefficient to the expected negative coefficient suggesting that the more deaths and individuals injured can hinder economic growth. However, total damage and homeless changed coefficients from negative to a positive suggesting that in both these models more damages and more individuals left homeless actually help stimulate economic growth in the long run. Furthermore, occurrence and total affected showed similar coefficients with no levels of significance. Severity factors in both models were the expected coefficients in both models, where intensity was negative and significant at a 5% level in model 2 and a 10% level in model 3. These results suggest that in the long run, earthquakes that affected up to more than 10% of the population do hinder economic growth. The democracy variable which can be seen in model 3 showed a negative coefficient, suggesting that in the long run the more democratic a country is the worse off it will be.

In model 4, where all factors are considered, *DISASTER* variables coefficients are flipped again. Occurrence for the first time showed a negative coefficient suggesting that the occurrence of an earthquake mitigates economic growth. However, the variable showed no signs of significance across all levels. Furthermore, total deaths changed coefficients again, suggesting that the more deaths caused from an earthquake in the long run the better off the country will be. All other disaster variables had consistent signs in their coefficients from models 2 and 3.

The *SEVERITY* and *SOCIAL* factors were unexpected, where the intensity variable was a positive coefficient and the democracy variable was a negative coefficient. These results suggest that in the long run developed countries that are hit with an earthquake that affects more than 10% of the population actually stimulates economic growth in the long run. However, intensity showed no level of significance. Furthermore, democracy was a negative coefficient, which suggests that the more democratic a country is the worse of its GDP per Capita growth will be in the long run. Although this variable showed no level of significance, meaning that it has little to no effect on GDP per Capita growth.

ECONOMIC factor results suggested that overall economic factors do not hinder or stimulate economic growth. However, the trade coefficient was negative and significant at the 5% level, suggesting that for every one percentage point increase in trade, GDP per Capita is expected to decrease by approximately one percentage point. Furthermore, electric power consumption coefficient was unexpectedly negative, suggesting that the more power consumed by a country the worse off it will be. Nonetheless, the variable shows no levels of significance suggesting that it does not impact GDP per Capita. Lastly, capital to GDP, private credit to GDP, government expenditures to GDP, and labor to population all showed the expected positive coefficients, but

none of the variables show significance across all levels suggesting that these variables do not hinder long run economic growth.

Table 11: Empirical Results (Lag 10 Years, Developed)

VARIABLES	(1) basic	(2) model 2	(3) model 3	(4) model 4
occdif	0.125	0.119	0.120	-0.113
	(0.147)	(0.133)	(0.137)	(0.0591)
totdeathdif	2.13e-05	-0.000213	-0.000213	5.36e-05
	(0.000169)	(0.000186)	(0.000193)	(7.63e-05)
injureddif	4.42e-05	-7.54e-06	-7.31e-06	-4.71e-05
	(3.44e-05)	(3.92e-05)	(4.05e-05)	(0.000114)
homelessdif	-1.16e-06	2.02e-06	1.90e-06	1.26e-05
	(3.66e-06)	(3.61e-06)	(3.79e-06)	(2.40e-05)
totaffectdif	-9.11e-08	-1.53e-07	-8.88e-08	-4.86e-06
	(1.01e-06)	(9.07e-07)	(9.98e-07)	(7.85e-06)
totdamdif	-5.70e-09	2.35e-08	2.33e-08	7.49e-09
	(1.67e-08)	(2.02e-08)	(2.09e-08)	(2.32e-08)
intensity		-1.353**	-1.351*	0.148
		(0.624)	(0.645)	(0.224)
dem			-0.0409	-0.506
			(0.218)	(1.717)
capgdpln				1.231
				(2.849)
credprivln				0.351
				(0.644)
epowerln				-1.660
				(1.799)
govgpdln				3.381
				(2.223)
laborpopln				20.39
				(30.45)
nxgdpln				-1.015**
				(0.301)
Constant	0.659***	1.048***	1.445	39.39
	(0.121)	(0.209)	(2.126)	(41.38)
Observations	25	25	25	20
R-squared	0.290	0.460	0.461	0.989
Number of country1	3	3	3	3

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

VI. Discussion:

All Countries:

As reported in the results above, the basic contemporaneous model demonstrated that, total deaths, number of individuals injured, number of individuals left homeless, and total affected variable were insignificant in the basic instantaneous model. However, occurrence and total damage showed to be both significant, occurrence at the 1% level and total damage at the 5% level. Thus, the more earthquakes that occurred, the greater GDP per Capita growth was. This is contrary to what one might expect due to the fact that the more earthquakes events that occur in a country

should cause hindrance in GDP per Capita. However, this paradoxical GDP per Capita growth may be due to the simplicity of the model as seen by the low R-squared value (R-squared = 0.182). Furthermore, total damage was a positive as opposed to a negative coefficient suggesting that total damage enhances GDP per Capita growth. Contrary to what one might expect, the positive coefficient of total damage was likely due to the simplicity of the model as well.

In model 2, the readings were similar to the basic population regression. Occurrence and total damage were both significant and positive, occurrence at the 1% level and total damage at the 10% level. Once again contrary to previous literature the coefficients were likely positive and significant due to the simplicity of the model and the need for more factors to be considered in order to receive a true reading on how disaster factors could impact the GDP per Capita of a country.

In model 3, occurrence, total deaths and democracy are shown to be significant. Occurrence and democracy being significant at the 1% carrying a positive coefficient while, number of individuals injured was significant at the 10% level and carried a negative coefficient. Occurrence carryed a slightly smaller coefficient than before, which could be demonstrating that we are finding a better fit for the model. Although, it still does not seem that earthquakes occurring should have a positive coefficient. However, number of individuals injured did carry a negative coefficient which stays consistent with previous literature as the more individuals that are injured the lower productivity and GDP per Capita growth. Moreover, the democracy did have a positive coefficient as expected; the more democratic a country is the more developed the country tends to be and the more economic output can be produced.

In model 4, we see occurrence showing a negative coefficient for the first time and no longer being significant at any levels. This is likely due to the model being a better fit, (R-squared

of 0.942) because the more earthquakes events that a country has, the lower the GDP per Capita growth. When *ECONOMIC* factors were introduced, Capital to GDP (significant at the 10% level), private credit to GDP (significant at the 1% level) and electric power consumption (significant at the 10% level) conveyed positive coefficients. This holds true with previous studies and economic growth models as the more capital formation a country has the greater the growth. Furthermore, private credit to GDP shows similar results to previous studies (Durusu-Ciftci et al. 2016, Barry et al. 2014), conveying the expected positive coefficient and used as a proxy for financial development, private credit to GDP which suggested that more countries with strong private credit to GDP ratios have shown to combat economic shocks better than countries with lower ratios. This is likely due to the fact that most of the countries selected were more developed countries. The positive coefficient aiding in GDP per Capita continues the ongoing trend that higher levels in private credit in a country help stimulate growth within a country. Lastly, electric power consumption showing a positive and significant coefficient shows similar results to the Benali and Saidi (2017) study. This likely suggests that the more electricity consumption in a country the greater the economic growth due to increases with technological progress and industrialization.

Although some *ECONOMIC* factors showed positive coefficients and were significant, government spending to GDP were significant at the 5% level but carried a negative coefficient. This is contradictory to previous literature and economic growth theories due the fact that government spending is usually a stimulator to economic growth. One reason for this could be that these governments could be running a large deficit and large debt to GDP ratios which can potentially hinder economic growth. Therefore, further investigation would be needed to be done in order to examine the true reasoning of why government spending hindering GDP growth in this model.

All these models looked at contemporaneous results, thus, I decided to lag certain variables specifically my independent variable GDP per Capita and my *DISASTER* factors and subtract them from the current GDP per Capita and *DISASTER* factors in order to see the overall short, mid, and long run effects that earthquakes have on GDP per Capita growth.

As reported in the results above, in the short run no disaster variables were shown to be significant towards hindering or stimulating economic growth. Though not significant, occurrence the total number of individuals affected and total damage from the disaster have a negative coefficient suggesting that disasters still could have a slight negative effect towards economic growth. However, total death, number of individuals injured and number of individuals left homeless were positive. Furthermore, looking at the *SEVERITY* factors, intensity also showed a positive but not significant correlation with to GDP per Capita growth. Therefore, it is hard to assume that disasters could have any effect towards impacting growth. Overall, in the short run, it seems that disasters do not have an impact on growth. However, government spending to GDP seems to hinder economic growth in the short run as it has a negative coefficient and is significant at the 1% level. As stated above, one suggestion could be that these governments could be running a large deficit and have large debt to GDP ratios which can potentially hinder economic growth but further investigation would be needed. Furthermore, looking at the results seen in model 4 of Table 10, private credit to GDP also shows a negative and significant coefficient, suggesting that the more developed the financial markets are in these countries the more they hinder economic growth. This contradicts previous studies (Barry et al., 2014; Durusu-Ciftci et al., 2016) that found that financial development helps mitigate the exogenous effects from a disaster and stimulate economic growth. Finally, democracy shows a positive coefficient suggesting the more democratic a country is the better it is able to grow after such an exogenous shock. These results are similar

to previous studies (Barry et al., 2014; Aldrich et al., 2015) as the more democratic a country is the better they are at handling disastrous events. This is likely to do with democratic countries voting and creating committees and open forums to discuss potential policies and procedures to help mitigate the exogenous effects. Furthermore, countries that are more developed tend to rank higher on the democracy index, thus, being more financially adept towards hindering the exogenous effects.

In 5 year lagged results, we once again see that *DISASTER* factors do not have any significance towards hindering or stimulating GDP per Capita growth. However, occurrence and total affected do show to have negative coefficients once again while number of individuals injured has a negative but insignificant coefficient. This suggests that earthquakes could potentially hinder GDP per Capita growth. However, overall, no factors, *DISASTER, SEVERITY, SOCIAL,* or *ECONOMIC,* seem to play a role in aiding or hindering economic growth.

Lastly, looking at the overall 10 year lagged results, we see that *DISASTER* factors show no signs of significance. Though the expected coefficients are all positive except for total affected which is a negative coefficient, as expected, it seems to be that in the long run disasters could actually have a positive impact on GDP per Capita growth. However, due to the fact that all the variables show no signs of significance it is still ambiguous as to whether natural disasters could positively affect long run GDP per Capita growth.

In the long run, only *SOCIAL* and *ECONOMIC* factors seem to impact a country's growth. Democracy, which showed the unexpected negative coefficient (significant at the 1% level), suggests that in the long run the more democratic a country is the worse off their economic growth will be. This could be due to the fact that a lot of developing countries either ranked low on the democracy index or changed back and forth from ranking higher to lower and vice versa on the

index while GDP per Capita was still growing, possibly affecting some results and showing that contradictions to Barry et al.'s (2014) and Aldrich et al.'s (2015) empirical findings.

Results from the *ECONOMIC* factors show similar findings to the Benali and Saidi (2017) study. Electric power consumption in the long run was significant at the 1% level, suggesting that their theory of electrical consumption increases with technological progress and industrialization, thus causing an increase in electrical consumption and increased economic growth holds true. Moreover, capital to GDP, which carried a large positive coefficient (significant at the 1% level), suggests that higher levels in of capital to GDP increase growth significantly. This makes sense as higher capital to GDP levels suggest that countries are investing in newer and more plants, machinery, equipment and buildings, thus increasing productivity and producing certain goods at a faster rate. However, trade was once again negative (significant at the 1% level), suggesting that more trade hinders economic growth going against basic growth theories and previous literature. One suggestion is that trade could hinder economic growth due to openness reaching a threshold in which too much trade could actually hinder economic growth similar to the findings in Zahonogo's (2016) study. Further investigations would have to be done in order to grasp a true understanding on the contradicting results.

Developing Countries:

Results from developing countries in both the short run and long run regression analysis suggest that natural disasters do not effect economic output; only social and economic factors do. In the short run, throughout all four models, only private credit to GDP and electric power consumption were significant (each at the 5% level). Private credit to GDP conveyed the negative unexpected coefficient, which suggests that increases in financial market development actually

decreases GDP per Capita growth. This is likely due to a similar threshold theory in which some countries whose private credit to GDP growth is past the threshold could actually hinder economic growth, especially when the threshold is reached and a recession has occurred within the country. However, further investigation would be needed to truly understand what might cause this. Nonetheless, electric power consumption did show positive effects on developing economies suggesting that Benali and Saidi's (2017) theory on electrical consumption increases technological advances thus, increasing economic output could hold true in the short term.

Long run results do show that *DISASTER* factors are significant in the basic model, model 2 and model 3, although when economic factors are introduced in model 4 all significant levels from the disaster variables disappear. This suggests that *DISASTER* factor impacts in the long run are miniscule or have no true impact on GDP per Capita growth. However, *SOCIAL* and *ECONOMIC* factors seem to play a significant role in economic growth. Democracy, which shows the unexpected negative coefficient (significant at the 1% level) suggests that the more democratic a country was the worse off its GDP per Capita growth. This could be due to various reasons: 1) There were missing data points within the data 2) The developing countries tended to rank lower on the democracy index 3) China and Russia, the economic powerhouses that ranked low on the democracy index, could have skewed some of the results due to their significantly larger sized economies. Furthermore, trade, which was significant at the 5% level, continued to show a negative impact on GDP per Capita growth in the long run. This is could be a result of Zahonogo's (2016) trade threshold theory due to the fact that previous studies (Barry et al., 2014; Benali and Saidi, 2017; Durusu-Ciftci et al., 2016) have shown trade to increase economic growth in the long run.

Lastly, electric power consumption has shown to stay consistent with previous short run results and literature; consumption has positive effects to GDP per Capita growth and is significant at the 1% level. Moreover, in the long run the magnitude of the coefficient has increased significantly compared to the short run results suggesting that electrical power consumption has a significant impact on GDP per Capita growth in developing countries.

Developed Countries:

From the results in model 4, seen above in Table 9, *DISASTER* factors have significant impacts towards economic growth and can be both positive and negative. Occurrence, total affected and total damage all show the expected negative coefficients; occurrence and total damage significant at the 1% level while total affected is significant at the 5% level. This suggest that these variables have significant hindrances to economic growth of the developed countries in the short run. The higher the number of occurrences, total deaths, and total affected has a direct negative impact on economic growth to individuals in developed countries. However, some *DISASTER* factors, specifically, number of individuals injured, number of individuals homeless, and total deaths showed unexpected positive coefficients and significance levels at the one and five percent levels. I believe these positive coefficients are due to the fact that there is a significant decrease in observations resulting in bias within the results. Further investigation would be needed to see how these specific disaster variables could have positive outcomes to GDP per Capita growth.

INENSITY and *SOCIAL* factors were significant at the 1% level in model 4, while intensity shows significance in the at the 10% level in model 2 and 5% level in model 3. Intensity throughout all 3 models shows the expected negative coefficient suggesting that when earthquakes affect more than 10% of the population they show to have dramatic negative impacts to GDP per Capita growth.

These results are similar to previous studies (Barry et al., 2014; Benali and Saidi, 2017) as more intense disasters tend to have larger negative impacts towards growth. Democracy, which shows the expected positive coefficient, suggests that the more democratic the country is the better off its GDP per Capita growth will be.

Looking at short run results of the *ECONOMIC* factors, all *ECONOMIC* factors are significant at the 1% level for developing countries. Capital to GDP, electric power consumption and government spending have the unexpected negative coefficients suggesting that increases in these variables will have a significant hindrance to economic growth within developing countries. This could be due to the fact that in these developed countries they are using capital, government spending, and electricity inefficiently resulting in the negative coefficients or because natural disasters have such a significant impact on the destruction of capital and electricity consumption, results in a decrease in economic output as seen in the Benali and Saidi (2017) study. Moreover, private credit to GDP, labor to population, and trade show to have the expected positive coefficients suggesting that these variables significantly increase GDP per Capita growth. This is expected, as developed countries tend to be the winners that benefit most from trade. Furthermore, developed countries tend to have much higher private credit to GDP ratios suggesting that they are more financially developed, as Durusu-Ciftci et al.'s (2016) study suggests countries with more developed financial markets tend to mitigate and stimulate growth after a natural disaster occurs. Lastly, higher labor force to population ratios suggests more workers are contributing to economic output. Ergo, stimulating economic growth significantly in the short run.

Long run results (seen in Table 11) of the developed countries portray a much different picture compared to the short run results. In the long run, disasters are suggested to have minimal to no impact on developed countries growth. Throughout all four models no disaster variable

showed any level of significance and due to the coefficients of the disaster variables changing from positive to negative throughout all four models it seems that disaster variables seem to play a minimal role in mitigating or aiding economic growth. However, the negative coefficients on occurrence, number of individuals injured and total affected do show the expected negative coefficients suggesting that they do in fact hinder economic growth. Due to the fact that the variables were insignificant across all levels it is still unclear as to whether or not disasters impact economic growth. Moreover, the intensity variable did show levels of significance at the 5% level in model 2, the 10% level in model 3 and portrayed the expected negative coefficient; however, in model 4 it did change its coefficient from negative to a positive and was not significant across all levels suggesting that when an earthquake affects more than 10% of a population the impact to economic growth in minute or shows no impact. Overall, for developed countries in the long run disaster factors do not play as significant a role to hindering or stimulating economic growth as they do in the short run.

SOCIAL and *ECONOMIC* factors also seem to have a minimal impact on economic growth. Democracy does however, show the unexpected negative coefficient in both model 3 and model 4 suggesting that the more democratic a country is in the long run the worse off its economic growth will be. However, both models show the variable is insignificant in both model 3 and model 4. I believe this variable is showing these results due to the fact that there is a smaller pool of countries causing bias in the results, resulting in the coefficient showing a negative sign. Results across all *ECONOMIC* factors display that only trade was significant at the 5% level showing the unexpected negative coefficient suggesting that for every one percentage point increase in trade, GDP per Capita is expected to fall by approximately one percentage point.

Limitations of the Model:

When examining these models, the countries that were chosen may have had various other factors that could have altered GDP per Capita such as, other natural disasters, wars, or fiscal and/or monetary policy implementations. Furthermore, the results might have been slightly affected by small gaps in the data for variables of some countries. Additional variables could have been added to the model to enhance it, such as, the GINI index to measure inequality within the selected countries and the corruption index which measures the level of corruption within a country, the World Bank's Control of Corruption: Percentile Rank to measure corruption in the country, and Depth of Credit Information Index that measures rules affecting the scope, accessibility, and quality of credit information available through public or private credit registries. These variables and similar variables have been considered in previous literature (Stromberg, 2009; Barry et al., 2014) and have shown to have a significant impact on economic growth when a natural disaster occurred, however I did not want to dilute the model.

Additionally, more countries could have been added to the model to show a greater diversity within the selected countries. Most of the countries selected tended to be skewed towards being developed compared to undeveloped or developing countries, which could have caused disaster variables to carry less of a weight due to the fact that previous literature has shown that more developed countries have higher safety standards, warning systems, and better technology to cope with the effects of a such an economic shock.

Furthermore, in areas where disasters are more frequent, including undeveloped and developing societies, Aldrich et al. (2015) have also shown that when a disaster does strike, community ties become stronger. Ergo, it has been suggested that stronger community ties, especially the ones established pre-disaster, help reduce the negative consequences of disasters

and speed up the recovery process. This is due to the fact that in these types of communities they have moderated focus groups that meet regularly to dialogue and discuss issues. Future studies should compare whether or not a country has such a group or committee in place in order to express how the country can combat the exogenous events. Additionally, future studies should compare and contrast the differences between developed and undeveloped countries instead of grouping them together. Lastly, because other sub-type disasters such as, tsunamis following an earthquake were not considered in this paper, it is hard to determine whether earthquakes could be the main exogenous shock towards hindering or stimulating economic growth. One suggestion could be the limited number of observations causing inaccurate results. Another suggestion could be Zahonogo's (2016) trade theory threshold in which once a trade threshold is past countries start seeing diminishing returns to trade. Further investigation would need to be done to show a greater understanding of why trade is showing the unexpected negative coefficients in this regression analysis.

VII. Policy Implications:

Though overall earthquakes seemed to have a minute impact on economic growth, some measures can still be taken when trying to mitigate risks of the natural disasters. Aldrich et al.'s (2015) study finds that countries that are more democratized have better governance and fewer casualties when facing the impact of natural disasters. Due to such societies being able to communicate better, share disaster risk information more willingly, develop early warning systems, and set up infrastructure and other risk management mechanisms to prevent or mitigate the impact of disasters, it could benefit countries to look towards more democratic ways and solutions.

For developing countries, setting up micro-finance institutions could prove to be monumentally beneficial towards reconstruction and growth. As micro-finance institutions can set

up microcredit programs in which individuals could have a flexible repayment system allowing members to reschedule installments during disasters periods. Furthermore, Howich (2000) suggests that governments of the developing countries should focus on building and maintaining the public goods safety infrastructure and improving building codes, which becomes more generally cost effective. Governments should be prepared to mandate their adoptions as this could prevent any negative externalities posted by stragglers.

Lastly, because insurance premiums tend to rise after a disaster occurs in these areas, individuals are less inclined or cannot afford insurance, thus, lowering the number of individuals insured by 20-50 percent as stated in Samphantharak (2014). Therefore, Kunreuther (1996) suggests that incentives such as premium reductions, lower deductibles and higher limits of coverage should be given to individuals living in hazard prone areas and countries in order to encourage them to adopt cost-effective measures voluntarily. Though insurance can be costly, in almost all cases it is better to be covered then to have to pay to rebuild out of pocket.

VIII. Conclusion:

Results from the 4 series of regressions, when all the countries were grouped together, suggest that earthquakes overall have a little effect on economic growth for the selected countries located within the Ring of Fire. Whether the earthquake was considered intense or mild, these countries seemed to be able to persevere through the exogenous shock in the short, mid, and long-run, due to no disaster variable showing constant significance throughout the series of regressions. From this analysis it shows that social factors and economic factors are the main stimulators and hinderers of economic growth. In the short-run, only the democracy, private credit to GDP and government spending to GDP variables portrayed a significant factor to growth. Results conclude that the more democratic a country the better it is able to grow. Private credit to GDP and

government spending to GDP, carried the unexpected negative coefficient suggesting that for the countries selected the greater the burden that government carries and the better the financial markets are, the worse off the countries will be. This contradicts Durusu-Ciftci et al. (2016) and Barry et al. (2014) studies as they found that more advanced financial markets and government spending stimulates economic growth.

In the mid-term, the trend of disasters not having a significant role in economic growth still holds true. In this time period, no factors were deemed significant, suggesting that out of the variables selected, none seemed to be hinderers or stimulators to the selected countries in the mid-term. In the long-run, where GDP per Capita and the *DISASTER* factors were lagged by 10 years, there was a large amount of variability in the significance of the variables. Looking at the long-run when all factors are considered, democracy, capital to GDP, electric power consumption (per kHw), and trade are seen to be the true stimulators and hinderers of a country's economy. Capital to GDP and electric power consumption all showed to be simulators of an economy in the long-run.

Results from the 4 series of regressions specifically for the developing countries show similar findings to the overall results. No disaster variable showed signs of significance towards hindering economic growth in the short or long run. For developing countries only *ECONOMIC* factors seem to drive and hinder economic growth. Surprisingly, the more financially advanced the developing countries were, the more it hindered economic growth, while the more electricity consumed suggested increases in growth. Looking at the long run, when all factors are considered, only *SOCIAL* and *ECONOMIC* are seen to stimulate and hinder economic growth. Democracy and trade hinder economic growth, suggesting that the more democratic these countries are and the more they trade the worse off they were economically. However, electricity power consumption

increases economic growth in the long run suggesting that the more industrialized and tech savvy the developing countries become the more their economies will prosper.

Finally, results from the developed countries paint a much different picture. In the short run regression analysis when all factors were considered, all disaster variables showed signs of significance. Occurrence, total affected, and total damage all showed the expected negative coefficients suggesting that earthquakes can greatly impact economic growth in the short term. Furthermore, when looking at the intensity variables, when the earthquakes affected more than 10% of the population it also showed a larger hindrance to economic growth. Looking at the *SOCIAL* and *ECONOMIC* factors the more democratic the developed countries are to be the better off they were economically. Moreover, for the developed countries selected, *ECONOMIC* factors both hindered and stimulated growth but the main driver seemed to be the ratio of labor force to population, which carried the largest coefficient suggesting that, in developed countries, having a strong and large labor force increases economic growth significantly. Looking at the long run effects, results show that disasters have no effect towards hindering economic growth. However, looking at other factors the only variable that seemed to impact growth was trade for the developed countries suggesting that trade hinders economic growth in the long run.

There are many future directions of this study, as outlined in the "Limitations of the Model" subsection of section VI, however, in the future I would like to analyze and study different natural disasters and more variables to determine whether or not natural disaster events have a significant effect on GDP per capita growth. Furthermore, it would be interesting to analyze the countries independently to see if the effect of the variables on GDP per Capita growth varied among the different countries. Finally, I would like to determine how these countries withstand the effects of the natural disaster events, at times multiple events, with no effect on GDP per Capita growth.

As illustrated in the results and analysis, overall, earthquakes have no significant effect on GDP per Capita growth in the selected countries. Because these countries border The Ring of Fire, it was thought that their economies would be significantly impacted by the number of natural disaster events they experience. However, from the data analysis this is not seen to be true. Upon closer inspection of the data it could be said that some variables affect GDP per Capita growth more than others in the short, mid, and long term as stated above. However, no factor globally affects the overall GDP per Capita growth of the economy either positively or negatively. When looking at developing countries, I see much of the same in which disaster factors do not impact economic growth in the short or long run. For developed countries, I do find that disasters do greatly impact short term growth but in the long run have no effect. In conclusion, the selected countries are able to cope with the effects of a natural disaster regardless of its severity with no penalty on GDP per Capita growth. Developed countries do show that disasters impact them greatly in the short run but not in the long run, as no disaster variable suggested to be significant positively or negatively.

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