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The Economic Development Impact of Natural Disasters in APEC Countries (1999-2013)

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Previous empirical literature has found that income reduces disaster risks in forms of human loss. This study will add socio-economic variables, such as trade openness, size of government and corruption level as well as economic damages as another disaster impact measurement. This study utilizes disaster impact data over 15-year span on 18 APEC economies and has found that, applying pooled least squares, random and fixed effect model, human losses and economic damages as forms of disaster risks are reduced by higher income per capita, higher educational attainment and trade openness, added with smaller government size and lower corruption level.

Keywords: Economic Development, Natural Disasters, Trade, GDP per capita, Government Expenditure, Corruption, APEC

1. Introduction

The strings of natural disasters have brought devastating impact on the affected countries. For either high, middle, or low-income countries, the tremendous power of nature has managed to disrupt the economies through generating both severe human and economic losses. Huge natural disasters worldwide including the tsunami that hit coastal regions of Southeast Asia in 2004, hurricanes in the coastal United States and the Caribbean, as well as floods which are disasters with high level of occurrence in some countries, have acted as shocking reminders that

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nature could affect deaths and economic damages in all countries altogether.

Between 1970 and 2001, natural disasters in global scale killed an estimated of 2.69 billion people and led to US$955 billion in economic damages (Kellenberg & Mobarak, 2008), and the number remains enormous even until current period. Through available evidences, it is very important for the damage impacts caused by natural disasters to be taken into full consideration by each country. The world has witnessed that APEC, as an economic cooperation of Asia-Pacific region that accounted for 56 percent of global economic output in 2011 and comprised nearly three billion people in 2011 and 44 percent of global trade, during the past 10 years has suffered significantly from the disaster events generating significant human, financial, and economic losses.

Natural disasters such as earthquakes, floods, tsunamis, and volcanic eruptions are common threats to many countries in the Asia-Pacific region that sit on the so-called "Pacific Ring of Fire", an area of high volcanic and seismic activities surrounding the basin of Pacific Ocean, which is home to over 75 percent of the world's volcanoes and 90 percent of the world's earthquakes (TFEP, 2008).

In 2012, seven of the ten costliest disaster events, measured by overall losses, occurred in APEC economies (OECD Secreatriat, 2013). Collectively, Japan and the 20 other APEC member economies that are home to about three billion people were hit by over 70 percent of natural disasters worldwide. As for the economic damages incurred, APEC member economies suffered US$68 billion annually in related costs from 2003 until 2013. Economies in APEC are thus extremely devastated by disasters.

As economies develop, the impact of natural disasters in a form of human losses and economic damages from natural disasters shall be diminished. The logic is that as an economy develops, it devotes greater resources to safety including implementing precaution measures designed to reduce the impacts of natural disasters (Toya & Skidmore, 2006). Income level and other variables of economic development are also better off, thereby helping to reduce the impact. Thus for an economy to be better managed and able to mitigate the damage caused by the disasters, its development is truly critical. Another study by Padly et al. (2010) accentuates the

significant impact of income in reducing the disastrous effect of natural disasters. It follows Rasmussen (2004) and Kahn (2005) who also find that countries with higher per capita income are relatively less impacted by the catastrophic event.

According to UNDP, countries might face similar pattern of natural disasters, but they often experience widely differing impacts when disasters occur. As countries become more prosperous, they are often better able to afford the investments needed to build houses and infrastructures that are more likely to withstand earthquakes, for example, in comparison with the less prosperous ones. It is intriguing then to find out the impact of economic development and reduction in natural disaster impact.

A study conducted by Kellenberg and Mobarak (2008) on natural disaster, using a country-year panel data set, indicates that there is a non-linear relationship between disaster risk and income level. Kellenberg and Mobarak (2008) argue that disaster risk exposure might increase with rising income in low-income countries due to urbanization and development (p.789). And facing downturn, as countries get richer due to better institutions, infrastructure, better construction in dwellings and technologies as well as safety concern development.

Based on a cross-sectional sample of countries in 2004, UNDP reports on disaster risks reduction provide evidences on how economic development (GDP per capita and the Human Development Index) has negative correlations with deaths caused by natural disaster events in a country.

Previous literature by Toya and Skidmore in 2006 argues that countries with higher economic development experience fewer losses overall and that other indicators beside income, such as educational attainment, trade openness and government expenditure, play a big role in mitigating the disaster damage. Richer nations also claim to suffer less deaths and damages according to Kahn (2005), although they do not experience fewer disasters compared to poor countries.

This research is premised on the belief that as economies develop, the process of development itself will cater reduction upon natural disaster impact. Specifically, the study will see how APEC countries' level of development, ranging from developing to developed countries, affects its

vulnerability to natural disasters during 1999-2013. In differentiating this study with the prior ones, the period used will be renewed and the observed countries will be narrowed down into 18 of APEC member economies. Considering APEC member countries have suffered massive amount of natural disasters followed by related tragic losses and yet the understanding of their relevance to economic development is still poor, it is thus interesting to conduct a study on this issue and concentrating on APEC as the subject.

2. Economic Development and Natural Disaster Impact

Basic Development Indicators

A very wide variety of indicators then can be used to characterize the difference between developed and developing countries. However, according to (Todaro & Smith, 2012), there are basic indicators of three aspects of development: real income per capita adjusted for purchasing power; health as measured by life expectancy, undernourishment, and child mortality; and educational attainments as measured by literacy and schooling.

Natural Disasters and Damages

Natural disaster is defined as a serious disruption triggered by a natural hazard causing human, material, economic or environmental losses, which exceed the ability of those affected to cope (UNDP, 2004). It refers to natural processes or phenomena occurring in the biosphere that may constitute a damaging event.

The Centre for Research on the Epidemiology of Disasters (CRED) defines a disaster as a "situation or event, which overwhelms local capacity, necessitating a request to national or international level for external assistance; an unforeseen and often sudden event that causes great damage." Natural disasters as defined by CRED are further classified into several groups, namely stated in the table 2.1 below.

Table 2.1: Natural Disaster Classifications

Disaster Subgroups	Disaster Main-Type	Disaster Sub-Type
Geophysical	Earthquake, Mass movement, Volcanic activity	Ground shaking, Tsunami, Ash fall, lahar, lava flow
Meteorological	Storm, Extreme temperature, Fog	Thunderstorm, Tornado, Wind, Freeze
Hydrological	Flood, Landslide, Wave Action	Coastal, Riverine, Ice jam Flood, Avalanche (snow, debris, mudflow)
Climatological	Drought, Glacial lake outburst, Wildfire	Forest Fire, Land Fire
Biological	Epidemic, Insect infestation, Animal accident	Bacterial, viral, fungal, parasitic prion diseases
Extraterrestrial	Impact, Space weather	Airburst, shockwave

Source: OFDA/CRED EMDAT classification

Each of the five types of natural disasters that will be used in this study can be defined according to various sources. Floods are defined as significant rises of the water level in stream, lake, reservoir and coastal region (Kahn, 2005). Earthquakes are sudden breaks within the upper layers of the earth, sometimes breaking the surface resulting in the vibration of the ground (Kahn, 2005). Webster et al. (2005) define storm as a violent disturbance of the atmosphere with strong winds attaining surface wind speeds between 18 and 33 m s^{-1}. Lastly, landslides are defined as sliding movements on the earth's surface (Lakakis, 2009).

Types of Damages

Disasters present a broad range of impacts, with potentially long-lasting, multi-generational effects. In other words, natural phenomena do not only produce immediate apparent effects, but they also unleash aftereffects that evolve slowly or emerge a relatively long time after the disaster has

occurred. In addition to causing direct damages to lives, buildings, equipment and infrastructure, they may produce major indirect consequences such as business interruption, loss of employment and output, and the like. Consequently, such classification of natural disasters' damages exists.

Expressed in simplest terms based on ECLAC report on estimating damages from disasters, a disaster could affects assets (direct damages); the flow for the production of goods and services (indirect losses); and the performance of the main macroeconomic aggregates of the affected country (macroeconomic effects).

Table 2.2: Comparisons between Types of Damages

Direct Damages	Indirect Damages	Macroeconomic Impact
Damages to home and content	Business interruption	The loss of the sector's contribution to the development growth rate of the national or local economy
Damages to firm structure, inventories and content	Losses in industrial and farming production	Effects on employment (labor force)
Damage to infrastructure	Costly adaptation from loss of use (i.e. greater transportation costs)	Effects on the external sector
Mortality and injury	Mortality and morbidity	Effects on public finances
Environmental degradation	Decreased tax revenues	Effects on prices and inflation
Emergency response and cleanup	Impaired institutional capacities	

Source: Kousky, Carolyn; Informing Climate Adaptation; and ECLAC; further processed

3. Links between economic development and natural disaster risk

Up until today, the development on literatures that link natural disasters with economic development is becoming more apparent. Not only impact measurement of natural disaster toward economies, but it is also growing critical to measure the relationship in reverse. The higher the economic development, the lesser will that particular economy suffer from higher level of death counts and economic damages caused by natural disaster event.

It is only natural to state that as economies advance, the impacts in forms of deaths and economic damages from natural disasters shall move in the opposite direction. The logic is when a country gets richer, there will be a better chance for it to survive due to better logistics. By measuring the economic development impact on human losses and economic damages from natural disasters do experience fewer losses. The authors' main objective is to show that higher income followed by high education, greater openness, more complete financial systems and smaller government is also important. The study is conducted using annual data across 151 countries over the 1960-2003 period.

Adding prior findings, one of the most visible conceptual links between economic development indicators and natural disaster impact is that as GDP per capita increases, the numbers of deaths are reduced along the way. Kahn in 2005 has found that richer nations do not experience fewer disaster shocks than the poorer nations, but they do suffer fewer deaths from natural disasters and has concluded that there exists a negative relationship between GDP per capita and deaths from natural disasters. One of the possible reasoning is when income per capita increases, people will demand homes that are located in safer communities and are built on stronger and durable material, thereby helping to reduce death counts (Kahn, 2005).

Another possible link would be, according to Kellenberg and Mobarak study in 2008, that in metropolitan areas, disaster impact may be mitigated by larger number of people having access to more adequate economic and social institutions, well designed infrastructure, and competent urban planning, which are not found in more rural locations (p. 792).
Following Kellenberg and Mobarak study, development may also lower disaster risk exposure by raising the quality of education and access to

health care (p. 792). Education level serves as one of the standard measurement of economic development, which holds certain impact upon disaster risk. Kellenberg & Mobarak (2008) however find that there is a nonlinear relationship where disaster risk, associated with flooding, landslides and windstorms, increases with incomes up to GDP per capita levels of $5044, $3360, and $4468 per year respectively and decreases after that (p. 795). They argue that disaster risk might increase with rising income in low-income countries due to urbanization and development. While the downturn in disaster damages as countries get richer due to better institutions, infrastructure, better construction in dwellings and technologies as well as safety concern development.

A better-developed economy followed by a higher level of education (Toya & Skidmore, 2006), where in this study is indicated by mean of total years schooling, implies that citizens are able to make better choices with safety concern on location decisions that subsequently result in fewer deaths from disasters (p. 22). Educated populations are also naturally more capable of circulating information and relaying risk prevention measures (UNDP, 2004).

Greater openness from trade that represents the degree of competition and transfer of technological knowledge from abroad might also lead to a reduction in damages risk from natural disasters (Toya & Skidmore, 2006). A higher degree of technological transfer would ameliorate disaster prevention program and improve building codes, thus reducing disaster impacts.

Another conceptual link, according to Toya and Skidmore findings in 2006, a larger government, measured from its expenditure, may indicate greater public assistance; hence stronger social response mitigating disaster risk. Infrastructure and structural soundness of a building should also become better made as the general government spending grows and therefore leads to a reduction in human loss and monetary damages related to disasters. Richer nations with higher economic development and large government may also invest in specific technology, for instance computer modeling of storms which spreads early warning information before the storm hits shore and thus saving lives (Kahn, 2005, p. 277). Kahn also believes that government corruption could increase deaths counts through the lack of enforcement of building codes, zoning, and infrastructure quality.

However, higher general government expenditure, or the larger the size of the government, the less efficient it might become in handling disaster response. For instance, the victims of Kobe Earthquake in Japan, studied by (Horwich, 2000), received slow government response.

Apart from its positive sides, economic development however may also pose significant impacts on environmental quality and effects of natural disasters according to (Kellenberg & Mobarak, 2008). For example in some South and Central American countries, (p. 792) where destruction of forests occurred due to pressure in developing agricultural land, the populations are more exposed to floods and landslides risks.

The last relevant findings would come from Padli & Muzafar (2009) who discover results suggesting that the relationship between disaster losses and the level of economic development is nonlinear in nature. Moreover, reporting that at lower income level, a country is more disaster-resilient, but at higher income level, an economy becomes less disaster-resistant.

4. Empirical Model

This study employs *pooled* data on selected natural disaster events and macroeconomic data act as a proxy of economic development of each country across 15-year span (1999-2013) and then the data collected will be limited to this period only. The data utilized in this study will be secondary data for all experimented variables, including natural disaster impacts and economic development indicators data. Natural disaster impacts as dependent variables are labeled into total human loss and missing (DEATHS), but for presumed dead and (Econ_Damages) monetary damage caused by natural disaster events, the data will be obtained from the EM-DAT database by OFDA/CRED, which has proven to be a very useful tool for analyzing human losses or monetary damages caused by natural disasters (Felbermayr & Gröschl, 2014).

As for the macroeconomic data that act as independent variables, different sources will apply for certain variables. *GDP per capita* (PCGDP) that reflects income per capita, *Trade openness* (OP) as a percentage of GDP, size of government as indicated by *general government expenditure per GDP* (SIZE) are extracted from the World Bank database. While *Corruption Perception Index* (CPI) that measures perspective of

corruption level in a country is obtained through Euro-Monitor International from Transparency International.

The selected natural disasters will vary from different natural disaster subgroups; geophysical (earthquake and volcanic eruption), hydrological (flood and landslide) and meteorological (storm) which appear to be top most frequent disasters suffered by APEC countries. All of the samples will be limited to APEC member countries only and narrowed down to 18 countries observed in total and further classified into nine middle-income countries and nine high-income countries that can be examined in table 4.1.

Table 4.1: Samples of 18 APEC Member Countries

Developing Countries	**Developed Countries**
China	Japan
Indonesia	USA
Vietnam	New Zealand
Philippines	Russia
Thailand	Canada
Korea Rep	Australia
Mexico	Chile
Malaysia	Hong Kong
Peru	Singapore

Two sets of models are used in this research where it is constructed based on Toya & Skidmore (2006) and are modified by adding new independent variables that apply for both models.

$$\left(ln\_deaths_{jit}\right) = \beta_0 + \beta_1(PCGDP_{it}) + \beta_2(Op_{it}) + \beta_3(SIZE_{it}) + \beta_5(CPI_{it}) + \beta_6\left(y_{jit}\right) + \varepsilon_{jit} \quad (1)$$

Where the dependent variable in the first model above (Eq. 1) denotes $deaths_{jit}$ or human loss (total deaths) that comprises the number of people who lost their life from the disaster and the number of missing people whose whereabouts are unknown since the time of the disaster event; hence they are presumed dead. It basically reflects as number of human losses caused by natural disaster event *j* in country *i* during period *t*. The value of deaths is measured in natural logarithmic forms.

$$\left(\ln\_econ\_damages_{jit}\right) = \beta_0 + \beta_1(PCGDP_{it}) + \beta_2(Op_{it}) + \beta_3(SIZE_{it}) + \beta_5(CPI_{it}) + \beta_6(y_{jit}) + \varepsilon_{jit} \quad (2)$$

Meanwhile, the second model measures the impact of the independent variables upon economic damages ($damages/GDP_{it}$), in which the damages value refers to the amount of damage to property, crops and livestock, measured in logarithmic form. The figure is the estimated damage in real US$ at the moment of the event or it simply reflects monetary damage caused by disasters incurred from a natural disaster event *j* in country *i* at time *t.* To better identify damages suffered in proportioned to countries' GDP, the economic damages will be presented as a share of GDP in respective countries.

As for the independent variables, both Eq. 1 and 2 consist of $pcgdp_{it}$ that represents natural logarithm of real gross domestic product per capita; Op_{it} serves as trade openness ((Export+Import)/GDP) in a country; $SIZE_{it}$ represents general government expenditure/GDP; CPI_{it} indicates corruption level measured through Corruption Perceptions Index; while y_{jit} represents additional variables that could affect deaths from natural disasters, such as series of occurrence per natural disaster events and number of population.

The authors hypothesize that higher income per capita increases sense of safety, allowing countries to employ more costly precaution measures and further leading to lower disaster impacts. Greater openness here serves as a proxy for the degree of transferal of technological knowledge from abroad that reduces impact. The higher the trade openness, the lower should the disaster impact be. The larger the size of the government, the more sources a country has to improve the infrastructure, education services and stronger disaster response impact, all of which lead to disaster impact reduction. On the other hand, higher corruption results in lower quality of building blocks, and reduce fund allocated for disaster management, thus increasing deaths and damages caused by natural disaster events. The lower the CPI, the more corrupt a country, the negative the relationship will be. Higher disaster event occurrences and the number of population lead to higher death counts and economic damages.

5. Estimation Results

This study basically involves two different models that require separate treatment or method to generate the estimation results. There are three types of method of processing the data and performing the regressions that will be used in this study; PLS (Pooled Least Squares), Fixed Effect and Random Effect method, founded from proper testing for method with the best fit for each model.

After applying the required procedures in finding the proper method to be used to estimate the model, the first model will be run with Error Components Model or simply *Random Effects Model* that was obtained through proper tests procedures that have been elaborated in previous chapter.

However when the regression is restricted into two parts, developing and developed economies only, the method applied differs from the prior full sample models. The restricted regressions on the first model employ *Pooled Least Squares* approach, deriving from the *Breusch/Pagan Test.* As for the Fixed Effect Model, it is applied based on significant value in Chow Test results. This condition is applicable to the second model on economic damages as well.

Table 5.1: Natural Disaster Losses and Economic Development: All Countries

Dependent Variables	Log (Deaths) (1)	Log (Economic Damages) (2)
GDP per Capita **(Ln_PCGDP)**	-0.739843**	2.801371**
Trade Openness **(OP)**	-0.0015594	-0.0302093*
Size of Government **(SIZE)**	-0.0044542	0.0063779
Corruption Level **(CPI)**	-0.0746305	-0.612304
Log of Population **(Ln_Pop)**	0.3349821	-
Storm	0.1286944***	0.1257169
Flood	0.0023391	-0.0431219
Earthquake	0.2456528***	0.4809086***
Landslide	0.2966076***	0.0949199
Volcanic	0.5112635**	0.4701551
No. of Observations	211	189
R^2	0.6223	0.0260

*Notes: *) Significant at the 10% level, **) Significant at the 5% level, ***) Significant at the 1% level*

Table 5.1 presents regression estimates for the number of deaths and economic damages equations using the full sample or all 18 APEC member countries. The results suggest that the only significant variable is income per capita, which is consistent with the prior findings by Toya and Skidmore (YEAR). In the interim, the rest of the significant variables are the number of occurrence of storm, earthquake, landslides, and volcanic activity, in affecting the total deaths.

As for the second dependent variable in column (2), income per capita is significant in affecting economic damages. Trade openness also plays a significant role, followed by some controlling variables of disaster

occurrences, namely earthquake, as the type of disaster that significantly affects economic damages.

GDP per capita has significantly been able to inversely affect the dependent variable, i.e. total death toll caused by natural disaster event in APEC economies. This is consistent with the proposed hypothesis. In column (1), a coefficient of 0.74 in GDP per capita highlights that when income per capita increases by one percent, the total deaths by disaster will be reduced by 0.74 percent during the observed years. This condition is appropriate as the higher the income per capita in a country, the higher their sense of safety and their willingness to afford any additional costly precautionary measures for avoiding disasters. For instance, houses that are located near landslide-prone area are usually cheaper than those that are not; hence higher income per capita will let them to pick more costly but safer housing location. Aside from location, houses that are built on stronger and durable material also help to reduce death count (Kahn, 2005) and can be achieved by higher level of income per capita.

Size of government is also consistent with the hypothesis that it has inverse relationship with deaths. As general government expenditure increases by one percent, human fatalities will decrease by 0.004 percent. Reduction in corruption level by one unit, which is shown in higher Corruption Perceptions Index value, is also able to reduce deaths by 0.074 percent that is again consistent with the hypothesis. It goes the same for trade openness where an increase in trade by one percent leads to increase in deaths by 0.001 percent. However, these three variables are not significant in the human losses model.

In table 5.1 it appears that storm, earthquake, landslide and volcanic activities are the disaster events that are significantly increasing the human fatalities in the 18 APEC economies, with volcanic activity having the largest coefficient magnitude in increasing death counts. An increase in volcanic activity event by one time will increase deaths by 0.511 percent since some of the APEC countries sit in the so-called Ring of Fire, where they experience severe volcanic activity.

As for the second model (damages/GDP) in column 2, the method used for this particular model is Fixed Effect, as proven through the value of Prob>F in *chow test* of 0.000 and an insignificant value of Prob>Chibar2 with 0.1831 in *Breusch and Pagan Langrangian multiplier test.*

In column 2, however, the result is inconsistent with the hypothesis of having a positive relationship between GDP per capita and economic damages/GDP for all APEC countries. The positive coefficient of 2.8 indicates that a one percent increase in GDP per capita will increase economic damages in proportion to GDP by 2.8 percent. Such thing can happen since when income per capita increases, as frequently found in developing countries, the higher the income, the higher as well the damages suffered from disasters. When income per capita is increasing, it means that countries are becoming richer and when development takes place, the number of infrastructure, built by removing forests and/or locating buildings near the shores, will increase. When this happens, more infrastructures are built and forest reduction that could lessen disaster damages will increase the damages/GDP.

Trade openness, as another significant variable of interest in reducing damages/GDP, is consistent with the hypothesis by embedding a negative relationship. The negative coefficient of 0.03 indicates that when trade openness increases by one percent, it will reduce damages/GDP by 0.03 percent. This condition persists because as openness increases, the degree of technological transfer improves and higher technological transfer can lead to better building codes and better construction of dwellings, and thus strengthening the infrastructure capability in facing disasters, which ultimately results in lower damages from disasters.

Corruption level, albeit having a consistent relationship with the hypothesis, is not significant in affecting damages/GDP. Size of government, on the other hand, is not consistent with the hypothesis by having a positive relationship and it is not significant either.

The most significant disaster events in affecting damages/GDP in APEC countries would be earthquake with a p-value of 0.005. Subsequently, an increase in earthquake occurrence by one time means an increase in damages in proportion to GDP by 0.48 percent.

Table 5.2: Natural Disaster Losses and Economic Development: Developing Countries

Dependent Variables	Log (Deaths) (1)	Log (Economic Damages) (2)
GDP per Capita **(Ln_PCGDP)**	-0.4167842	-0.9591021
Trade Openness **(OP)**	0.0036423	0.0083765
Size of Government **(SIZE)**	-0.0047623	-0.023786***
Corruption Level **(CPI)**	-0.3333658	0.748385
Log of Population **(Ln_Pop)**	1.615866	-
Storm	0.122764*	0.3096725***
Flood	-0.0179998	-0.1459954*
Earthquake	0.3277999***	0.2601806
Landslide	0.2896762***	-0.1489856
Volcanic	0.6630816***	0.3998032
No of Observations	127	105
R^2	0.5431	0.2347

*Notes: *) Significant at the 10% level, **) Significant at the 5% level, ***) Significant at the 1% level*

This restricted model for developing countries only utilizes different method, which is Fixed Effect Model. Different from the full sample model, in column (1), none of the variables of interests is significant in affecting death counts in developing countries. Meanwhile, in the case of the disaster event occurrences as the controlling variables that could also affect deaths, there are four disasters that significantly increase total death toll in APEC developing economies, namely storm, earthquake, landslides, and volcanic activity.

The four variables of interest have consistent relationship with the proposed hypothesis, except for trade openness for having positive relationship with the death count in APEC developing economies. This is

because a high level of trade for developing countries could endanger domestic firms for having to compete with international firms. These domestic companies might need to lay off workers to cut costs, which will cause unemployment and lower income per capita. This situation will also prevent these companies from performing additional costly disaster prevention, thereby leading to more deaths. Still, none of them is significant in affecting death counts in APEC developing economies.

Storm, earthquake, landslide and volcanic activities are the four disaster events that manage to bring significant impact upon the increase in deaths by disasters. All of them are positively correlated and aligned with the hypothesis. With volcanic activity holding the highest coefficient magnitude of 0.66, that represents an increase in volcanic events by one time, the death count will increase by 0.66 percent. Second largest coefficient magnitude of 0.33 is held by earthquake.

Some of the APEC member economies are located in the Pacific Ring of Fire, namely Indonesia and the Philippines. This location is consistent with the results that earthquake and volcanic activity will be the disaster events that will significantly bring largest impact upon human losses in APEC developing countries.

The second model for developing countries, as seen in column (2), utilizes Pooled Least Square as the appropriate method for conducting the proper testing. However heteroscedasticity is found (Prob>Chi2 = 0.0232) and further treatment to make the regression *robust* is performed. The results reported below are in robust estimates. Both autocorrelation and high multicollinearity between the regressors are absent.

After performing robust estimation, the R^2 has improved value of 0.235, which indicates that this model is able to explain 23.5 percent of all the variability effect between the independent variables and the dependent variables.

As what can be observed from Table 5.2 column (2), the only significant variable is the size of government as measured with general government expenditure in proportion to GDP coefficient and a couple of disaster event occurrences, storm and flood.

The size of government is consistent with the hypothesis, that is negatively related the damages/GDP. A coefficient of -0.024 in the Size of Government and with a p-value of 0.000 indicates that size of government is highly significant in reducing the damages/GDP caused by disasters. The interpretation stands for an increase in general government expenditure (size of government) by one percent will reduce damages/GDP by 0.024%.

This condition holds because, as what the hypothesis has proposed, higher government expenditure means that government in a country has increased its spending and allocated it to different sectors, including infrastructure, building codes, education, as well as disaster management program that will eventually lead to lower damages/GDP. In developing countries, government expenditure will certainly play a big role in affecting the economic development. Within the table, we can see that the country holding highest general government expenditure in proportion to GDP is Philippines (109 percent), which is a country inside developing group.

As for the rest of the variables of interests, GDP per capita is consistent with the hypothesis of negative relationship and so is the corruption level. Meanwhile, trade openness is again positively related with damages/GDP. However, those three variables are not significant in affecting damages/GDP in developing countries.

Storm and flood also significantly affect the damages/GDP in developing countries, with storm holding the highest coefficient magnitude compared to that of flood. Storm and flood are basically types of disaster events that could cause significant damage on crops, property, and livestock, making it consistent with the estimation results.

Table 5.3: Natural Disaster Losses and Economic Development: Developed Countries

Dependent Variables	Log (Deaths) (1)	Log (Economic Damages) (2)
GDP per Capita **(Ln_PCGDP)**	-1.508026	2.058986
Trade Openness **(OP)**	-0.0006105	-0.0947243*
Size of Government **(SIZE)**	-0.0212908	0.7322295**
Corruption Level **(CPI)**	0.3740325*	-1.507622*
Log of Population **(Ln_Pop)**	0.8851633***	-
Storm	0.127391*	0.0207771
Flood	0.0201241	0.0623536
Earthquake	0.4509196*	0.9990224**
Landslide	0.9049964*	0.9075745
Volcanic	-0.3461145	-0.0680176
No of Observations	84	84
R^2	0.4910	0.1333

*Notes: *) Significant at the 10% level, **) Significant at the 5% level, ***) Significant at the 1% level.*

Results from table 5.3 will be restricted on nine APEC developed countries only. In the deaths model regression, the method used will be Pooled Least Squares in accordance with the developing model.

The only significant variable of interest in Column (1) is corruption level. Moreover, log of population, storm, earthquake, and landslide occurrences are also significant and positively correlated with the dependent variables.

Corruption level is significant in the developed countries. Yet, the relationship is not in accordance with the proposed hypothesis. The coefficient value of 0.374 indicates that an increase in one unit of CPI signifies an increase in deaths by 0.374 percent. In other words, when

corruption level decreases (increase in CPI), the number deaths by disaster increases.

This positive correlation can be affected by certain factors. The financial crisis in 2007-2008 has brought impact upon United States as a whole, including hurting government budget. Assuming that the corruption level is declining, which leads to more funds to be allocated for disaster management during the recovery period, the Federal spending is allocated mostly in government's bailout for banks to revive the economy. To get the funds for bailout, government must either borrow or squeeze tax out of the economy. Tax revenue allocation will then be mainly used for huge bailouts and automatically reducing the fund allocation for other sector, including infrastructures and disaster management, which might lead to more deaths.

Another significant variable is log of population where it shows a positive correlation with human losses by disaster. This estimation results are aligned with the proposed hypothesis that the larger the population, the more the deaths caused by natural disaster events.

As for the column 2, the R-squared has improved to 0.1333, which indicates that the model can explain 13.3 percent of all the variability effect between independent variables and the dependent variables.

Variables of interest that is significant in affecting damages/GDP in APEC developing economies will be trade openness, size of government and corruption level, followed by controlling variable of disaster events namely earthquake.

Trade openness shows an increase relationship with the damages deriving from disasters in developing economies. A negative coefficient of 0.095 indicates that an increase in trade openness by one percent will significantly reduce damages/GDP in developing countries by 0.095 percent. This condition persists because again as openness increases, the degree of technological transfer improves, and higher technological transfer can lead to better building codes and better construction of dwellings, which ultimately lead to lower disaster impacts.

According to Kahn in 2005, richer governments or governments with high level of expenditure can provide implicit disaster insurance through

effective regulation and planning and by providing quality infrastructure. However, Toya and Skidmore in 2006 also found that size of government was inversely related with the damages/GDP suffered from disasters. As they say, the larger the government, the less responsive and less efficient it becomes in handling disaster response initiatives, such in the case of Kobe earthquake, when the government had a slower response than the market-oriented Japanese Mafia.

This study has found similar findings to that of Toya and Skidmore (2006) that argues when size of government increases by one percent, the damages/GDP in developed countries surges by 0.732 percent, showing inconsistency with the hypothesis.

Corruption level measured with Corruption Perceptions Index (CPI) has the desired coefficient direction and significantly affects the damages/GDP deriving from disasters in APEC developed economies. It is crucial to remember that the lower the value of the CPI, the more corrupt a country is and vice versa. Accordingly the negative relationship implies that every increase in the CPI value suggests reduction in disaster damages. The statement indicates that when CPI value increases by one point, corruption level falls, and damages/GDP drops significantly by 1.51 percent.

This estimation results is in accordance with the hypothesis that higher corruption leads to more damages/GDP incurred, especially when earthquake, flood, storm and landslides play a role in it. Funds that are supposedly allocated for improving infrastructures or building codes are corrupted and set in motion poor level of building codes. Shoddy school construction in Sichuan China due to corruption, for instance, was politically alleged in increasing the amount of deaths caused by Earthquake with 88305 people were confirmed dead and missing, thus presumed dead, making it the highest death toll in China since 1999-2013 (EM-DAT). Higher corruption level makes infrastructure become less resilient in facing disaster events and brings about more damages suffered from disasters.

Earthquake events being the controlling variable holds significant impact in increasing the damages/GDP suffered in APEC developed countries. An increase in earthquake occurrence by one time denotes an in increase in damages/GDP by 0.99 percent. Aside from being the only significant

disaster events, earthquake also holds the highest magnitude among the others in affecting damages since earthquake might be able to bring the largest impact in increasing damages per GDP such what happened in Japan, where the damages due to earthquake reached US$212 billion in 2011.

6. Conclusion

Human fatalities caused by natural disaster events have becoming more apparent in the past years. APEC economies as a strong economic cooperation has also suffered from severe losses due to natural disaster. The amount human losses and damages sustained are highly apparent and therefore it is captivating to observe APEC economies as the samples in this study. This study is conducted to measure the impact of economic development, measured through several proxies, on human fatalities in 18 studied APEC economies from 1999-2013.

In general, the results obtained from both model regressions conclude that higher income per capita manages to reduce total deaths when regressing all countries altogether. Nevertheless, it increases economic damages/GDP induced from disasters. The higher the income per capita, the higher the sense of safety and the capability to afford costly precautionary measures, thereby leading to lower death counts. This condition suffices the hypothesis that when GDP per capita increases, death counts are reduced.

Higher trade openness reduces damages/GDP in all countries regression and even more when it is restricted to developed countries regression. The result demonstrates that an increase in trade by one percent leads to increase in deaths. Nonetheless, these three variables are not significant in the human losses model.

Larger size of government has significantly reduced damages/GDP in developing countries especially. As at this stage of economies, government may have greatest impact in reducing disaster impacts and on economic development. The size of government is also inversely related with deaths that as government expenditure increases by one percent, human fatalities will decrease. Lower corruption level reduces damages/GDP from disasters in developing countries but increases deaths in developed countries because some of the un-corrupted funds might not

be efficiently allocated toward disaster impacts reduction measures. Reduction in corruption level (shown through higher CPI value) by one unit also manages to reduce deaths. Moreover, population and disaster event variables have positive impact with the death counts in developed countries, yet this does not hold in developing countries. Some differences are also found in the variables of development being significant in reducing the disaster impacts, between developing and developed countries. Developed countries with higher income per capita in average, lower corruption level, higher government expenditure (larger size of government) experience fewer deaths and economic damages (damages/GDP) than developing countries, although this condition might be affected with other factors such as countries geographical location.

References

Anderson, D. R., Sweeney, D. J., & Williams, T. A. (2011). *Statistics for Business and Economics.* South-Western CENGAGE Learning.

Anderson, D. R., Sweeney, D. J., & Williams, T. A. (2011). *Statistics for Business and Economics* (International Edition ed.). South-Western Cengange Learning2.

Asquer, R. (2011). *Deadly Effects of Corruption: A Cross-National Study of Natural Disasters, 1980-2010.* UCLA, Department of Political Science .

Cavallo, E., & Noy, I. (2010). *The Economics of Natural Disasters A Survey* . Inter-American Development Bank (IDB), Department of Research and Chief Economist.

Chang, A. Y., Richards, Seville, E., Wilkinson, S., & Walker, B. (2013). *Building natural disaster response capacity: sound workforce strategies for recovery and reconstruction in APEC economies* . Resilient Organisations.

ECLAC. (2003). *Handbook for Estimating the Socio-economic and Environmental Effects of Disasters.*

Felbermayr, G., & Gröschl, J. (2014, August). Naturally Negative: The Growth Effects of Natural Disasters. *Journal of Development Economics*, 92-106.

Guha-Sapir, D., & Hoyois, P. (2012). *Measuring The Human and Economic Impact of Disasters.* Government Office of Science, Foresight project 'Reducing Risks of Future Disasters: Priorities for Decision Makers' .

Gujarati, D. N. (2004). *Basic Econometrics* (4th Edition ed.). The McGraw-Hill.

Gujarati, D. N. (2004). *Basic Econometrics* (4th Edition ed.). Mc Graw Hill.

Horwich, G. (2000). Economic Lessons of The Kobe Earthquake. *Economic Development and Cultural Change , 48*(3), 521-542.

IDMC. (2014). *Global Estimates 2014 - People displaced by disasters.* Norwegian Refugee Council.

Ingmar Schumacher, E. S. (2011, October 18). Economic development and losses due to natural disasters: The role of hazard exposure . *Ecological Economics*.

Kahn, M. E. (2005, May). The Death Toll from Natural Disasters: The Role of Income, Geography and Institutions. *The Review of Economics and Statistics*, 271 - 284.

Kaufmann, D., Kraay, A., & Mastruzzi, M. (2006). *Measuring Corruption: Myths and Realities* . World Bank. World Bank.

Kellenberg, D. K., & Mobarak, A. M. (2008,). Does rising income increase or decrease damage risk from natural disasters? *Journal of Urban Economics*, 788-802.

Kousky, C. (2012). *Informing Climate Adaptation: A Review of the Economic Costs of Natural Disasters, Their Determinants, and Risk Reduction Options* .

Lakakis, Konstantinos., Manolis Charalampakis., Paraskevas Savvaidis (2009). *Landslide Definition by an Integrated Monitoring System*, Fifth International Conference on Construction in the 21st Century (CITC-V) "Collaboration and Integration in Engineering, Management and Technology" Turkey.\Nachrowi, D. N., & Usman, H. (2006).

Pendekatan Populer dan Praktis Ekonometrika untuk Analisis Ekonomi dan Keuangan. Lembaga Penerbit FEUI.

OECD. (2013). *Issues Paper on Corruption and Economic Growth.*

OECD Secreatriat. (2013). *Disaster Risk Financing in APEC Economies.*

Padli, J., & Muzafar, H. S. (2009). Natural Disaster Death and Sosio-Economic Factors in Selected Asian Countries: A Panel Analysis. *Asian Social Science, 5*(4), 65-71.

Padli, Jaharudin Muzafar Shah Habibullah, A.H. Baharom, (2010) *Economic impact of natural disasters' fatalities*, International Journal of Social Economics, Vol. 37 Iss: 6, pp.429 - 441 Pindyck, R. S., & Rubinfeld, D. L. (2013). *Microeconomics* (8th Edition ed.). USA: Pearson Education .

Rasmussen, T.N. (2004), *Macroeconomic implications of natural disasters in the Caribbean*, IMF Working Papers, No. WP/04/224, International Monetary Fund, Washington, DC

Rohwer, A. (2009). *Measuring Corruption: A Comparison between The Transparancy International's Corruption Perceptions Index and The World Bank's Worldwide Governance Indicators.*

TFEP. (2008). *Strategy for Disaster Risk Reduction and Emergency Preparedness and Response in the Asia Pacific region: 2009 to 2015* . Peru.

The World Bank. (2014). *World Development Indicators.*
Todaro, M. P., & Smith, S. C. (2012). *Economic Development* (11th Edition ed.). Pearson.

Torres, O., & Reyna. (2007, December). *Panel Data Analysis Fixed and Random Effects using Stata (v.4.2).* Princeton University.

Toya, H., & Skidmore, M. (2006, November 13). Economic development and the impacts of natural disasters. *Economic Letters*.

Toya, H., & Skidmore, M. (2006, November 13). Economic development and the impacts of natural disasters. *Economic Letters*, 20-25.

UNDP. (2004). *Reducing Disaster Risk: A Challenge for Development.* United Nations Development Programme, Bureau for Crisis Prevention and Recovery .

Webster, P,J., G,J Holland., Curry,. J,A,. H,R., Chang, (2005) *Changes in Tropical Cyclone Number, Duration, and Intensity in a Warming Environment*. Science, Vol. 309, pp. 1844-1846.

Wooldridge, J. M. (2012). *Econometric Analysis of Cross Section and Panel Data* (2nd Edition ed.). MIT Press.

Wooldridge, J. M. (2013). *Introductory Econometrics: A Modern Approach* (5th International Edition ed.). South-Western CENGAGE Learning.