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NATURAL DISASTER DEATH AND SOCIO-ECONOMIC FACTORS IN SELECTED ASIAN COUNTRIES: A PANEL DATA ANALYSIS

by

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ABSTRACT

The purpose of the present study is to investigate the relationship between disaster fatalities with the level of economic development, years of schooling, land area and population for a panel of fifteen Asian countries over the sample period over 1970 to 2005. Our results indicates that the relationship between disaster losses and the level of economic development is nonlinear in nature suggesting that at lower income level, a country is more disaster resilience but at higher income level, an economy become less disaster resistant. Other disaster determinants of interest is the level of education which suggests that educational attainment reduces human fatalities as a result of disaster; larger population will increase death toll and larger land area will reduce disaster fatalities.

1. INTRODUCTION

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. Destruction and human suffering.” has divided natural disaster into groups and types. CRED (see Guha-Sapir, 2008b) further divided natural disaster into several specific groups, namely; biological (including epidemic and insect infestation), climatological (including drought, extreme temperature and wildfire), geophysical (including earthquake, mass movement dry, volcano and tsunami), hydrological (including flood and mass movement wet), and meteorological (including wind, and storm).

According to the “Statistical Yearbook for Asia and the Pacific 2007” natural disasters have a profound impact on the quality of life through their destruction of food crops and livestock, and forced dislocation of households and communities. Their toll on lives and the instant poverty cause are among their most devastating impacts (UNESCAP, 2007. p. 175). The economic impact of a disaster usually,

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among others, consists of damage to infrastructure, crops, housing, loss of revenue, unemployment, market destabilization on the local economy. The Canadian Red Cross has reported that in the year 2007 alone, the total number of natural disasters is 546 and of which more than half were weather-related (see also Schlein, 2008). Schlein (2008) reports that the climate-related disasters, floods and windstorms are the two disasters which have killed more people in 2007 than they have overall in the last five-year average.

By region, 33 percent of disasters occurred in Asia and the Pacific region while 30 percent in Africa, 25 percent in the Americas, 8 percent in Europe and 4 percent in the Middle East and North Africa. By type of disaster, in the Asia and the Pacific region, about 25 percent of disasters were floods (22%) and flash floods (3%), followed by 17 percent were earthquake, 12 percent were tropical cyclones, and 7 percent were severe local storms. Table 1 reports the Top-10 countries experienced the number of deaths as a result of natural disaster. It is clear that majority of the countries are in Asia. Bangladesh, India and Pakistan are the most vulnerable countries hit hard by natural disaster. In Table 2, the Asian countries still recorded the highest number of reported natural disasters for the year 2007, with China recorded 20 number of natural disasters occurred, followed by India (18), the Philippines (160, Indonesia (16), Pakistan (9) and Japan (8). Further, during the same year, natural disaster has affected 211 million people and killed almost 17 thousand people. On economic perspectives, natural disasters also are an economic disaster. According to Table 3, the ten most affected countries have wracked up about US$60 billion in disaster-related economic losses (sse Guha-Sapir, 2008a).

The purpose of the present study is to determine the impact of socio-economic factors on natural disaster damages in selected Asian countries using annual data for the period 1970 to 2005. The present study is important because of the devastating results of a disaster to an economy. Natural disasters can affect long-term outcomes through a number of channels including environmental damage to agriculture, fishing and forestry (ECLAC, 2000). The destruction of schools could have a long-lasting negative impact on the stock of human capital; reconstruction efforts could crowd out productive capital expenditure; increased indebtedness could raise the rate of interest and reduce investment; and a worsening of fiscal and external balances could trigger inflation and/or financial crises (IMF, 2003). Furthermore, Benson and Clay (2003) present findings suggesting that proneness to natural disasters has a negative impact on long-term economic growth. By identifying factors affecting natural disaster damages would help policy makers to prepare for future events. Thus disaster preparedness, prevention and mitigation would reduce economic losses in the event of future disasters.

The paper is organized as follows. In the next section we discuss some of the previous literature related to the present study. In section 3, we provide our model, and discussion on the empirical analysis is provided in section 4. The last section contains our conclusion.

2 LITERATURE REVIEW

Since the seminal work by Dacy and Kunreuther (1969), a plethora of researches on investigating the socio-economic determinants of natural disaster has been conducted in recent years.

Raschky (2008) has point out that socio-economic factors have been found to be the key determinants of a society's response to disasters, apart from other factors such as climatic and topographic factors. In his study that consists of 2,792 events for the period 1984-2004, Raschky (2008) found that economic development (measured by GDP per capita) is an important factor in determining a society's vulnerability against natural hazards in which higher-income countries experience a lower death toll from natural disasters. On the other hand, the institutional factors such as government stability and investment climate reduce the adverse effects on both, the death toll and the overall economic losses from natural disasters.

Horwich (2000) argues that a critical underlying factor in any economy's response to a natural disaster is its level of wealth. A wealthy or richer country relate to safer country. Wildavsky (1988) interprets safety as a natural product of a growing market economy. Since the demand for safety rises with income, a nation's per capita income is a good first approximation of the degree of safety it enjoys. Furthermore, a rise in income will provide not only general safety but, at high enough income levels, protection specific to disasters (Horwich, 2000). Rasmussen (2004) also found out the negative relationship between income and the number or persons affected by natural disasters. His cross-country regression results for the ECCU countries suggest that the capacity of countries to avoid the human cost of disasters improves as income levels increases. In other study, Albala-Bertrand (1993) argues that the higher the level of development, the smaller both the number of deaths, injured and deprived and the relative material losses. The level of development includes income per capital and income distribution, economic diversification and social inclusion, institutionalization and participation, education and health, choice and protection.

Kahn (2005) shows that countries with higher per capita income experience a similar amount of catastrophic events but suffer less death from these events. He points out that though richer nations do not experience fewer natural disasters than poorer nations, richer nations do suffer less death from disaster. Thus economic development provides implicit insurance against nature's shocks. Richer nations will have the resources to make investment to preempt such events. Further in his study, Kahn (2005) shows that better institutional quality insulates against death from earthquakes. Countries with better institutions, lower income inequality and higher levels of democracy experience fewer earthquake fatalities.

A study by Toya and Skidmore (2007) using annual data for 151 countries over the 1960-2003 period tested several measures of social/economic infrastructure variables that includes income, education, openness, financial development, and the size of the government as determinants of disaster. They found out that economic development and economic losses from disasters are inversely related. Nation with higher levels of educational attainment and greater openness for trade are less vulnerable to disasters. A stronger financial sector and a smaller size of government are associated with a lower disaster death toll. In a more recent study, Noy (2008) found out that countries with a higher literacy rate, better institutions, higher per capita income, and higher degree of openness to trade and higher levels of government spending are better able to withstand the initial disaster shock and prevent further spillovers into the macro-economy. He also points out that countries with more foreign exchange reserves and higher levels of domestic credit but with less-open capital accounts appear more robust and better able to endure natural disasters, with less adverse spillover into domestic production.

3. DATA AND METHOD OF ESTIMATION

To determine the relationship between the socio-economic variables and disaster impact, we follow Raschky (2008) and estimate the following pooled time-series regression:

$$\log Death_{it} = \alpha_{it} + \beta_1 \log GDPpc_{it} + \beta_2 \log(GDPpc)^2_{it} + \beta_3 \log Land\,area_{it} + \beta_4 \log Population_{it} + \beta_5 \log School_{it} + \varepsilon_{it}$$

where $i\,and\,t$ denotes the number of country $i = 1,...,N\ and\ t = 1,...,T$ respectively. The variable *Death* is measured using the number of people killed in the event of disaster. *GDPpc* is real gross domestic product per capita, *Land area* is measured as land area square km, *Population* is total population and *School* is secondary school enrolment.

The benefit of using a pooling technique is that it provides an examination of variations among cross-sectional units simultaneously with variations within individual units over time. The ultimate advantage is that it allows for more complex analysis over either cross-section or time series analysis individually. However, there are other advantages to using pooled regression, such as: pooled data sets usually provide an increased number of data points, and that generates additional degrees of freedom and; incorporating information relating to both cross section and time series variables can substantially diminish the problems that arise when there is an omitted variables problems.

According to Raschky (2008), higher income does not necessarily lead to better protection against natural disaster. Thus, Raschky suspects that the process of economic development is nonlinear, the regression will be more appropriate by incorporating both $\log GDPpc$ and $\log(GDPpc)^2$ in the equation. Raschky contends that economic development partly reduces disaster fatalities and losses, but increasing wealth inverts this relationship and thus causes relatively higher losses in high-income countries. In this study we test the assumption that the relationship between disaster losses and the level of development is nonlinear. Higher income people can self-protect through a number of strategies to reduce their natural disaster risk exposure. The reason behind it was, with higher income, it enable the individuals respond to the risk around them by employing additional costly precautionary measures. Besides, after a disaster has struck, richer economies are able to provide high-quality emergency care to protect the population against death from disaster. Nevertheless, a nonlinear relationship would imply that economic development provides protection but with a diminishing rate.

The effect of *Population* and *Land* size is ambiguous. Even though one might expect that bigger countries (in term number of populations) and land area have economies of scale in providing mitigative measures and more people increase the damage potential. Nevertheless, the inclusion of population and land area act as control variables (see also Skidmore and Toya, 2002; Raschky, 2008). On the other hand, as for the *School* variable, higher educational attainment may enable the citizens to make a series of choices from engaging safe construction practices to assessing potential risk that result in fewer deaths when the disasters strike.

Sources of Data

Due to the difficulties of getting a continuous time-series data on economic disaster losses, we analyze the disaster-economic development relationship for only fifteen Asian countries. These countries are Bangladesh, China People's Republic, India, Indonesia, Iran, Israel, Japan, Malaysia, Myanmar, Nepal, Pakistan, Philippines, Sri Lanka, Syrian Arab Republic, Thailand and Turkey. The period of study ranges from 1970 to 2005 using annual data from EM-DAT database. As a result of missing observations for some data for some countries, we are left with 15 (balance) observational data for the analysis throughout the study.

We used data on deaths from natural disasters to measure economic disaster losses. The data are collected from the Centre for Research on the Epidemiology of Disasters (CRED) (see International Federation of Red Cross, 2002). Since 1988, CRED has maintained the Emergency Events Database (EM-DAT), accessible at http://www.cred.be/emdat/. In the raw data, the unit of analysis is the number of disasters. The CRED uses specific criteria for determining whether an event is classified as a natural disaster. These include: ten or more people were killed; 100 or more people were affected, injured, or homeless; significant damage was incurred; a declaration of a state of emergency and/or an appeal for international assistance was made (http://www.cred.be/emdat/).

Another measure of economic disaster losses is the monetary damage caused by disaster. However, these there are several limitations that warrant discussion. First, this measure of economic damages only includes direct costs and not indirect costs (lost future income for example) of the disaster. Second, developing countries have an incentive to exaggerate the scale of damages in order to secure international assistance. Third, obtaining damage estimates in developing countries is challenging because the poor are often without insurance, bookkeeping and formal markets (Tol and Leek, 1999). Nevertheless, the OFDA/CRED data are best data on economic damages available, and the analysis should provide an initial indication of the relationship between the level of development and economic damages from disasters.

In this study, we focus on ten types of natural disasters. Drought is an extended period of time characterized by a deficiency in a region's water supply that is the result of constantly below average precipitation. A drought can lead to losses to agriculture, affect inland navigation and hydropower plant, and cause a lack of drinking water and famine. An earthquake is the result of a sudden release of stored energy in the Earth's crust that creates seismic waves. At the earth's surface they are felt as a shaking or displacement of the ground. Epidemic is the cases of an infectious disease, which already exist or previously absent in the region or population concerned. Extreme temperature events are heat waves and cold waves. Floods are significant rise of water level in the stream, lake, reservoir or coastal region. Mass movement is divided into two categories wet and dry. Wet mass movement is such as avalanche, landslide and subsidence. Meanwhile, rock-fall is categorized as dry mass movement. Storm is referring to local windstorm and typical cyclone; strong winds caused by regional atmospheric phenomena which are typical for a certain area. Volcanic activity describes activity like rock-fall, ash fall, lava streams, and emissions of gases which can result in pyretic eruptions. Wildfire is described as uncontrolled burning fire, usually in wild lands, which can cause damage to forestry, agriculture, infrastructure and buildings.

For real GDP per capita the data are collected from the World Development Indicator 2007 Database and International Financial Statistics 2008. Meanwhile, for year of schooling data, we refer to Barro and Lee (1996) data set taken from the World Bank Research Department's Web page (http://www.worldbank.org).

4. THE EMPIRICAL RESULTS

The estimated regression result for the relationship between disaster fatalities and the socio-economic determinants are presented in Table 4. As observed in Table 4, all five independent variables are statistically significant at least at the 5 percent level. The null hypothesis that $\beta's$ is zero can easily be rejected.

Our results clearly support Raschky (2008) contention that the relationship between disaster fatalities and the level of economic development is nonlinear in nature. Both variables $\log GDPpc$ and $\log GDPpc^2$ are statistically significant and show expected sign with negative sign for $\log GDPpc$ and positive sign for $\log GDPpc^2$. This result suggest that the level of wealth of a nation though provides protection but with a diminishing rate. This implies that there is a threshold whereby the level of economic development would provide safety to the population, but after a certain point higher income growth will limit the general level of safety and its disaster resilience. A good example is the lessons from Kobe earthquake that struck Japan in January 1995. Horwich (2000) points out that although Japan is one of the wealthiest nations in the world, and therefore are said to be relatively disaster resistant, but Japan remains well below its potential resilience to disaster occurrence. This is because Japan faced with vast array of government regulations and private practices that insulate its enterprises, large and small, from both domestic and foreign competition and thereby limit the economy's income and growth, its general level of safety and its disaster resilience.

Further form Table 4, our results indicates that higher educational attainment enable people to make better choices with regard to safe construction practices, location decisions, and other safety infrastructures that will result in lesser deaths from disasters. As for the control variables – *Population* and *Land* our results suggest that an increase in the number of people in a country will result in more casualty or death as result of disasters. However, the negative relationship between land and disaster death toll indicates that bigger land area presumably with scattered population will leads to fewer death if disaster occur.

5. CONCLUSION

The purpose of the present study is to investigate the relationship between disaster fatalities with the level of economic development, years of schooling, land area and population for a panel of fifteen Asian countries over the sample period over 1970 to 2005. The fifteen countries considered in the present study include Bangladesh, China People's Republic, India, Indonesia, Iran, Israel, Japan, Malaysia, Myanmar, Nepal, Pakistan, Philippines, Sri Lanka, Syrian Arab Republic, Thailand and Turkey.

Our results indicates that the relationship between disaster losses and the level of economic development is nonlinear in nature suggesting that at lower income level, a country is more disaster resilience but at higher income level, an economy become less disaster resistant. Other disaster determinants of interest is the level of education which suggests that educational attainment reduces human fatalities as a result of disaster; larger population will increase death toll and larger land area will reduce disaster fatalities.

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Table 1: Top-10 Country-Natural disasters by number of deaths in 2007

Type of disaster	Country	Number of death
Cyclone Sidr, November	Bangladesh	4,234
Flood, July-August	Bangladesh	1,110
Flood, July-September	India	1,103
Flood, August	Korea, Dem P Rep	610
Flood, June-July	China, P Rep	535
Earthquake, August	Peru	519
Heat wave, July	Hungary	500
Cyclone Yemyin, June	Pakistan	242
Flood and landslides, June	Pakistan	230
Flood, July	India	225

Source: EM-DAT: The OFDA/CRED International Disaster Database.

Table 2: Number of reported natural disasters by country in 2007

Country	Number of natural disasters occurred
United States	22
China, P Rep	20
India	18
Philippines	16
Indonesia	15
Pakistan	9
Japan	8
Mexico, Haiti, Algeria, Afghanistan	7
Bulgaria, Romania, Colombia	6
Mozambique, Brazil, Bangladesh, Dominican Rep., Viet Nam, Thailand	5

Source: EM-DAT: The OFDA/CRED International Disaster Database.

Table 3: Economic impact in 2007

Country	In absolute amounts (US$ billion)
Japan	13.8
United Kingdom	9.6
United States	9.4
China P Rep	8.0
Germany	5.5
Oman	3.9
Mexico	3.6
Bangladesh	2.4
Peru	2.0
Pakistan	1.9

Source: EM-DAT: The OFDA/CRED International Disaster Database.

Table 4: Results of estimated Equation (1)

Dependent Variable: DEATH
Method: Pooled Least Squares
Sample: 1970 2005
Included observations: 36
Cross-sections included: 15
Total pool (balanced) observations: 540

Variable	Coefficient	Std. Error	*t*-Statistic	Prob.
C	-20.53258	1.335125	-15.37877***	0.0000
GDPPC	-0.482501	0.169962	-2.844767**	0.0046
$GDPPC^2$	2.816369	0.595146	4.732235***	0.0000
LAND AREA	-0.687707	0.140349	-4.899958***	0.0000
POPULATION	2.393459	0.271765	8.803420***	0.0000
SCHOOL	-0.516354	0.231706	-2.228492**	0.0263

R-squared	0.428610	Mean dependent var	4.320941
Adjusted R-square	0.423260	S.D. dependent var	2.997028
S.E. of regression	2.276046	Akaike info criterion	4.493805
Sum squared resid	2766.326	Schwarz criterion	4.541490
Log likelihood	-1207.327	Hannan-Quinn criter.	4.512455
F-statistic	80.11250	Durbin-Watson stat	1.503824
Prob(F-statistic)	0.000000		

Note: Asterisk (***), (**) denote statistically significant at the 1% and 5% level, respectively. The *t*-values are based on the White (1980) heteroscedasticity-consistent covariance matrix.