THE EFFECT OF NATURAL DISASTERS ON INTERNATIONAL TRADE AND COUNTRIES' CAPITAL

Miss Yada Phutaworavong

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ผลกระทบของภัยธรรมชาติต่อการค้าระหว่างประเทศและทุนของประเทศ

นางสาวญาดา พูถาวรวงศ์

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By	Miss Yada Phutaworavong
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Thesis Advisor	Touchanun Komonpaisarn, Ph.D.

Accepted by the Faculty of Economics, Chulalongkorn University in Partial Fulfillment of the Requirements for the Master's Degree

.....Dean of the Faculty of Economics

(Associate Professor Chayodom Sabhasri, Ph.D.)

THESIS COMMITTEE

.....Chairman

(Associate Professor Pongsa Pornchaiwiseskul, Ph.D.)

.....Thesis Advisor

(Touchanun Komonpaisarn, Ph.D.)

.....Examiner

(Watcharapong Ratisukpimol, Ph.D.)

.....External Examiner

(Associate Professor Somchai Ratanakomut, Ph.D.)

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การวิจัยนี้ศึกษาผลกระทบภัยภิบัติทางธรรมชาติที่มีผลต่อการค้าระหว่างประเทศ การวิจัยครั้งนี้ใช้ข้อมูลแผงทางสถิติของจำนวนภัยพิบัติทางธรรมชาติที่เกิดขึ้นและปริมาณการค้าระหว่างประเทศจำนวนทั้งสิ้น 49 ประเทศในช่วงเวลา ปี 2533 ถึง 2553 โดยที่ภัยพิบัติทางธรรมชาติสามารถแบ่งได้เป็น 4 ประเภท ได้แก่ ภัยพิบัติทางธรรมชาติทางภูมิอากาศ, ภัยพิบัติทางธรรมชาติทางธรณีฟิสิกส์, ภัยพิบัติทางธรรมชาติทางบรรยากาศและดวงดาว, ภัยพิบัติทางธรรมชาติทางอุทกวิทยา

ผลการศึกษาพบว่า เมื่อเวลาผ่านไปภัยพิบัติทางธรรมชาติทางอุทกวิทยาเท่านั้นที่มีผลกระทบทางบวกต่อปริมาณการส่งออกและนำเข้า ปัจจัยสำคัญของผลกระทบภัยพิบัติทางธรรมชาติที่มีต่อการค้าระหว่างประเทศ คือ ระดับรายได้ของประเทศ การศึกษานี้แสดงให้เห็นว่าภัยพิบัติทางธรรมชาติสามารถส่งเสริมการสะสมทุนมนุษย์ ในขณะที่ไม่มีความเชื่อมโยงกับทุนทางกายภาพ

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ลายมือชื่อ อ.ที่ปรึกษาวิทยานิพนธ์หลัก .....

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This paper studies the effect of natural disasters on international trade. The panel dataset of natural disaster number and international trade volume in 49 countries from 1990-2010 were used in this study. Four types of natural disasters of interest are Climatological disasters, Geophysical disasters, Meteorological disasters and Hydrological disasters. Only Hydrological disasters are found to be positively associated with the Export and Import volume over time. An important determinant of the impact of natural disasters on international trade is the level of income of the country. Natural disasters could encourage Human capital accumulation, although no association is found with physical capital counterpart.

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Student's Signature .....

Advisor's Signature .....

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LIST OF ABBREVIATIONS

ASEAN	Association of South-East Asian Nations
CRED	Centre for Research on the Epidemiology of Disaster
EMDAT	Emergency Events Database
GDP	Gross domestic product
GFCE	Government final consumption expenditure
GNI	Gross national income
G5	Group of 5countries, namely USA, UK, France, Germany and Japan
R&D	Research and development
US	United State
WB	World Bank
WTO	World Trade Organization

CHAPTER I

INTRODUCTION

1.1 Problem and Significance

The number of natural disasters has risen at an alarming rate in recent years, and despite the rapid development of all kinds of technology, it is still impossible to forecast the possibility of these harmful events. The unpredictable nature of these natural disasters causes enormous devastation, and the sudden loss of life and assets is followed by psychological effects, such as stress, sadness, and depression. Not only is the economy of the affected country severely damaged, but there may be domino effect on neighboring countries' exports and imports, due to the global connection.

The Centre for Research on the Epidemiology of Disaster (CRED) is an international research unit that compiles, analyzes and stores data about the impact of natural disasters on the populations most at risk. According to CRED, natural disasters are divided into 4 categories: Climatological, Geophysical, Meteorological, and Hydrological disasters. Climatological disasters refer to climate-related disasters such as extreme temperatures, drought, and wild fires; Geophysical disasters involve the movement of the earth's tectonic plates, for example, earthquakes and volcanoes; Meteorological disasters occur during extreme weather, e.g. storms and hurricanes; and Hydrological disasters relate to water, i.e. floods and wet mass movement.

The growth in the number of natural disasters is evident. Statistics collected by the Centre for Research on the Epidemiology (CRED) in Brussels indicate that the annual average number of disasters was 332 between 2001 and 2010, while 384 events were recorded in 2011 alone. Approximately 244.7 million people suffered and the death toll reached 30,733. The total economic loss was tremendous, estimated to be US$366 billion (Debby Guha-Sapir 2011) which exceeded the previous highest record in 2005 (US$ 246.8 billion). This represented a more than 200 percent increase from the annual average damage from 2001 to 2010 (US$109.3

billion). Among the four types of disaster, geophysical disasters caused the greatest loss in 2011 with 68.1 percent of the total fatalities.

For the past ten years, the countries most frequently hit by natural disasters have been China, the United States, the Philippines, India, and Indonesia. In 2011, the Philippines experienced a total of 33 natural disasters in the form of 18 floods and landslides, 12 storms, 2 volcanic eruptions, and one earthquake, which was the highest number of natural disasters ever registered. On the other hand, the highest death toll in 2011 came from Japan's gigantic earthquake and tsunami in March, killing nearly 19,850 people (64.5 percent of global disaster mortality).

China experienced its worst natural disasters in 2011. Floods in June caused the most victims (67.9 million), followed by drought from January to May (35.0 million), a storm in April (22.0 million), and another flood in September (20 million) claimed about 159.3 million victims, representing 65.1 percent of disaster victims around the globe.

In terms of engendering economic loss, the two largest disasters were the earthquake and tsunami in Japan with an estimated economic loss of US$210.0 billion. Other significant contributions to the massive economic loss in 2011 included floods in Thailand (US$ 40.0 billion), New Zealand's earthquake in February (US$ 15.0 billion), and two storms in the United States (US$ 25.0 billion). Asia suffered the most damage (75.4 percent), since it was the continent most often struck by natural disasters in 2011 (44.0 percent) and accounted for 86.3 percent of global disaster victims. Compared with other continents, the amount of damage in Asia increased the most in 2011 compared to the annual average in the past decade, largely due to the many mega-disasters that hit Japan (earthquake, tsunami), China (earthquake, floods, storms), and Thailand (flood).

Although the negative side of natural disasters seems apparent, (Popp 2006) proposes that the temporary inability to accumulate physical capital may have a net positive effect on the growth of human capital. (Albala-Bertrand 1993); (Dacy 1969) found that the gross domestic product (GDP) generally increases in the period immediately following a natural disaster. In addition, (Skidmore and Toya 2002) discovered that climatic disasters are positively correlated with the accumulation of

human capital, total factor productivity growth, and GDP per capita growth. Therefore, natural disasters serve as a means of "creative destruction" through R&D spillover (R&D stock embodied in the imports of developing countries) by providing an opportunity for capital accumulation and enabling a greater growth of GDP per capita in the long term (Crespo Cuaresma J 2008).

When natural disasters occur, it is necessary to measure the frequency and value of economic loss, and estimate how long the export and import recovery will take, in order to better plan for the next catastrophic event, since no theory can directly explain the relationship between natural disasters and international trade in both exports and imports. Furthermore, despite there being huge progress in analyzing the effect of natural disasters on international trade in exports and imports in recent years, empirical research on the connection between natural disasters and the accumulation of human capital and physical capital is conspicuous by its absence. The most recent relevant research was the work of Skidmore and Toya in 1990. Therefore, this paper aims to investigate the linkage between natural disasters and international trade, as well as the relationship between natural disasters and the accumulation of both human and physical capital. The scope of the study, hypothesis, and recent information about disasters throughout the world will be presented, and this will be followed by a review of empirical studies and theoretical evidence of the impact of natural disasters on human and physical capital. Subsequently, the research methodology will be explained, and the results of the study will be summarized and discussed in the last section of this paper.

1.2 Research question

- Do natural disasters effect on international trade?
- Do natural disasters effect on countries' capital?

1.3 Research objectives

- To determine the effect of total natural disasters –Climatological disasters, Geophysical disasters, Meteorological disasters and Hydrological disasters on exports and imports[1].
- To analyze the effect of natural disasters –Climatological disasters, Geophysical disasters, Meteorological disasters and Hydrological disaster- on human capital accumulation and physical capital investment.

1.4 Scope of Study

This empirical analysis will be confined to the number and frequency of natural disasters. It mainly adopts the Skidmore and Toya approach (2002) to compare the value of economic loss caused by natural disasters in thousands of US dollars and the effect of four types of natural disaster (based on the recent classification of the CRED. these consist of Climatologically disasters, Geophysical disasters, Hydrological disasters, and meteorological disasters) on international trade (export and import volume). The effect of either the frequency or value of economic loss caused by natural disasters on the accumulation of human capital and physical capital investment will also be explored. Moreover, the scope of this empirical analysis is confined to disasters that occur in countries on three income-levels, as identified by the World Bank, using gross national income (GNI) per capita: (i) low-income countries (earnings of $1,035 or less), (ii) middle-income countries (earnings of $1,036- $12,615) and (iii) high-income countries (earnings of $12,616 or more). The yearly panel data of 49 countries from 1990 to 2010 are used for the panel data model.

[1] Export volume and Import volume

1.5 Hypothesis

1.5.1 H_0: Natural disasters have no effect on Exports.

H_1: Natural disasters have an effect on Exports.

1.5.2 H_0: Natural disasters have no effect on Imports.

H_1: Natural disasters have an effect on Imports.

1.5.3 H_0: Natural disasters have no effect on human capital accumulation.

H_1: Natural disasters have an effect on human capital accumulation.

1.5.4 H_0: Natural disasters have no effect on physical capital investment.

H_1: Natural disasters have an effect on physical capital investment

CHAPTER II

Literature review

The literature review for this thesis contains seven main components, namely categories of natural disasters, creative destruction impact on economic growth, natural disasters and natural resources, natural disasters, human capital and economic growth, human capital accumulation and secondary school enrollment, growth determinants and natural disasters, and natural disasters and trade.

2.1 Categories of Natural disasters

There were two types of natural disaster in 1990, namely Climatological disasters and Geophysical disasters (see Table II-1). Climatological disasters are climatic disasters caused by atmospheric processes and the main result is a change in the normal water cycle. Climatological disasters contain two-interrelated subgroups, namely meteorological disasters, and hydrological disasters, and floods, hurricanes, and drought are the major disasters in this group. In contrast, geophysical disasters occur on solid ground or are caused by the movement of the earth's plates. Examples of this category include earthquakes, volcanic eruptions, landslides, avalanches, and other dry mass movements.

TableII 1 Old Type of Disaster Classification in 1990

Disaster	Disaster Main Types
Climatological	Extreme Temperature,Drought, Wildfire, Storm, Flood
Geophysical	Earthquake,Volcano, Mass Movement, Tsunami

Source: See Skidmore and Toya (2002), Center for research on the Epidemiology of Disasters: (CRED)(1990)

Climatological disasters are atmospheric phenomena caused by long-term climate change. The climatic disaster group includes extreme temperatures (heat wave, cold wave, and extreme winter conditions), drought, and wildfires (forest fire,

land fire). Hydrological disasters, i.e. floods, take place when the normal water cycle deviates and/or bodies of water overflow their banks. Meteorological disasters involve short-term or sudden changes in atmospheric processes, such as storms and hurricanes. In short, climatic disasters affect people and capital through forces of wind and water.

Geophysical disasters consist of earthquakes, volcanic eruptions, and other disasters related to geologic changes. Earthquakes are the most hazardous geologic disaster, depending on the area and size of the quake. Geophysical disasters can produce other associated or secondary disasters; for instance, earthquakes can lead to tsunamis, landslides, and severe aftershocks, while the eruption of volcanoes, similar to earthquakes, can cause tsunamis.(Abbott 2004).

The Centre for Research on the Epidemiology of Disasters(CRED) in Brussels categorizes new sub-groups of natural disasters. There were four broad categories of natural disasters in 2011, namely Climatological, Geophysical, Meteorological and Hydrological disasters, as shown in Table 1 (see Table II-2 below).

TableII 2 Definition and Classification of Types of Disaster in 2011

Disaster	Definitions	Disaster Main Types
Climatological	Events caused by long-lived/meso to macro scale processes (in the spectrum from intra-seasonal to multi-decadal climate variability)	Extreme Temperature, Drought, Wildfire
Geophysical	Events originating from solid earth	Earthquake, Volcano, Mass Movement (dry)
Meteorological	Events caused by short-lived/small to meso scale atmospheric processes (in the spectrum from minutes to days)	Storm, Hurricanes, Typhoons
Hydrological	Events caused by deviations in the normal water cycle and/or overflow of bodies of water caused by wind set-up	Flood, Mass Movement (wet)

Source: Annual Disaster Statistical Review 2011, the numbers and Trends, CRED, 2012

2.2 Creative Destruction Impact on Economic Growth

(Cuaresma et al 2008) suggest that natural disasters serve as a means of creative destruction by supporting the improvement of capital instruments in countries hit by disaster. Natural disasters can empower the long-term growth rate of GDP per capita. They estimate the knowledge flow and R&D stock incorporated in imports from G5 countries to a sample of 49 developing countries. The results showed that a country whose level of capital stock has decreased due to loss from disasters may be motivated to replace it with capital that embodies new technologies. This would decrease the potential damage from future disasters and raise the growth of GDP per capita. In accordance with the endogenous growth theory, this is called "Creative Destruction", which has lately become a crucial explanation of long-term economic growth (Howitt 2004, Okuyama 2004) argue that, when a disaster damages capital stock, older buildings or machines are more likely to be destroyed; therefore, the replacement of these facilities will generate a positive productivity shock, which may have a permanent impact on the growth rate of the whole economy.

However, economists have still not reached a consensus regarding the effect of natural disasters on long-term growth. Very few studies have concluded that natural disasters are able to promote long-term growth. According to (Skidmore and Toya 2002), climatic disasters, excluding drought, lead to an increased growth rate, while geologic disasters have the opposite effect. The increase in growth rate after climatic disasters comes from an increase in the accumulation of human capital and technologies. The decrease in economic growth after geological disasters is caused by a decrease in physical capital and the loss of human capital caused by the initial loss of life. Therefore, the total effect of natural disasters on countries' long-term growth is rather ambiguous (Skidmore and Toya, 2002).

2.3 Natural Disasters and Natural Resource

(Popp 2006) indicates that natural disasters have a negative effect on the stock of natural resources in the short term; however, the impact of natural disasters on countries natural resources is not all negative. Benefits from disasters may not be instant and direct, but appear over the long term, and this is most evident in the agricultural sector, where farmers will not benefit from disasters immediately. There may be sudden damage to crops, but benefits such as fertile soil and water for reservation may follow. However, the net result of natural disasters on natural resources will greatly depend on the circumstances, the characteristics of the country, and the type of disaster.

2.4 Disasters, human capital accumulation and economic growth

Growth Approach

This starts with a basic analysis using a growth equation with y representing the total output per capita at time t, h is the level of human capital per capita, and k is the capital stock per capita. A is a coefficient that represent the level of technology. Therefore, the Cobb-Douglas production function is as follows:

$$y=A_t k_t^{\alpha} h_t^{1-\alpha}$$

Then, transform the function into a growth equation production.

$$\frac{\dot{y}_t}{y_t} = \frac{\dot{A}_t}{A_t} + \alpha \frac{\dot{k}_t}{k_t} + (1-\alpha)\frac{\dot{h}_t}{h_t}$$

This equation shows if disasters have an effect on long-term growth. The effect of natural disasters is shock for accumulation that consists of human capital, namely learning by doing, and the accumulation of physical capital in the form of capital stock, according to the output. Therefore, natural disasters would be a crucial factor of investment decisions and the adoption of new technology. In terms of the accumulation of human capital, according to (Drazen 1993) the endogenous growth theory introduced by (Lucas 1998), human capital is a vital key to economic growth. (Skidmore and Toya 2002) consider that the increase in the risk of the destruction of

human and physical capital will be lower when it is substitutable to capital accumulation.

(Dacy 1969) discussed and proposed a theoretical analysis of behavior following natural disasters in two phases: 1) The short-term recuperation phase was examined using a microeconomic theory, such as decision- making and the law of demand and supply; and 2) The long-term recovery problem was investigated using a macroeconomic theory, such as the economic growth theory. The impact of natural disasters on physical capital accumulation plays a vital role in achieving economic growth by enabling workers to produce more than they could without tools. Since economic growth is directly related to the output of each worker, a greater amount of physical capital in an economy should yield a higher level of per capita income.

(Rasmussen 2004) denotes that natural disasters could permanently reduce growth by destroying agricultural, fishery, or other natural resources. He also points out that reconstruction efforts could crowd-out productivity investment, increase interest rates, and reduce investment, leading to inflation or financial crises, all of which would decrease economic growth. A regression analysis of the occurrence of natural disasters, controlling for affected land area and population, found a positive, but only marginally significant relationship with GDP growth, which "could be driven by other factors". (Noy. 2010) found that growth in poor countries is likely to suffer more severely from further disasters in the short term.

(Auffret 2003) found that the effect of natural disasters on long-term growth is difficult to predict because countries' growth prospects depend on how much they improve after the reconstruction attempt; moreover, the substitution of physical capital is crucial. If the economy cannot or does not replace the physical capital, this will have a negative effect on the growth rate. However, there is no empirical evidence to support this claim. Similarly, (Clay 2003) emphasize that the economic impact of natural disasters depends on several factors, but there are few reasons to show that natural disasters generate long-term growth. They highlight the fact that each natural disaster has a unique effect and that most studies have found that natural disasters do not greatly affect long-term growth, although the results tend to be ambiguous. According to (Popp 2006), the effect of natural disasters is part of the

key macroeconomic variables that determine long-term economic growth. Natural resources, the accumulation of physical capital, the accumulation of human capital, and technologies are the four key macroeconomic variables studied; however, it is still uncertain that these can generate net positive growth, even when natural disasters occur.

2.5 Human capital accumulation and secondary school enrollment

An advanced research qualification WTO (2009) ordinarily requires minimum condition of admission, secondary education attainment as determinant of human capital accumulation. (Sabot 1990) suggests that the human capital accumulation that occur during secondary school enrollment increases wages around 25 percent in urban labor markets in East Africa. (Jamison 1982) supports that secondary education can improve productivity, both agriculture and non-agriculture. (Daniele Checchi 2007) need to clarify the relationship between enrolment rates and human capital effect on FDI flow, thus they have experimented with optional measures of human capital stock in term percentage of three population educational attainment; primary, secondary and tertiary education. FDI be attracted by existing educational endowment of human capital, but only at the secondary school level. They find that only the population share with secondary school attainment is statistically significant. This measure of human capital stock is positively correlated with FDI inflow. In such a case the local endowment of human capital is the incentive to further human capital accumulation.

2.6 Growth Determinants and Natural Disasters

By using panel dataset overlaping 5-year period with crossing developed and developing country & time series, (loayza and Olaberria 2009) concluded in their study that natural disasters have diverse effects on growth performance in different sectors. The Service sector had the fastest growth performance, followed by industrial sector and agricultural sector at the rate of 1.83 percent, 1.73 percent, and 0.33 percent respectively. Transititional convergence, structural& stabilization impact

to monetary and fiscal policies and institutions were measured. The variables of natural disasters have proxy the role of external conditions that could impact the growth performance across countries, shocks to the terms of trade, which are measured by the growth rate of terms of trade represented by export prices in relation to import prices) over each five-year period. Period-specific dummies variables were included in the regressions to capture the shiefts in the exports demand of the country. Since terms of trade rely heavily on global conditions that assumed to be exogenous to a country's contemporaneous growth of per capita GDP and take in period-specific dummies in order to capture the impact of other global shocks to growth across countries. Therefore, it was found that droughts's negatively impact on agricultural growth and industry, especially in developing countries. Storms cause a reduction in agricultural growth but an increase in industrial growth in delevoping countries. Similarly, earthquakes bring about higher industrial growth. In contrast, on the average temperate floods have a positive effect on agricultural growth, and other sectors of the economy. It is likely that localized flood reflects general of rain fall.

(Albala-Bertrand 1993) found the expected fall in the growth rate of output from disasters. Capital loss appears to represent only a small fraction of the ratio disaster loss-to-output in LatinAmerica, even before applying the more realistic corrections to both actual losses and the incremental capital-output ratio. The total compensatory expenditure, and especially the minimum compensatory reconstruction investment, required keeping the level of output as if there were no disaster. It appears to be an even smaller fraction of the disaster loss ratio. This finding implies that the required reconstruction effort in each year rarely needs to be large, even in case of a massive natural disaster (i.e. very large ratio of direct disaster loss-to-output) - even less if emergency recovery activities are taken to represent at least in part additional expenditure in the economy. The reconstruction effort can be both moderate and spread over a number of years without negative effects on output.

2.7 Natural disasters and trade

(Gassebner M. 2006) observe that natural disasters reduce trade in both exporting and importing countries and the government is one of the key factors to determine the magnitude of their effect on trade. In particular, the lower the level of democracy in a country, the more the trading loss. This statement is supported by (Oh 2009), who applies a large-N analysis using a sample of countries and years to demonstrate that an increase in climatic disasters and political risk can lessen bilateral trade in both importing and exporting countries. Countries with lower political risk experience a smaller reduction in the flow of trade, even when they are more frequently struck by climatic disasters. The results of climatic disasters have a macroeconmic impact on a variety of economic variables, for example, consumption, investment, and government expenditure, due to the essential role of economics and trade in the global system. Moreover, technological improvement can reduce the vulnerablility of trade resulting from climatic disasters by considering the relocation of industrial facilities for export to safer areas. The production capacity of small-exporting countries is especially vulnerable to external shocks (Gassebner et al, 2006). For example, (Mohan 2009) used data obtained from 24 countries in the Caribbean and Central American region for the period from 1961 to 2009 to prove that hurricanes have a significant negative effect on exports, particularly agricultural, in the year they attack, as well as the subsequent year. Finally, (Bluedorn 2005) maintains that hurricanes in Central America and the Caribbean region evoke a temporary trade reaction to the damage and loss they cause. The damage caused by hurricane disasters can ruin the GDP in the affected country in one year by decreasing the value of the current account to GDP.

The literature reviewed above provides a few basic ideas about the effect of natural disasters on international trade that indicate that natural disasters can increase countries' accumulation of human capital and decrease their physical capital. However, no economic studies have closely investigated the link between types of natural disaster and international trade. Therefore, this study seeks to fill the gap in the literature by further examining the effect of different types of natural disaster on countries' exports and imports.

CHAPTER III
RESEARCH METHODLOGY

3.1 Conceptual Framework

Natural disasters certainly have an effect on countries' exports and imports. The areas mainly affected by natural disasters appear to be loss of infrastructure (buildings, roads, telecommunications, water supply facilities, and other related infrastructure), the death of humans and livestock, disease and injury, as well as psychological damage, including depression, anxiety, and weariness. Loss of income and other losses from destruction also directly affect international trade.

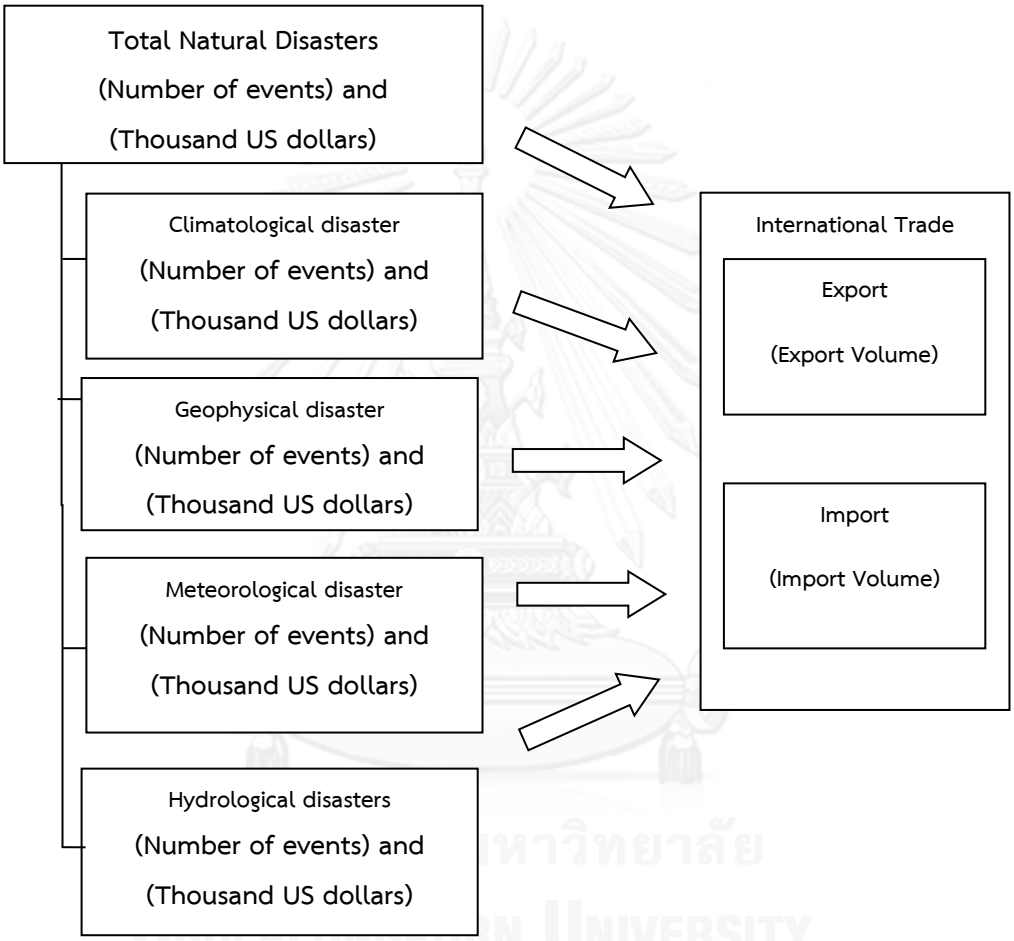
The accumulation of human capital and physical capital investment is also affected. Damage from disasters could add extra costs to producers from the need to use alternative or potentially inferior means of production and/or distribution of good and services. These collective losses contribute to the overall performance of countries' exports and imports, especially in terms of the growth rate of GDP per capita, fertility, and government expenditure. (Skidmore and Toya 2002) also note that the risk of disasters greatly influences the decision of companies in disaster-prone areas to invest more or adopt new technologies. However, not all the effects of natural disasters are negative. For example, (Popp 2006) believes that it is possible for natural disasters to have a positive impact on macroeconomic variables, depending on the country's institutions and how well it recovers from each particular disaster. According to him, any effort by countries to prepare for disasters, recover from the devastation, and improve their institutions after a natural disaster will undoubtedly reap rewards in the long term.

This study employs an adaptation and revision of the Skidmore and Toya model in order to analyze the direct effect of natural disasters on international trade and on countries' capital. Natural disasters are divided into two main categories (1) frequency of natural disasters (events), (2) value of economic loss of natural disasters (in thousands of US dollars). Moreover, natural disasters are categorized as four main types, namely Climatological, Geophysical, Meteorological and Hydrological. The differences in countries' income level are analyzed according to the objectives of the study (see Figures III-1 and III-2).

3.2 Research method flow chart

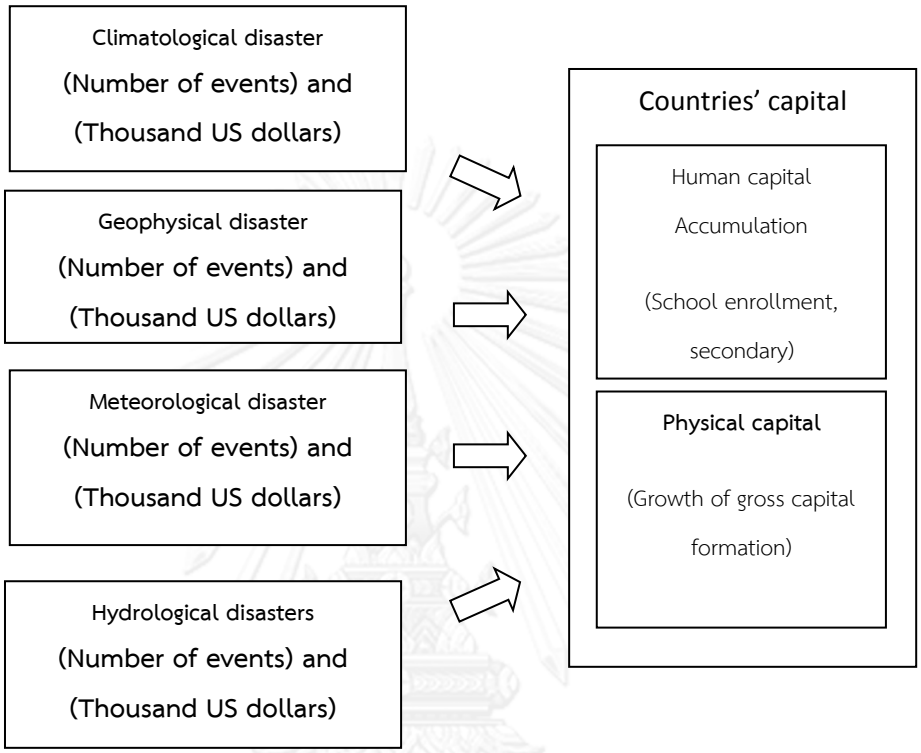
Part 1. Natural disasters and International trade

Figure III-1 Both Frequency and Value Economic Loss of Natural disasters on International Trade



Part2. Natural disasters and countries' capital

Figure III-2 Both Frequency and Value the Economic Loss of Natural Disasters on Human capital accumulation and physical capital



3.3 Expected signs of variables

According to the literature review, the coefficient sign of the frequency of natural disasters is expected to be in the same direction as the coefficient sign of the effect of the economic loss of natural disasters on international trade. This study will divide the prediction of the signs into 2 main parts: (1) the prediction of the sign of variables on international trade, namely exports and imports (2) the expectation of the sign of variables on countries' capital, namely the accumulation of human capital and physical capital investment.

Part 1.Expected signs of the effect of natural disaster and international trade

Total Natural disasters and International trade

$$\ln(export)_{it} = \beta_1 + \beta_2 (income)_{it} + \beta_3 (fert)_{it} + \beta_4 (govc)_{it} + \beta_5 (disasters)_{i,t-k} + \varepsilon_1$$

$$\ln(import)_{it} = \gamma_1 + \gamma_2 (income)_{it} + \gamma_3 (fert)_{it} + \gamma_4 (govc)_{it} + \gamma_5 (disasters)_{i,t-k} + \varepsilon_2$$

Table III 1 Expected signs of total natural disaster and international trade

Variables	Expected Sign	Reason of expected signs
		Description
income growth (income)	+	The sign of the coefficient depends on countries' income level. Normally, countries import more goods as the initial income rises. Due to the convergence effect, countries with low initial income develop faster; thus, they produce more and exceed supply and tend to export more goods and services. Therefore, the predicted sign of initial income could be positive on international trade.
Fertility (fert)	-	Countries with a low fertility rate have lower domestic consumption leading to an excess supply. They export more goods and services. At the same time, countries with a low fertility rate have higher disposable income and more purchasing power, thus they tend to import more luxury goods and machinery. Therefore, fertility could be a negative sign for international trade.
Government consumption (govc)	+	Government expenditure stimulates investment in infrastructure e.g. transport, storm water drains, roads, hospitals, and schools. These projects normally involve international companies, technologies, consultants and/or materials, so that government expenditure can increase import volume. At the same time, the country's economy

		will grow due to the increment of government expenditure, demand will increase and raise the price of local products. More goods and services will be produced leading to excess supply. So, the prediction sign of government consumption is positive for international trade
total disasters (disasters)	-/+	Natural disasters can have a positive or negative impact on international trade. On the negative side, disasters damage the agricultural sector, diminishing the supply of food and goods. Disasters cause production activities to stagnate almost immediately. Export and investment are interrupted, and households lose income. However, countries will import commodities to substitute domestic production along with new machinery and equipment for restoration and rebuilding.

Four types of Natural disasters and International trade

$$\ln(export)_{it} = \beta_1 + \beta_2(income)_{it} + \beta_3(fert)_{it} + \beta_4(govc)_{it} + \beta_6(climate)_{i,t-k} + \beta_7(geo)_{i,t-k} + \beta_8(meteo)_{i,t-k} + \beta_9(hydro)_{i,t-k} + \varepsilon_3$$

$$\ln(import)_{it} = \gamma_1 + \gamma_2(income)_{it} + \gamma_3(fert)_{it} + \gamma_4(govc)_{it} + \gamma_6(climate)_{i,t-k} + \gamma_7(geo)_{i,t-k} + \gamma_8(meteo)_{i,t-k} + \gamma_9(hydro)_{i,t-k} + \varepsilon_4$$

Table III 2 Expected signs of each type of natural disaster and international trade

Variables	Expected Sign	Reason of expected signs
		Description
income growth (income)	+	The sign of the coefficient depends on countries' income level. Normally, countries import more goods as the initial income rises. Due to the convergence effect, countries with low initial income develop faster;

		thus, they produce more and exceed supply and tend to export more goods and services. Therefore, the predicted sign of initial income could be positive on international trade.
Fertility (fert)	-	Countries with a low fertility rate have lower domestic consumption leading to an excess supply. They export more goods and services. At the same time, countries with a low fertility rate have higher disposable income and more purchasing power, thus they tend to import more luxury goods and machinery. Therefore, fertility could be a negative sign for international trade.
Government consumption expenditure (govc)	+	Government expenditure stimulates investment in infrastructure e.g. transport, storm water drains, roads, hospitals, and schools. These projects normally involve international companies, technologies, consultants and/or materials, so that government expenditure can increase import volume. At the same time, the country's economy will grow due to the increment of government expenditure, demand will increase and raise the price of local products. More goods and services will be produced leading to excess supply. So, the prediction sign of government consumption is positive for international trade.
Climatological (climate)	-	Climatological disasters could lead to decreased international trade according to the literature review.

		An increment of climatic disasters and political risk can reduce the bilateral trade of both importing and exporting countries. Therefore, the expected sign of Climatological could be negative.
Geophysical (geo)	-	Geological disasters (e.g. volcano, earthquake and tsunami) are likely to reduce the volume of exports. When disasters strike, domestic production will automatically decrease, causing the contraction of exports. Therefore, the expected sign of Geophysical disasters could be negative.
Meteorological (meteo)	-	Meteorological disasters could have a negative impact on trade. As stated in the literature review, hurricanes have a significant negative impact in the Caribbean and Central American region, particularly on agricultural exports. An increment of meteorological disasters can decrease the bilateral trade of both importing and exporting countries. Therefore the expected sign could be negative.
Hydrological (hydro)	+	Hydrological disasters have a positive impact on international trade. These kinds of disasters do not impact countries as a whole. Some regions may experience hydrological disasters but they are able to build embankments and dams to prevent flood damage when disaster strikes again so that they can still export and import goods and services.

Part 2. Expected signs of Natural disaster and countries' capital

Consistent with the literature review, the coefficient sign of the frequency of natural disasters is expected to be in the same direction as the coefficient sign of the effect of the economic loss caused by natural disasters on countries' capital.

Total Natural disasters and Human capital accumulation

$$\ln(school)_{it} = \alpha_1 + \alpha_2 (income)_{it} + \alpha_3(disasters)_{i,t-k} + \varepsilon_9$$

$$\ln(school)_{it} = \alpha_1 + \alpha_2 (income)_{it} + \alpha_3(climate)_{i,t-k} + \alpha_4(geo)_{i,t-k} + \alpha_5(meteo)_{i,t-k} + \alpha_6(hydro)_{i,t-k} + \varepsilon_{10}$$

Table III 3 Expected signs of Human capital and natural disasters

Variables	Expected Sign	Reason of expected signs
		Description
income growth	+	When annual initial income increases, laborers tend to acquire new skills and enhance their knowledge for professional development. They demand more education and training. The new skills and knowledge they develop accumulates human capital. In addition, as income rises, parents tend to pay more for the quality and level of their children's education. This also leads to accumulating human capital. Thus, the initial income will be a positive sign for human capital.
total disasters	+	Total natural disasters may have a positive impact on the accumulation of human capital. Countries that

		continuously risk the impact of natural disasters, countries exposed to disasters, and countries located in disaster-prone areas will invest in research and development, new technologies, and innovation to better forecast natural disasters and prevent damage and destruction. They are able to learn all knowledge spillover resulting in the accumulation of human capital of many generations. For this reason, the sign is expected to be positive.
Climatological	-	Agriculture is a sector greatly affected by climatological disasters such as drought and wildfire. Farmers cannot grow and harvest. Crop and farm production are diminished. Loss of income and loans will impel countries' capital. In contrast, some families may not have enough money for their children's education and may need more laborers for their crop and farm production. Disruption from climatic disasters causes lower quality and level of education. Consequently, they reduce human capital accumulation.
Geophysical	-	Geologic disasters could have a negative sign because of the loss of human capital with the initial loss of life. Therefore, some people will emigrate from disaster-prone areas, thus decreasing the accumulation of human capital.
Meteorological	+	Meteorological disasters, previously classified as climatic

disasters		disasters in the 1990s, mainly consist of storms. According to the literature review, there is a positive correlation between climatic disasters and the accumulation of human capital. Thus, meteorological disasters will also have a positive effect on human capital accumulation, so the sign is expected to be positive.
Hydrological	+	Hydrological disasters, namely flood and mass wet movement, were categorized as climatic disasters in the 1990s. According to the literature review, climatic disasters are positively correlated with the accumulation of human capital and technological advancements. Therefore, hydrological disasters will also have a positive effect on human capital accumulation and are expected to have a positive sign.

Natural disasters and Physical capital

$$(gcap)_{it} = \mu_1 + \mu_2 (income)_{it} + \mu_3 (school)_{it} + \mu_4(disasters)_{i,t-k} + \varepsilon_{13}$$

$$(gcap)_{it} = \mu_1 + \mu_2 (income)_{it} + \mu_3 (school)_{it} + \mu_4(climate)_{i,t-k} + \mu_5(geo)_{i,t-k} + \mu_6 (meteo)_{i,t-k} + \mu_7 (hydro)_{i,t-k} + \varepsilon_{14}$$

Table III 4 Expected signs of Physical capital and natural disasters

Variables	Expected Sign	Reason of expected signs
		Description
income growth	+	The initial income or growth rate of GDP per capita could be a negative sign due to the “convergence effect”. Countries with

		low initial income develop faster, and with more productivity, personal sectors, public sectors, and private sectors are likely to spend more money, thereby increasing consumption and investment.
secondary school enrollment	-	Education accumulates human capital. Students will acquire more knowledge and new technologies in countries with a better developed higher educational level or quality of education. As a result, the accumulation of human capital will substitute physical capital investment causing a decrease in the growth and investment in physical capital stock. In this case, secondary school enrollment could have a negative sign.
Total disasters	-	Natural disasters stop and/or delay the production process prompting a decrease in investment. Physical infrastructure (i.e. roads, railway tracks, telephone lines) are damaged or completely destroyed. Transportation is interrupted causing difficulty in movement of goods and services so that more money needs to be spent and more investment must be poured into the country. Hence, the sign of the growth of physical capital is expected to be negative.
Climatological disasters	-	Drought, wildfire and extreme temperatures have a great impact on living beings and forestry, so that the growth of physical capital and investment will decrease. This implies that climatological disasters could be a negative sign for the growth of physical capital and investment
Geophysical	-	Geologic disasters could have a negative sign because of a

disasters		decrease in physical capital and the initial loss of life and assets (e.g. houses, cars, lines). Some people will move away from disaster-prone areas, thereby decreasing the growth of physical capital and investment.
Meteorological disasters	-	According to the literature review, meteorological disasters mainly consist of storms (e.g. hurricanes, typhoons, cyclones). When storms hit an area, infrastructure and assets will be lost and the growth of physical capital will decrease. Thus, metrological disasters are expected have a negative sign.
Hydrological disasters	+	Hydrological disasters can be beneficial. A variety of new infrastructure, such as embankments and dams, will be built to prevent water overflow and/or flash flood when the next disaster strikes and rebuilding the area will generate work, income, and physical capital investment. On the other hand, knowledge and technological advancement will be stimulated to find ways to predict and prevent future destruction; therefore, hydrological disasters could have a positive sign.

3.4 Methodology and Technique

This study employs an adaptation and revision of the Skidmore and Toya model (2202) in an attempt to analyze the direct effect of natural disasters on international trade and on countries' capital using panel data. Yearly panel time series data of the number of natural disasters in each of the 49 countries included in the sample during the period from 1990 to 2010 are used to run a panel regression model to analyze the objectives stated below.

The effect of the frequency of total natural disasters and the value of the economic loss of exports and imports caused by four main types of natural disasters (Climatological disasters, Geophysical disasters, Meteorological disasters and Hydrological disasters) is analyzed in part one. This is followed by an exploration to determine the direct economic loss to international trade caused by natural disasters, valued in terms of thousands of US dollars of damage (controlling for variables such as income growth, fertility rate and government expenditure).

The effect of the frequency of each type of natural disaster and the value of economic loss on the accumulation of human capital and physical capital investment caused by natural disasters are analyzed in part two of the paper. Additionally, this study uses a time-lag method to determine how long it takes for international trade to recover when natural disasters occur. The maximum lag is 13 years because it is not significant after that. The relationship between the effect of natural disasters on export volume and import volume is interpreted in terms of percentages; for example, if the number of natural disasters change by 1 percent, how much the export volume will increase or decrease as a percentage.

Ordinary Least Square (OLS)

Two main equations use an export and import fixed-effect design (e.g., Feenstra R. (2003); Gil-Pareja S (2006) and these are widely-used to calculate the effect of natural disasters on international trade.

Simple Model:

$$\ln(export)_{it} = \beta_1 + \beta_2 (income)_{it} + \beta_3 (fert)_{it} + \beta_4 (govc)_{it} + \beta_5 (disasters)_{i,t-k} + \varepsilon_1 \quad (1)$$

$$\ln(import)_{it} = \gamma_1 + \gamma_2 (income)_{it} + \gamma_3 (fert)_{it} + \gamma_4 (govc)_{it} + \gamma_5 (disasters)_{i,t-k} + \varepsilon_2 \quad (2)$$

where the subscript i denotes country, t denotes year, i denotes country, k denotes the number of lag-times for k = 0, 1, 2,..n and the Greek symbols denote the empirically-estimated coefficients. Equations 1 and 2 are the two main equations used to calculate the effect of natural disasters on international trade, which employ the widely-used export and import in fixed-effect model (e.g., (Robert Feenstra 1962-2000);(Gil-Pareja 2006).)

The dependent variables, $export_{it}$ and $import_{it}$ are the export volume and import volume reported by 49 countries respectively. There is a rival independent variable, or key variable, of total natural disasters lagged k year. The variable $disasters_{i,t-k}$ measures the logarithm of (1 + number of total disasters events) following (Skidmore and Toya 2002) for the period between 1990 and 2010 in 49 countries in t-k year (see Appendix B). Total natural disasters consist of Climatological disasters, Geophysical disasters, Meteorological disasters and Hydrological disasters. The level of natural disasters is set to zero in years when there were no natural disasters. This study includes the usual control variables, such as $income_{it}$ which measures the income growth for the period 1990-2010, $fert_{it}$, which measures the fertility rate for the period 1990-2010, $govc_{it}$, which measures the ratio of government consumption expenditure to real GDP for the period 1990-2010. These control variables are not lagged. This model focuses on countries with three different income levels: (low-income, middle-income and high-income) that are affected by international trade, more precisely, the volume of exports and imports.

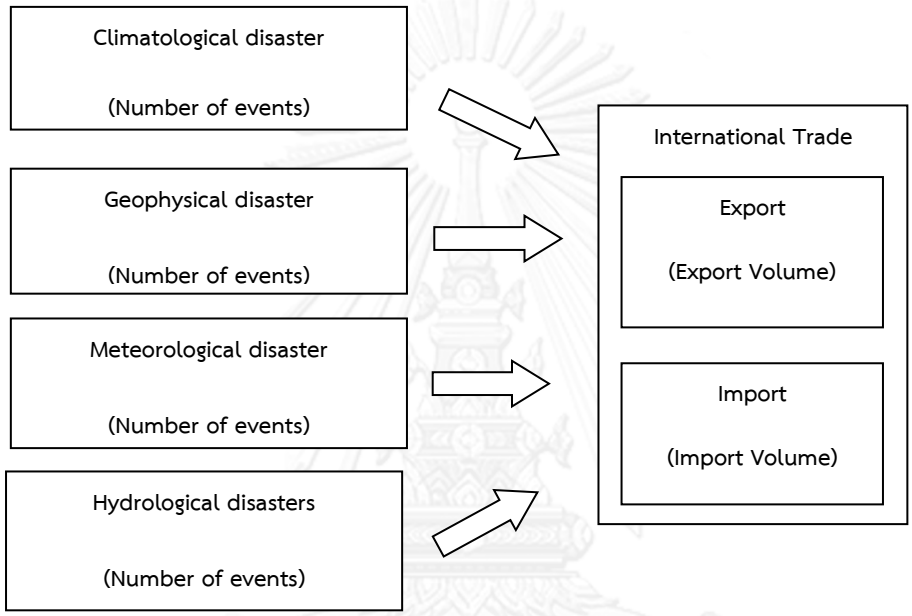
3.5 Estimation

Part 1.

3.5.1 Impacts of natural disasters on international trade

Frequency of natural disasters and international trade

Figure III-3 Frequency of natural disasters and their effect on international trade



We study the frequency of natural disasters, a number of events from each type of natural disasters (Climatological disaster, Geophysical disaster, Meteorological disaster, Hydrological disasters) on international trade (export volume and import volume) in 49 countries, see figureIII-3, as result that

$$\ln(export)_{it} = \beta_1 + \beta_2 (income)_{it} + \beta_3(fert)_{it} + \beta_4(govc)_{it} + \beta_6(climate)_{i,t-k} + \beta_7 (geo)_{i,t-k} + \beta_8(meteo)_{i,t-k} + \beta_9(hydro)_{i,t-k} + \varepsilon_3 \quad ...(3)$$

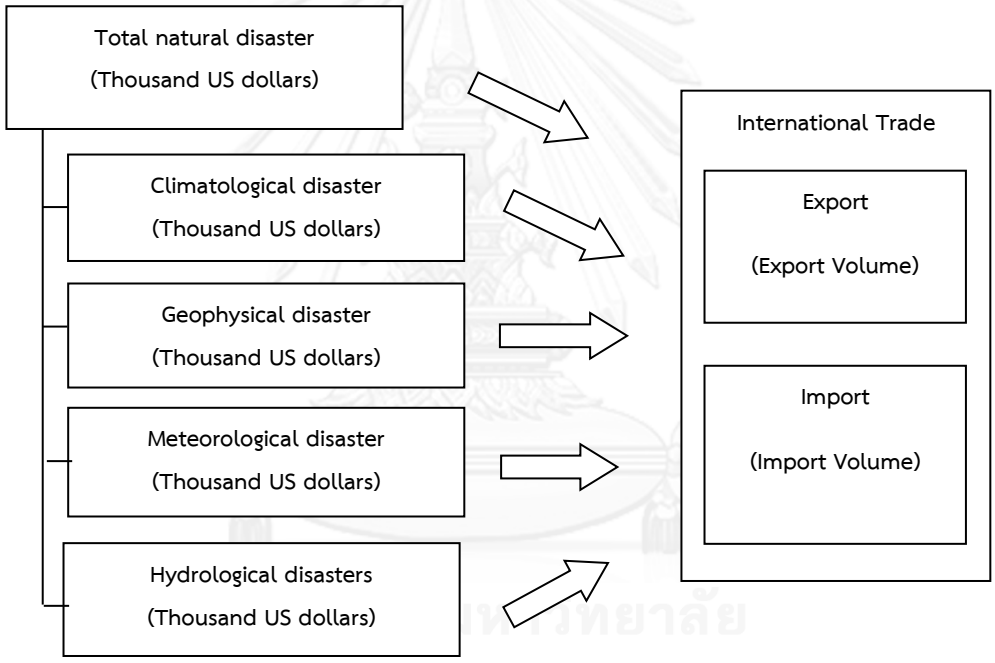
$$\ln(import)_{it} = \gamma_1 + \gamma_2 (income)_{it} + \gamma_3 (fert)_{it} + \gamma_4(govc)_{it} + \gamma_6(climate)_{i,t-k} + \gamma_7(geo)_{i,t-k} + \gamma_8(meteo)_{i,t-k} + \gamma_9(hydro)_{i,t-k} + \varepsilon_4 \quad ...(4)$$

The year lags on each type of natural disaster variable is used, but no other control variable. Equations (3) and (4) examine the same four independent variables, namely $climate_{i,t-k}$ measures the logarithm of (1 + number of Climatological

disasters)(e.g., extreme temperature, drought, wildfire) in t-k year, $geo_{i,t-k}$ measures the logarithm of (1 + number of Geophysical disasters) (e.g., earthquakes, volcano eruptions, mass movement (dry)) in t-k year, $meteo_{i,t-k}$ measures the logarithm of (1 + number of Meteorological disasters) (e.g., storm) in t-k year and $hydro_{i,t-k}$ measures the logarithm of (1 + number of Hydrological disasters) (e.g., flood, mass movement (wet)) in t-k year. The study includes three usual control variables, namely $income_{it}$, $fert_{it}$, $govc_{it}$ which are not lagged.

Value of the economic loss of natural disasters to international trade

Figure III-4 Value of economic loss from natural disasters to international trade



As discussed below, the panel data of the value of the economic loss from natural disasters is used as an independent variable rather than the frequency of natural disasters (see Figure III-4). The value of the economic loss to international trade caused by total natural disasters (in thousands of US dollars) is employed in equations (5) and (6). Furthermore, the effect of each type of natural disaster on international trade is estimated in equations (7) and (8) as shown below.

$$\ln(export)_{it} = \beta_1 + \beta_2(income)_{it} + \beta_3(fert)_{it} + \beta_4(govc)_{it} + \beta_{10}(totalValue)_{it-k} + \varepsilon_5 \ldots \quad (5)$$

$$\ln(import)_{it} = \gamma_1 + \gamma_2(income)_{it} + \gamma_3(fert)_{it} + \gamma_4(govc)_{it} + \gamma_{10}(totalvalue)_{i,t-k} + \varepsilon_7 \ldots (6)$$

$$\ln(export)_{it} = \beta_1 + \beta_2 (income)_{it} + \beta_3 (fert)_{it} + \beta_4(govc)_{it} + \beta_{11}(Value1)_{i,t-k} + \beta_{12}(Value2)_{i,t-k} + \beta_{13}(Value3)_{i,t-k} + \beta_{14}(Value4)_{i,t-k} + \varepsilon_6 \quad ...(7)$$

$$\ln(import)_{it} = \gamma_1 + \gamma_2 (income)_{it} + \gamma_3 (fert)_{it} + \gamma_4 (govc)_{it} + \gamma_{10}(Value1)_{i,t-k} + \gamma_{11}(Value2)_{i,t-k} + \gamma_{12}(Value3_3)_{i,t-k} + \gamma_{13}(Value4)_{i,t-k} + \varepsilon_8 \quad ...(8)$$

where the $totalvalue_{i,t-k}$ measures the logarithm of (1 + value of the economic loss of total disasters in thousands of US dollars) of the 49 countries for the period between 1990 and 2010 lagged t-k year.

The total disasters were divided into four categories of natural disasters. There were four keys of value of the economic loss caused by natural disasters in the lagged t-k year. $Value1_{i,t-k}$ measures the logarithm of (1 + the value of the economic loss caused by climatological disasters in thousands of US dollars), $value2_{i,t-k}$ measures the logarithm of (1 + the value of the economic loss caused by geophysical disasters in thousands of US dollars), $value3_{i,t-k}$ measures the logarithm of (1 + the value of the economic loss of meteorological disasters in thousands of US dollars) and $value4_{i,t-k}$ measures the logarithm of (1 + the value of the economic loss of hydrological disasters in thousands of US dollars). We have the interpretation of parameters of natural disasters on international trade in table III-5 as following.

Table III 5 Interpretation of parameters of natural disasters on international trade

Coefficients	Description of coefficients of natural disasters on Export
β_5	For a given country, as disasters variable, logarithm of (1+Number of total disasters events), varies across time by one percent, export variable increases or decreases by β percent.
β_6	For a given country, as climate variable, logarithm of (1+Number of Climatological disasters events), varies across time by one percent, export volume increases or decreases by β percent.

β_7	For a given country, as geo variable, logarithm of (1+Number of Geophysical disasters events), varies across time by one percent, export volume increases or decreases by β percent.
β_8	For a given country, as meteo variable, logarithm of (1+Number of Meteorological disasters events), varies across time by one percent, export volume increases or decreases by β percent.
β_9	For a given country, as hydro variable, logarithm of (1+Number of Hydrological disasters events), varies across time by one percent, export volume increases or decreases by β percent.
β_{10}	For a given country, as totalvalue variable, logarithm of (1+value of the economic loss of total disasters in thousand US dollars), varies across time by one percent, export volume increases or decreases by β percent.
β_{11}	For a given country, as Value1 variable, logarithm of (1+value of the economic loss of Climatological disasters in thousand US dollars), varies across time by one percent, export volume increases or decreases by β percent.
β_{12}	For a given country, as Value2 variable, logarithm of (1+value of the economic loss of Geophysical disasters in thousand US dollars), varies across time by one percent, export volume increases or decreases by β percent.
β_{13}	For a given country, as Value3 variable, logarithm of (1+value of the economic loss of Meteorological disasters in thousand US dollars) varies across time by one percent, export volume increases or decreases by β percent.
β_{14}	For a given country, as Value4 variable, logarithm of (1+value of the economic loss of Hydrological disasters in thousand US dollars), varies across time by one percent, export volume increases or decreases by β percent.
Coefficients	Description of coefficients of natural disasters on Import

γ_5	For a given country, as disasters variable varies across time by one percent, import variable (import volume) increases or decreases by γ percent.
γ_6	For a given country, as climate variable varies across time by one percent, import volume increases or decreases by γ percent.
γ_7	For a given country, as geo variable varies across time by one percent, import volume increases or decreases by γ percent.
γ_8	For a given country, as meteo variable varies across time by one percent, import volume increases or decreases by γ percent.
γ_9	For a given country, as hydro variable varies across time by one percent, import volume increases or decreases by γ percent.
γ_{10}	For a given country, totalvalue variable varies across time by one percent, import volume increases or decreases by γ percent.
γ_{11}	For a given country, Value1 variable varies across time by one percent, import volume increases or decreases by γ percent.
γ_{12}	For a given country, Value2 variable varies across time by one percent, import volume increases or decreases by γ percent.
γ_{13}	For a given country, Value3 variable varies across time by one percent, import volume increases or decreases by γ percent.
γ_{14}	For a given country, as Value4 variable varies across time by one percent, import volume increases or decreases by γ percent.

Part2.

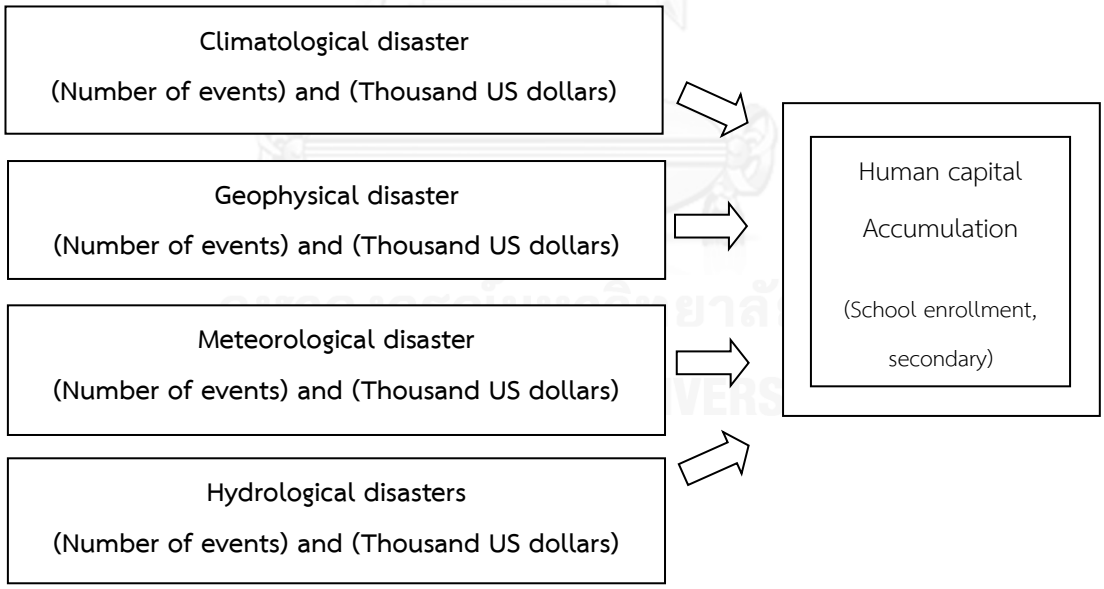
3.5.2 Impacts of natural disasters on countries' capital

This study makes an in-depth investigation of the effect of natural disasters on the accumulation of human and physical capital (see Figures III-5 and III-6) using the same panel dataset as in Part 1. However, only a few countries keep a record of these variables, namely, income and schooling. In fact, only 7 of the 49 countries provide relevant data. In terms of income level, these 7 comprise 6 middle-income countries and 1 high-income country.

The country-fixed effects cannot be included in the model due to the unavailability of a panel dataset, and the number of high-income countries that can be used for the estimation, specifically 1, is not able to represent the whole group. Therefore, only data on middle-income countries can be used to estimate the correlation.

Effect of natural disasters on the accumulation of human capital

Figure III-5 Effect of natural disasters on the accumulation of human capital



The control variable used to estimate the impact of natural disasters on the accumulation of human capital is income and the dependent variable is schooling, as shown below.

Effect of frequency of each natural disaster on the accumulation of human capital

$$\ln(school)_{it} = \alpha_1 + \alpha_2 (income)_{it} + \alpha_4(climate)_{i,t-k} + \alpha_5(geo)_{i,t-k} + \alpha_6(meteo)_{i,t-k} + \alpha_7(hydro)_{i,t-k} + \varepsilon_{10} \quad ...(10)$$

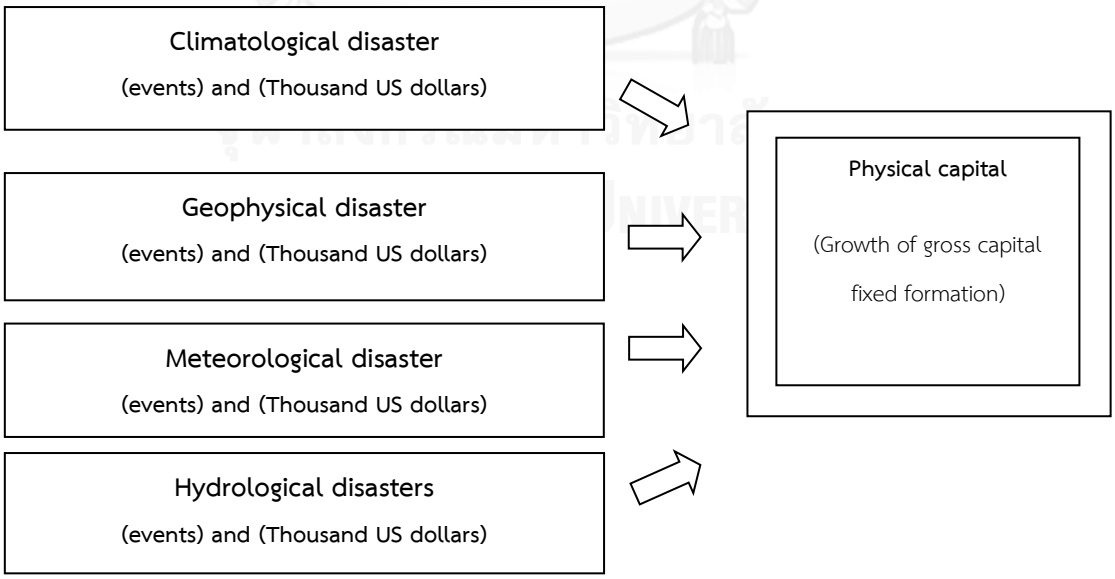
Value of the economic loss of each natural disaster to the accumulation of human capital

$$\ln(school)_{it} = \sigma_1 + \sigma_2 (income)_{it} + \sigma_4(Value1)_{i,t-k} + \sigma_5(Value2)_{i,t-k} + \sigma_6(Value3)_{i,t-k} + \sigma_7(Value4)_{i,t-k} + \varepsilon_{12} \quad ...(11)$$

The dependent variable, $school_{it}$ measures secondary school enrollment for the period between 1990 and 2010 as reported by the seven countries. They include the usual control variable, and $income_{it}$ measures the income growth following (Skidmore and Toya 2002) or the growth rate of GDP per capita for the period of 1990-2010, which is not lagged. Moreover, there are four independent variables for the frequency of each type of natural disaster, namely $climate_{i,t-k}$, $geo_{i,t-k}$, $meteo_{i,t-k}$, $hydro_{i,t-k}$ in equation (10), and the value economic loss; $value1_{i,t-k}$, $value2_{i,t-k}$, $value3_{i,t-k}$, $value4_{i,t-k}$ in equation (11).

Effect of natural disasters on the accumulation of physical capital

Figure III 6 Effect of natural disasters on the accumulation of physical capital



Effect of the frequency of each type of natural disaster on the accumulation of physical capital

$$(gcap)_{it} = \mu_1 + \mu_2 (income)_{it} + \mu_3 (school)_{it} + \mu_5(climate)_{i,t-k} + \mu_6(geo)_{i,t-k} + \mu_7 (meteo)_{i,t-k} + \mu_8 (hydro)_{i,t-k} + \varepsilon_{14} \quad ...(12)$$

Value of the economic loss of each type of natural disaster to the accumulation of physical capital

$$(gcap)_{it} = \lambda_1 + \lambda_2(income)_{it} + \lambda_3(school)_{it} + \lambda_5(Value1)_{i,t-k} + \lambda_6(Value2)_{i,t-k} + \lambda_7 (Value3)_{i,t-k} + \lambda_8 (Value4)_{i,t-k} + \varepsilon_{16} \quad ...(13)$$

In both equation (12) and equation (13), the dependent variable, $gcap_{it}$ measures the annual growth rate of capital fixed formation for the period between 1990 and 2010, as reported by seven countries that pararel the effect of natural disasters on the accumulation of physical capital. The two usual control variables following (Skidmore and Toya 2002) are included. The variable, $income_{it}$ measures the income growth for the period of 1990-2010 and $school_{it}$ measures the number of secondary school enrollments for the period of 1990-2010, which are not lagged. As discussed above, the four independent variables are the frequency of each type of natural disaster in equation (12) and the value of economic loss in equation (13).

We have the interpretation of parameters of natural disasters on countries' capital, both human capital accumulation and physical capital in table III-6 as following.

Table III 6 Interpretation of parameters of natural disasters on countries' capital

Coefficients	Description of coefficients of natural disasters on Human capital
α_4	For a given country, as climate variable logarithm of (1+Number of Climatological disasters events) varies across time by one percent, school variable (secondary school enrollment) increases or decreases by α percent

α_5	For a given country, as geo variable logarithm of (1+Number of Geophysical disasters events) varies across time by one percent, school variable (secondary school enrollment) increases or decreases by α percent.
α_6	For a given country, as meteo variable logarithm of (1+Number of Meteorological disasters events) varies across time by one percent, school variable (secondary school enrollment) increases or decreases by α percent
α_7	For a given country, as hydro variable logarithm of (1+Number of Hydrological disasters events) varies across time by one percent, school variable (secondary school enrollment) increases or decreases by α percent
σ_4	For a given country, as Value1 variable logarithm of (1+value of the economic loss of Climatological disasters in thousand US dollars) varies across time by one percent, school variable (secondary school enrollment for period 1990-2010) increases or decreases by σ percent.
σ_5	For a given country, as Value2 variable logarithm of (1+value of the economic loss of Geophysical disasters in thousand US dollars) varies across time by one percent, school variable (secondary school enrollment for period 1990-2010) increases or decreases by σ percent.
σ_6	For a given country, as Value3 variable logarithm of (1+value of the economic loss of Meteorological disasters in thousand US dollars) varies across time by one percent, school variable (secondary school enrollment for period 1990-2010) increases or decreases by σ percent.
σ_7	For a given country, as Value4 variable logarithm of (1+value of the economic loss of Hydrological disasters in thousand US dollars) varies across time by one percent, school variable (secondary school enrollment for period 1990-2010) increases or decreases by σ percent.
Coefficients	Description of coefficients of natural disasters on physical capital

μ_5	For a given country, as climate variable varies across time by one percent, gcap variable (annual growth rate of capital fixed formation for period 1990-2010) increases or decreases by μ percent.
μ_6	For a given country, as geo variable varies across time by one percent, gcap variable (annual growth rate of capital fixed formation for period 1990-2010) increases or decreases by μ percent.
μ_7	For a given country, as meteo variable varies across time by one percent, gcap variable (annual growth rate of capital fixed formation for period 1990-2010) increases or decreases by μ percent.
μ_8	For a given country, as hydro variable varies across time by one percent, gcap variable (annual growth rate of capital fixed formation for period 1990-2010) increases or decreases by μ percent.
λ_5	For a given country, as value1 variable varies across time by one percent, gcap variable (annual growth rate of capital fixed formation for period 1990-2010) increases or decreases by λ percent.
λ_6	For a given country, as value2 variable varies across time by one percent, gcap variable (annual growth rate of capital fixed formation for period 1990-2010) increases or decreases by λ percent.
λ_7	For a given country, as value3 variable varies across time by one percent, gcap variable (annual growth rate of capital fixed formation for period 1990-2010) increases or decreases by λ percent.
λ_8	For a given country, as value4 variable varies across time by one percent, gcap variable (annual growth rate of capital fixed formation for period 1990-2010) increases or decreases by λ percent.

CHAPTER IV

MEASUREMENT AND DESCRIPTIVE STATISTICS

4.1 MEASUREMENT AND DATA SOURCE

A panel data set of 49 countries between 1990 and 2010 (appendix A) was analyzed in this thesis. The dataset was obtained either directly from the Center for Research on the Epidemiology of Disasters (CRED), EMDAT, or the World Bank Database (WB). The input variables are defined in Table VI-1 below.

Table IV 1 Measurements and Data Source

Variables	Abbreviation	Measurements	Data Source
Income growth	income	Annual percentage growth rate of GDP per capita based on constant U.S. dollars local currency in 2005 for the period 1990-2010	WB
Fertility	fert	Children birth to a woman (births per woman) for the period 1990-2010	WB
Government consumption	govc	Government final consumption expenditure (% of GDP) for the period 1990-2010	WB
total disasters	disasters	Logarithm of (1+number of each type of natural disasters events) for the period 1990-2010	CRED

Climatological disasters	climate	Logarithm of (1+number of Climatological disasters events) for the period 1990-2010	CRED
Geophysical disasters	geo	Logarithm of (1+number of Geophysical disasters events) for the period 1990-2010	CRED
Hydrological disasters	hydro	Logarithm of (1+number of Hydrological disasters events) for the period 1990-2010	CRED
Meteorological disasters	meteo	Logarithm of (1+number of Climatological disasters events) for the period 1990-2010	CRED
Value of the economic loss of total natural disasters	totalvalue	Logarithm of (1+Value of the economic loss of total natural disasters) for the period 1990-2010	CRED
Value of the economic loss of Climatological disasters	Value1	Logarithm of (1+Value of the economic loss of Climatological disasters) for the period 1990-2010	CRED
Value of the economic loss of Geophysical disasters	Value2	Logarithm of (1+Value of the economic loss of Geophysical disasters) for the period 1990-2010	CRED
Value of the economic loss of	Value3	Logarithm of (1+Value of the economic loss of Meteorological	CRED

Meteorological disasters		disasters) for the period 1990-2010	
Value of the economic loss of Hydrological disasters	Value4	Logarithm of (1+Value of the economic loss of Hydrological disasters) for the period 1990-2010	CRED
Secondary school enrollment	school	Percent gross of secondary school enrollment for the period 1990-2010	WB
Growth in Capital	gcap	Growth rate of gross capital formation based on constant local currency. Aggregates are based on constant 2005 US. dollars. for the period 1990-2010	WB

Natural Disasters are collected into CRED database must be fulfilled at least one of definition as following[2];

(i) 10 or more people reported killed that confirmed as dead and person missing and presumed officially dead.

(ii) 100 or more people reported affected which people enforcing sudden assistance during a period of disasters emergency.

(iii) Declaration for state of emergency for countries in which the disaster has attacked.

(iv) Countries with disasters call for international assistance.

[2] Website: http://www.emdat.be provided this information.

.Climatological disasters

Climatological disasters can be divided into three main categories: (i) droughts- caused by water deficiency, both on surface and underground, as well as below average rainfall. Intense droughts can greatly impact agricultural areas, resulting in economic loss, even if they are short, (ii) wildfires- uncontrolled fire in an area of flammable plants. Wildfire risk areas include houses that ignore the pruning, maintenance and watering of lawns, and those that keep a stock of firewood close to home, (iii) extreme temperatures-caused by severe and unseasonal weather, when temperatures reach degree on either side of the thermometer. In extremely hot weather, the temperature is higher than the average temperature at the Equator, whereas in the extremely cold weather, the temperature is lower than the average temperature in the cold season.

Geophysical disasters

The four major types of Geophysical disasters are (i) volcanic- exploded magma steams or the release of gases into the atmosphere or ash falling onto the Earth, etc., (ii) earthquakes caused by the abrupt shaking of the earth itself without secondary continuous effects due to seismic waves. The severity of the earthquake, Richter, depends on the different scale of magnitude. (iii) Tsunami, which are gigantic waves that advance inland caused by disturbances above or below water surfaces. Events like earthquakes, volcanic eruptions, or other underwater explosions could generate a tsunami. The advancing wave can enlarge over thousands of kilometers and its effect is extremely destructive as it moves closer inshore.(iv) Mass dry movement caused by mass-wastage of soil and/or sand from the earth's gravity along sloping ground.

Meteorological disasters

The major type of meteorological disasters is storms. Storms are usually named after the area in which they originate, although they have the same wind speed as they move. For example, the huge-scale storms in the atmosphere above the western Atlantic are called hurricanes, and they have the same scale as those in

the atmosphere above the western Pacific, which are called typhoons, and they are called cyclones when they are in the atmosphere above the southern Pacific and/or the Indian Ocean.

Hydrological disasters

Hydrological disasters are events occur due to diversion of water cycle or water overflow caused by wind setup events. Five main categories of Hydrological disasters are (i) Flood- water overflow from a river, cannel, lake, embankment or seaside area. (ii) Mass wet Movement- it is generated from mass-wasting of ice and/or snow slide from earth' gravity. (iii) Landslide- mudslide, Lahar and Debris flow (iv) Avalanche- there are snow avalanche and Debris avalanche (v) Subsidence- sudden Subsidence and long-lasting subsidence.

4.2 DESCRIPTIVE STATISTICS

Table IV 2 Descriptive Statistics in 49 countries (use in the estimation of the impact on international trade)

Variable	Mean (Std. Dev)	Min	Max
year	2000 (6.058)	1990	2010
export (export values / export prices in term of US Dollars: 2005=100)	114.423 (79.888)	15.81	903.17
import (import values / import prices in term of US Dollars: 2005=100)	119.352 (71.014)	0	517.34
Income (growth rate of GDP per apita)	1.988 (4.570)	-47.31	36.77
fert (births per woman)	3.963 (1.723)	0	7.81
govc GFCE (% of GDP)	12.446 (4.013)	2.05	31.82
disasters (number of total natural disasters events)	3.370 (4.729)	0	35
climate (number of Climatological disasters events)	0.367 (0.864)	0	11
geo (number of Geophysical disasters events)	0.723 (1.088)	0	8
meteo (number of Meteorological disasters events)	0.885 (2.539)	0	27
hydro (number of Hydrological disasters events per)	1.398 (2.016)	0	19
value1	39.313	0	4632.1

Variable	Mean (Std. Dev)	Min	Max
(value of the economic loss of Climatological disasters in thousand US dollars)	(318.463)		
value2 (value of the economic loss of Geophysical disasters in thousand US dollars)	102.851 (1,489.745)	0	3,0002.1
value3 (value of the economic loss of Meteorological disasters in thousand US dollars)	437.9359 (5,601.878)	0	158,230
value4 (value of the economic loss of Hydrological disasters in thousand US dollars)	126.868 (861.916)	0	12,600.8
totalvalue (thousand US dollars)	706.966 (6,044.585)	0	158,715.3

Descriptive statistics of independent variables are illustrated in Table IV-2 the mean of total natural disasters is about 3.37 events for 1990-2010 and the maximum is 35 events in United State in 1991. On average, the highest frequency disaster observed is Hydrological disaster in 49 countries during the period 1990-2010 is around 1.4 events and the maximum is 19 events in India in 2005. Climatological disasters record the lowest average frequency (0.37 events) and the maximum is 11 events in United State in 2002. In terms of value of the economic loss, the lowest mean of economic damage observed is Climatological disasters at 39.3 thousand US dollars and the maximum is 4,632.1 thousand US dollars in United State in 2002 while Meteorological disasters record the highest average value of the economic loss at around 438 billion US dollars and the maximum is 158,715.3 thousand US dollars in United State in 2005. The minimum both of frequency and value of the economic loss are zero meaning that there was no natural disaster in some years. For three control variables, Income growth or an annual growth rate of GDP per capita used

based on constant U.S. dollars local currency in 2005 is about 2 percent and the minimum is -47.31 percent. A proportion of children birth to a woman is around four percent, while government consumption is around 12.45 percent. The mean of export volume is lower than import volume.

Table IV 3 Descriptive Statistics in low income countries (use in the estimation of the impact on international trade)

Variable	Mean (Std. Dev.)	Min	Max
Year	2000 (6.066)	1990	2010
export (export values / export prices in term of US Dollars: 2005=100)	128.85 (126.029)	17.14	903.17
import (import values / import prices in term of US Dollars: 2005=100)	125.149 (75.228)	12.04	517.34
Income (growth rate of GDP per apita)	1.093 (6.133)	-47.31	36.77
fert (births per woman)	5.691 (1.154)	2.25	7.81
govc GFCE (% of GDP)	12.343 (4.854)	2.05	31.57
disasters (number of total natural disasters events)	2.5 (2.546)	0	15
climate (number of Climatological disasters events)	0.276 (0.505)	0	2
geo (number of Geophysical disasters events)	0.840 (1.057)	0	5
meteo	0.510	0	8

Variable	Mean (Std. Dev.)	Min	Max
(number of Meteorological disasters events)	(1.269)		
hydro (number of Hydrological disasters events)	0.874 (1.118)	0	7
value1 (value of the economic loss of Climatological disasters in thousand US dollars)	0.345 (4.117)	0	50
value2 (value of the economic loss of Geophysical disasters in thousand US dollars)	0.578 (7.108)	0	100
value3 (value of the economic loss of Meteorological disasters in thousand US dollars)	11.438 (115.566)	0	1,780
value4 (value of the economic loss of Hydrological disasters in thousand US dollars)	21.003 (253.555)	0	4,300
totalvalue (thousand US dollars)	33.364 (284.708)	0	4,300

Table IV-3 presents the distribution of natural disasters on international trade in low income countries. The average export volume is more than import volume for 1990-2010. Among those disasters, Hydrological disasters are the highest mean frequency of disasters, which are around 0.874 events and the maximum is 7 events in Kenya in 2008. The average total natural disasters, which are about 2.5 events, is around 3 times higher than Hydrological disaster and the maximum of total natural disasters is 15 events in Bangladesh in 2000. Like frequency, the mean of value of the economic loss of hydrological disasters is the highest at around 21 thousand US dollars and the maximum is 4,300 thousand US dollars in Bangladesh in 1998. On the other hand, Climatological disaster has the lowest value of the economic loss

(around 0.35 thousand US dollars) and the maximum value of the economic loss of Climatological disasters in low income countries is 50 thousand US dollars from Mozambique in 1992 and Zimbabwe in 1995. The minimum and maximum value of the economic loss of total natural disasters are zero and 4,300 thousand US dollars respectively.

Table IV 4 Descriptive Statistics in middle income countries (use in the estimation of the impact on international trade)

Variable	Mean (Std. Dev.)	Min	Max
Year	2000 (6.060)	1990	2010
export (export values / export prices in term of US Dollars: 2005=100)	109.134 (49.079)	15.81	299.96
import (import values / import prices in term of US Dollars: 2005=100)	119.197 (73.030)	0	469.62
Income (growth rate of GDP per apita)	2.164 (3.695)	-11.53	30.34
fert (births per woman)	3.591 (1.308)	1.47	6.65
govc GFCE (% of GDP)	12.658 (3.819)	3.22	31.82
disasters (number of total natural disasters events)	3.388 (4.007)	0	29
climate (number of Climatological disasters events)	0.325 (0.699)	0	8
geo (number of Geophysical disasters events)	0.747 (1.152)	0	8

Variable	Mean (Std. Dev.)	Min	Max
meteo (number of Meteorological disasters events)	0.654 (1.599)	0	14
hydro (number of Hydrological disasters events)	1.668 (2.229)	0	19
value1 (value of the economic loss of Climatological disasters in thousand US dollars)	16.793 (127.101)	0	1,800
value2 (value of the economic loss of Geophysical disasters in thousand US dollars)	70.197 (893.202)	0	21,000
value3 (value of the economic loss of Meteorological disasters in thousand US dollars)	72.957 (495.078)	0	7,910
value4 (value of the economic loss of Hydrological disasters in thousand US dollars)	106.164 (633.321)	0	9,518
totalvalue (thousand US dollars)	266.111 (1228.643)	0	21,000

Descriptive statistics of independent variables for international trade in middle income countries are illustrated in tableIV-4. Among all disaster types, Hydrological disasters hit the country most often. During 1990-2010, these disasters struck 1.67 events on the average and the maximum frequency of disasters reached 19 events in India in 2005. Moreover, the average of total natural disasters event is about threefold in comparison with the combination between Climatological and Geophysical disasters. The maximum of total natural disasters in middle income countries is 29 events in India in 2005. Like disasters frequency, an average value of the economic loss of Hydrological disasters is the highest. The damage cost for this

type of disaster is around 106.16 thousand US dollars and the maximum cost is 9,518 thousand US dollars in Pakistan in 2010. The value of the economic loss of Geophysical disasters is close to Meteorological disasters, which are 70.2 and 72.96 thousand US dollars respectively.

Table IV 5 Descriptive Statistics in high income countries (use in the estimation of the impact on international trade)

Variable	Mean (Std. Dev.)	Min	Max
year	2000 (6.079)	1990	2010
export (export values / export prices in term of US Dollars: 2005=100)	106.326 (53.364)	24.19	288.39
import (import values / import prices in term of US Dollars: 2005=100)	106.573 (44.970)	38.35	264.01
Income (growth rate of GDP per apita)	3.227 (3.687)	-7.75	12.77
fert (births per woman)	1.728 (0.499)	0	2.62
govc GFCE (% of GDP)	11.666 (2.324)	6.84	16.94
disasters (number of total natural disasters events)	5.317 (9.222)	0	35
climate (number of Climatological disasters events)	0.786 (1.719)	0	11
geo (number of Geophysical disasters events)	0.333 (0.681)	0	3
meteo	2.881	0	27

Variable	Mean (Std. Dev.)	Min	Max
(number of Meteorological disasters events)	(5.676)		
hydro (number of Hydrological disasters events)	1.317 (2.300)	0	13
value1 (value of the economic loss of Climatological disasters in thousand US dollars)	239.081 (842.129)	0	4,632.1
value2 (value of the economic loss of Geophysical disasters in thousand US dollars)	499.309 (3766.025)	0	30,002.1
value3 (value of the economic loss of Meteorological disasters in thousand US dollars)	3,197.165 (15751.29)	0	158,230
value4 (value of the economic loss of Hydrological disasters in thousand US dollars)	473.954 (1964.206)	0	12,600.8
totalvalue (thousand US dollars)	4409.509 (16646.78)	0	158,715.3

According to table IV-5, the average total natural disaster is 5.31 events for 1990-2010 and the maximum frequency of disasters reached 35 events in United State in 1991. In high income countries, Meteorological disasters happen most frequently. The mean of its frequency is the highest (around 2.88 events) among all disaster types and even higher than sum of all average values. The maximum frequency of Meteorological disasters reached 27 events in United State in 1992 Unpredictably, economic losses from Meteorological disaster are the highest with the average value of the economic loss around 3,200 thousand US dollars and its maximum loss is 158,230 thousand US dollars in United State in 2005 while Climatological disaster is a disaster type with the lowest value of the economic loss

at the average value of 239.08 thousand US dollars and its maximum loss is 4,632.1 thousand US dollars in United State in 2002.

Table IV 6 **Descriptive Statistics in seven countries (use in the estimation of the impact on countries' capital)**

Variable	Mean (Std. Dev.)	Min	Max
Year	2000 (6.076)	1990	2010
gcap (annual % growth)	6.042 (12.702)	-43.04	37.41
income (growth rate of GDP per apita)	2.969 (3.682)	-9.64	10.76
school (secondary school enrollment)	70.605 (19.202)	35.62	104.47
climate (Climatological disasters events)	0.327 (0.621)	0	3
geo (Geophysical disasters events)	0.531 (0.924)	0	4
meteo (Meteorological disasters events)	0.694 (1.225)	0	5
hydro (Hydrological disasters events)	1.293 (1.289)	0	5
disasters (total natural disasters events)	2.844 (2.616)	0	11
value1 (value of the economic loss of Climatological disasters in thousand US dollars)	31.325 (184.136)	0	1,800
value2	23.126	0	1,150

(value of the economic loss of Geophysical disasters in thousand US dollars)	(121.677)		
value3 (value of the economic loss of Meteorological disasters in thousand US dollars)	214.469 (978.484)	0	7,910
value4 (value of the economic loss of Hydrological disasters in thousand US dollars)	60.047 (294.090)	0	3,000
totalvalue (thousand US dollars)	328.968 (1089.89)	0	7,910

Descriptive statistics of independent variables are illustrated in tableIV-6 for physical capital and Human capital accumulation in seven countries for the period 1990-2010. The average total natural disaster is 2.84 events and the maximum frequency of disasters reached 11 events in Mexico in 1995. On average, the highest frequency of disaster is Hydrological disasters (1.29 events) following by Meteorological disasters (0.69 events), Geophysical disasters (0.53 events) and Climatological disasters (0.33 events). Unlike frequency disasters, the worst economic loss comes from Meteorological disasters with the average value of the economic loss around 214.4 thousand US dollars and the maximum loss reaching 7,910 thousand US dollars in Mexico in 2005. The value of the economic loss of Hydrological disasters is double that of Climatological disasters while Geophysical disasters causes the lowest value of the economic loss at the average of around 23.12 thousand US dollars and the maximum frequency of Geophysical disasters reached 1,150 thousand US dollars in Mexico in 2010.

In order to measure the impact of natural disasters on Human capital accumulations and Physical capital investment, two variables are used in the model,

namely, the income growth variable (growth rate of GDP per capita) and School variable (secondary school enrollment). The income growth variable is used to determine the effect on both Human capital accumulation and Physical capital investment. The minimum and maximum of growth rate of GDP per capita is -43.04 percent in Malaysia in 1998 and 37.41 percent in Peru in 2010 while the average is approximately 2.96 percent. School variable is the only control variable to measure the impact on Physical capital investment. The minimum secondary school enrollment is 35.62 in Morocco in 1991 while the average is approximately 70.61 percent. During the same period, it is found that the average growth of capital formation is much lower than the mean of secondary school enrollment meaning that human capital accumulation is lower than Physical capital accumulations in these 7 countries.

Table IV 7 Descriptive Statistics in middle income countries (use in the estimation of the impact on countries' capital)

Variable	Mean (Std. Dev.)	Min	Max
Year	2000 (6.079)	1990	2010
gcap (annual % growth)	6.238 (12.888)	-43.04	37.41
income (growth rate of GDP per capita)	2.699 (3.633)	-9.64	10.76
school (secondary school enrollment)	66.100 (16.906)	35.62	99.69
climate (number of Climatological disasters events)	0.333 (0.632)	0	3
geo (number of Geophysical disasters)	0.595 (0.973)	0	4
meteo	0.587	0	5

Variable	Mean (Std. Dev.)	Min	Max
(number of Meteorological disasters events)	(1.195)		
hydro (number of Hydrological disasters events)	1.349 (1.352)	0	5
disasters (number of total natural disasters events)	2.865 (2.726)	0	11
value1 (thousand US dollars)	36.546 (198.519)	0	1,800
value2 (thousand US dollars)	26.981 (131.102)	0	1,150
value3 (thousand US dollars)	162.262 (912.318)	0	7,910
value4 (thousand US dollars)	48.921 (288.295)	0	3,000
totalvalue (thousand US dollars)	274.709 (1039.402)	0	7,910

Table IV-7 presents the average total natural disaster is around 2.87 events and the maximum frequency of total disasters reached 11 events in Mexico in 1995. The mean of Geophysical disasters and Meteorological disasters are parallel (roughly 0.6 events). On average, Hydrological disasters record the highest in terms of frequency (1.35 events) and the maximum reached 5 events in Mexico and Peru in 2009, but in terms of the highest value of the economic loss, it is the Meteorological disasters (around 162.26 thousand US dollars). The maximum damage is equal to the maximum value of total natural disasters at 7,910 thousand US dollars in Mexico in 2005.

CHAPTER V

EMPIRICAL RESULTS

Given the other things held constant, a panel dataset of 49 countries for the period 1990-2010 was used to determine the effect of natural disasters on international trade and countries' capital with different income-level, i.e., low-income, middle-income, and high income countries by employing fixed-effect model. To interpret the estimated coefficients of explanatory variables on the effect of natural disasters on export and import, a 1 percent level of significance was chosen for the ease of interpretation.

This study set the maximum lags at 13 years in their figures because all disasters are not statistically significant from the 13th year onwards. Furthermore, the results are presented within the four year lags in results' tables due to all significantly coefficients of explanatory variables do not change signs from the 4th year onwards. The results base on export and import are mainly focused.

5.1 Natural disasters on Export

The result present that frequency of natural disasters, denoted disasters variable on export in 49 countries is not-significant. However, the sign of coefficient is positive showing that export volume would increase. A possible reason involves a rare chance that a country will be hit by multiple natural disasters at the same time. Countries can continue to export goods and services.

This study also explains coefficients corresponding of three controlled variables. The first variable, fertility, denoted by fert variable, shows a statistically significant negative sign meaning that export volume, denoted export variable is reduced when fertility have statistically significant increased. It is in consistent with the prediction that Countries with low fertility rate result in lower domestic consumption leading to excess supply. Countries will export more goods and services. The second variable, growth rate of GDP per capita, denoted by income

variable shows a positive sign and is statistically significant. That means the increment of initial income can boost export volume. Due to Convergence effect, if countries have low initial income, they will have faster speed of development. Thus, countries will have more production and excess of supply. They tend to export more goods and services. The last controlled variable, government consumption expenditure variable or govc variable is expected to be positive. It is similar to the result of the parameter corresponding to this variable is shown statistically positive sign on export volume as following.

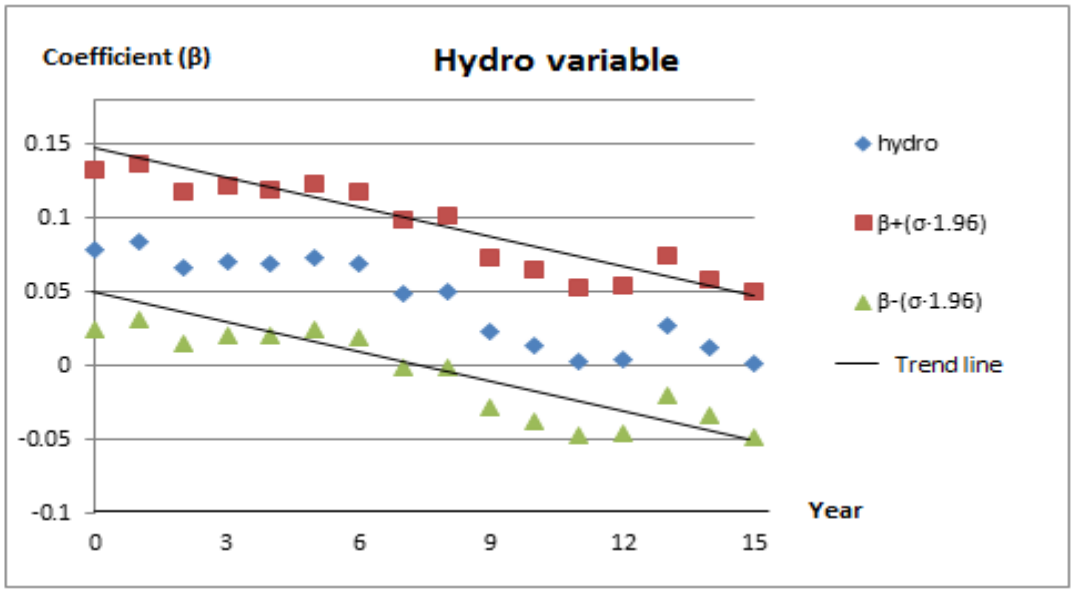
TableV-1 Estimated result the effect of frequency of each type of natural disasters on Export *in 49 countries*

Specification	K=0	K=1	K=2	K=3	K=4
variable	Coefficient on export (Standard Error)				
$income_{it}$	0.011***	0.011***	0.011***	0.010***	0.010***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
$fert_{it}$	-0.742***	-0.758***	-0.768***	-0.766***	-0.753***
	(0.031)	(0.033)	(0.035)	(0.037)	(0.038)
$govc_{it}$	0.017***	0.015***	0.015***	0.013***	0.012***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
$climate_{i,t-k}$	0.026	0.032	0.054	0.032	0.049
	(0.038)	(0.039)	0.038)	(0.037)	(0.035)
$geo_{i,t-k}$	0.007	0.015	0.029	0.029	0.026
	(0.027)	(0.026)	(0.026)	(0.025)	(0.025)
$meteo_{i,t-k}$	-0.036	-0.040	-0.039	-0.027	-0.027
	(0.038)	(0.037)	(0.037)	(0.036)	(0.035)
$hydro_{i,t-k}$	0.079***	0.084***	0.066***	0.071***	0.069***
	(0.027)	(0.027)	(0.026)	(0.026)	(0.025)
const	7.248***	7.333***	7.378***	7.414***	7.385***
	(0.158)	(0.161)	(0.167)	(0.172)	(0.174)
No of obs.	1029	980	931	882	833

Note: ***,**, *Coefficients and Standard error of estimated coefficient in parentheses is significant level at 1%, 5%and 10%

Hence, see in tableV-1 presented the effect of frequency of each type natural disasters on export given the other things held constant, Surprisingly, the frequency of Hydrological disasters, denoted by hydro variable on export has a statistically significant positive sign. It could strongly increase export volume around 0.079 percent in the same year and slightly rose on export year by year until on 8th year, see in FigureV-1, which is the last statistically significant year. This suggests that Hydrological disasters do not impact the countries as a whole, some region may have experienced Hydrological disasters but they are able to build embankments and dams to prevent flood damage when disasters strike again. They can still export goods and services.

FigureV-1 Coefficient of Hydrological disasters on export in 49 countries



Climatological disasters, Geophysical disasters and Meteorological disasters have the same non-significant as total natural disasters' result. Climatological and Geophysical disasters have shown positive sign while Meteorological disasters have shown a negative, they can either have a positive impact or a negative impact on the export variable in the year disasters occurred.

In this study, not only the general effect of natural disasters is mainly interested, but the effect of natural disasters that have changed in countries with different income level is also taken into account. Pertaining to income level, the

significant effect of fert variable on export variable is presented statistically significant in all income level countries. The result on export volume employs negative sign. The govc variable is statistically significant relationship with export variable and show positive sign in all income level. However, income variable has only significant effect on export in middle-income countries as seen in tableV-2 and tableV-3.

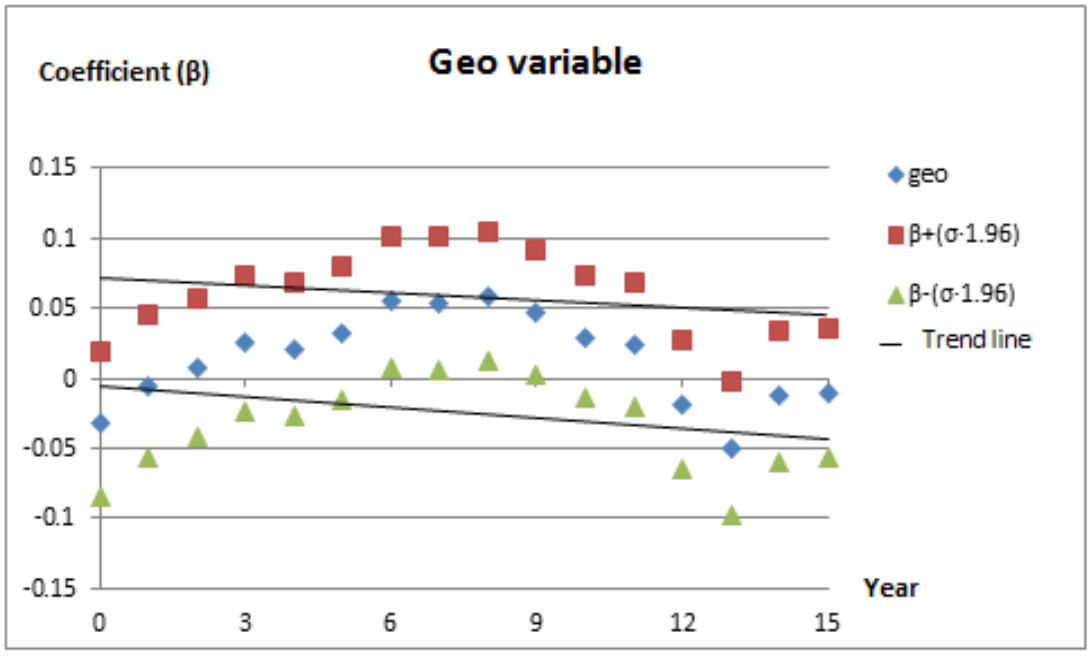
Table V-2 Estimated result the effect of frequency of each type natural disasters on Export *in middle-income countries*

Specification	K=0	K=1	K=2	K=3	K=4
variable	Coefficient on export (Standard Error)				
$income_{it}$	0.010*** (0.004)	0.009** (0.004)	0.011*** (0.004)	0.010*** (0.003)	0.011*** (0.003)
$fert_{it}$	-0.760*** (0.031)	-0.790*** (0.032)	-0.812*** (0.034)	-0.819*** (0.036)	-0.809*** (0.038)
$govc_{it}$	0.015*** (0.006)	0.013** (0.005)	0.014** (0.006)	0.013** (0.006)	0.016*** (0.006)
$climate_{i,t-k}$	0.004 (0.038)	0.025 (0.038)	0.033 (0.037)	0.022 (0.036)	0.033 (0.035)
$geo_{i,t-k}$	-0.032** (0.027)	-0.005 (0.026)	0.007 (0.025)	0.025 (0.025)	0.021 (0.024)
$meteo_{i,t-k}$	-0.002 (0.038)	-0.024 (0.037)	-0.026 (0.037)	-0.011 (0.036)	-0.024 (0.035)
$hydro_{i,t-k}$	0.075*** (0.027)	0.074*** (0.026)	0.056** (0.025)	0.057** (0.024)	0.058** (0.024)
const	7.058*** (0.151)	7.195*** (0.153)	7.267*** (0.161)	7.294*** (0.166)	7.241*** (0.169)
No of obs.	609	580	551	522	493

Note: ***,**, *Coefficients and Standard error of estimated coefficient in parentheses is significant level at 1%, 5%and 10%

TableV-2 estimate the effect of frequency of each type of natural disasters on export in middle-income countries, Geophysical disasters denoted geo variable could have statistically significant effect on Export. The parameter corresponding shows a negative sign but only no-lag time at the year disaster hit. It means when Geophysical disasters immediately increased one percent in a particular year, it is likely to reduce export volume about 0.032 percent in the same year, see in FigureV-2. The hydro variable has statistically significant positive effect on export variable. This suggests that whenever hydrological disasters in middle income countries increase one percent, export volume would increase around 0.075 percent in the same year and 0.074 in the year after. The export shows gradual increase in percent from 0.056 percent to 0.057 percent to 0.058 percent and last significant increase on export on the 6th year, see in FigureV-2.1.

FigureV-2 Geophysical disasters on export in middle-income countries



FigureV-2.1 Hydrological disasters on export in middle-income countries

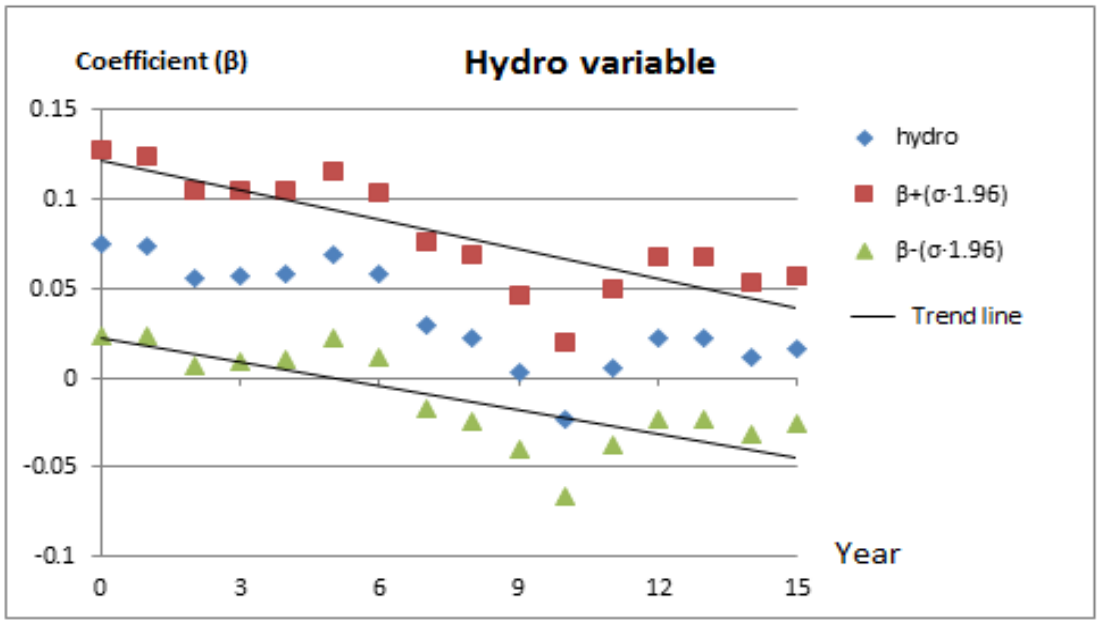


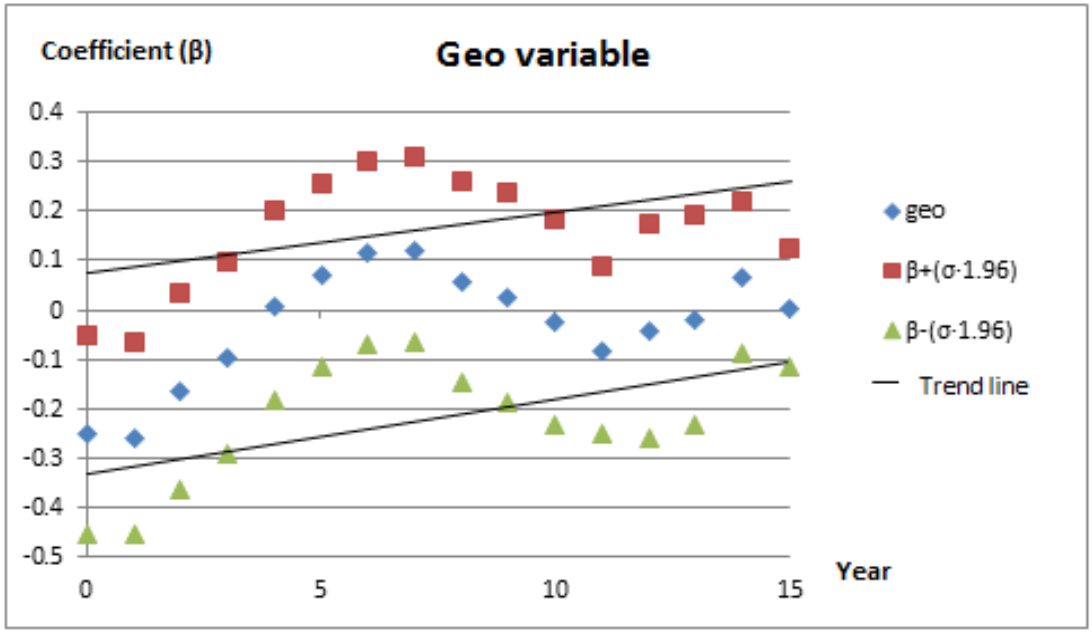
Table V-3 Estimated result the effect of frequency of each type natural disasters on Export *in high income countries*

Specification	K=0	K=1	K=2	K=3	K=4
variable	Coefficient on export (Standard Error)				
$income_{it}$	0.008 (0.010)	0.008 (0.009)	0.010 (0.009)	0.012 (0.009)	0.014 (0.009)
$fert_{it}$	-1.209*** (0.158)	-1.139*** (0.157)	-0.974*** (0.161)	-0.838*** (0.164)	-0.687*** (0.168)
$govc_{it}$	0.158*** (0.039)	0.151*** (0.038)	0.158*** (0.038)	0.155*** (0.037)	0.153*** (0.036)
$climate_{i,t-k}$	0.093 (0.097)	0.073 (0.103)	0.064 (0.104)	0.055 (0.101)	0.096 (0.099)
$geo_{i,t-k}$	-0.252** (0.102)	-0.260*** (0.099)	-0.164* (0.101)	-0.096 (0.099)	0.008 (0.098)
$meteo_{i,t-k}$	0.009 (0.084)	-0.014 (0.081)	0.020 (0.082)	-0.013 (0.083)	-0.033 (0.081)
$hydro_{i,t-k}$	-0.021 (0.084)	-0.030 (0.084)	-0.003 (0.084)	0.064 (0.084)	0.045 (0.083)
const	4.781*** (0.673)	4.799*** (0.655)	4.400*** (0.656)	4.191*** (0.641)	3.968*** (0.634)
No of obs.	**126**	**120**	**114**	**108**	**102**

Note: ***,**, *Coefficients and Standard error of estimated coefficient in parentheses is significant level at 1%, 5%and 10%

TableV-3 show the effect of frequency of each type natural disasters on export in high income countries, this test employs the statistically significant negative effect of Geophysical disasters on export volume as shown a negative sign on this coefficient. When Geophysical disasters strike, domestic production will automatically decrease causing export contraction. This can be explained that whenever high income countries are increased one percent of Geophysical disaster, it could reduce export volume around 0.252 percent with the 5% significant level in that year and down to 0.26 percent the year after at 1% significant level. These effects would finish on the 3th year which decreases about 0.164 percent at 5% significant level. After that, the export shows slight recovery, see in FigureV-3. A gradual increase in percent from -0.26 percent to -0.16 percent to -0.096 percent and finally to the positive sign at 0.008 percent confirm the continuous significantly increase of export volume in three years after the disaster although this recovery period has no statistically significant impact (coefficient signs show no statistically significant). While total of natural disasters and other types of disasters are non-significant on export volume.

FigureV-3 Geophysical disasters on export in high income countries



5.2 Natural disasters on Import

By estimating a panel data frequency of natural disasters on import equation, given the other things held constant, in 49 countries, the frequency of total natural disasters, denoted disasters variable is non-significant on import volume but the sign of coefficient is negative.[3] Unlike a positive result of frequency of natural disasters effect on export volume, this is similar to empirical results from Gassebner et al.(2006) stating that natural disasters reduce trade in importing countries

This study explains that all of the coefficients corresponding of controlled variables, income, fert and govc varibales, are seen statistically significant on import volume, denoted import variable, in TableV-4. This results of all three controlled variable show the same sign- positive sign for income-and govc variable and negative sign for fert variable- as frequency of natural disasters on export equation. This is consistent with the prediction in the literature reviews.

Table V-4 Estimated result the effect of frequency of each type natural disasters on Import *in 49 countries*

Specification	K=0	K=1	K=2	K=3	K=4
variable	Coefficient on import (Standard Error)				
$income_{it}$	0.017*** (0.003)	0.016*** (0.003)	0.016*** (0.003)	0.016*** (0.003)	.0158*** (0.003)
$fert_{it}$	-0.785*** (0.029)	0.796*** (0.031)	-0.803*** (0.033)	-0.808*** (0.035)	-0.820*** (0.037)
$govc_{it}$	0.019*** (0.005)	0.015*** (0.005)	0.015*** (0.005)	0.013*** (0.005)	0.014*** (0.005)
$climate_{i,t-k}$	0.026 (0.035)	-0.015 (0.036)	0.001 (0.035)	-0.004 (0.035)	0.000 (0.035)
$geo_{i,t-k}$	-0.010	0.005	0.020	0.023	0.022

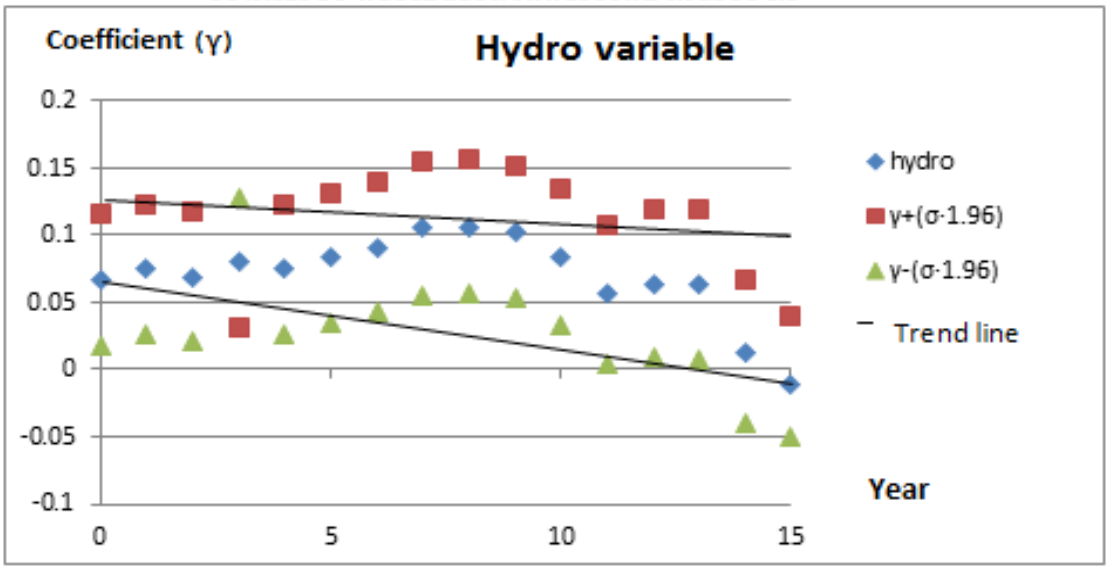
[3] The results are not reported here, available upon request

Specification	K=0	K=1	K=2	K=3	K=4
	(0.025)	(0.025)	(0.024)	(0.024)	(0.024)
$meteo_{i,t-k}$	-0.035	-0.040	-0.043	-0.025	-0.032
	(0.035)	(0.034)	(0.034)	(0.035)	(0.035)
$hydro_{i,t-k}$	0.066***	0.074***	0.069***	0.079***	0.075***
	(0.025)	(0.025)	(0.025)	(0.025)	(0.025)
const	7.456***	7.561***	7.586***	7.628***	7.670***
	(0.144)	(0.150)	(0.156)	(0.164)	(0.172)
No of obs.	1029	980	931	882	833

Note: ***,**, *Coefficients and Standard error of estimated coefficient in parentheses is significant level at 1%, 5%and 10%

TableV-4 show the effect of frequency of each type natural disasters on import in 49 countries, a frequency of Hydrological disasters, denoted by hydro variable has a statistically positive sign on import volume at 1% significant level. In the same year that Hydrological disaster event such as flash flood increase one percent, it could increase import volume remarkably about 0.066 percent at 1% significant level in that year. Import volume can increase year by year. Hydrological disasters continue to increase import volume substantially for 13 years, see in FigureV-4. A possible reason could be countries will import commodities to substitute domestic production along with new machinery and equipment for restoration and rebuilding.

FigureV-4 Hydrological disasters on import in 49 countries



However, the frequencies of each type of natural disasters such as Climatological, Geophysical and Meteorological disasters resulting in the same non-significant result as total natural disasters. Climatological disasters, denoted climate variable shows a positive sign as opposed to Geophysical and Meteorological disasters. These variables can either have a positive impact or a negative impact on the export variable in the year disasters take place.

Further in Table 5 to Table 8, data obtained from low- and middle income countries can be used for three significant controlled variables, income, fert and govc variable on import. They have the same sign as frequency of natural disasters effect on import volume in 49 countries.

Table V-5 Estimated result the effect of frequency of total natural disasters on Import *in low income countries*

Specification	K=0	K=1	K=2	K=3	K=4
variable	Coefficient on import(Standard Error)				
$income_{it}$	0.012***	0.012***	0.012***	0.012***	0.010***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
$fert_{it}$	-0.618***	-0.613***	-0.623***	-0.623***	-0.7271***
	(0.052)	(0.056)	(0.057)	(0.062)	(0.065)
$govc_{it}$	0.020***	0.018***	0.016**	0.016***	0.011*
	(0.007)	(0.007)	(0.006)	(0.007)	(0.007)
$disasters_{i,t-k}$	0.082**	0.108***	0.116***	0.116	0.055
	(0.041)	(0.041)	(0.041)	(0.041)	(0.040)
constant	7.874***	7.847***	7.929***	7.929***	8.632***
	(0.335)	(0.353)	(0.353)	(0.378)	(0.394)
No of obs.	**294**	**280**	**266**	**252**	**238**

Note: ***,**, *Coefficients and Standard error of estimated coefficient in parentheses is significant level at 1%, 5%and 10%

TableV-5 estimated result the effect of frequency of total natural disasters on import in low income countries, surprisingly, the frequency of total natural disasters is statistically significant on import and the coefficient of this disasters variable is a positive sign. Additionally, disasters variable continues statistically significance at 1% level only 2 years after natural disasters, columns (k=1) and (k=2), had occurred, see in FigureV-5. This result explains that when natural disasters in low income countries increase one percent in that year, import volume will increase about 0.082 percent that year, 0.108 percent next year, 0.116 percent in the year after the next. A possible reason could be countries will import commodities to substitute domestic production along with new machinery and equipment for restoration and rebuilding

FigureV-5 Total natural disasters on import in low income countries

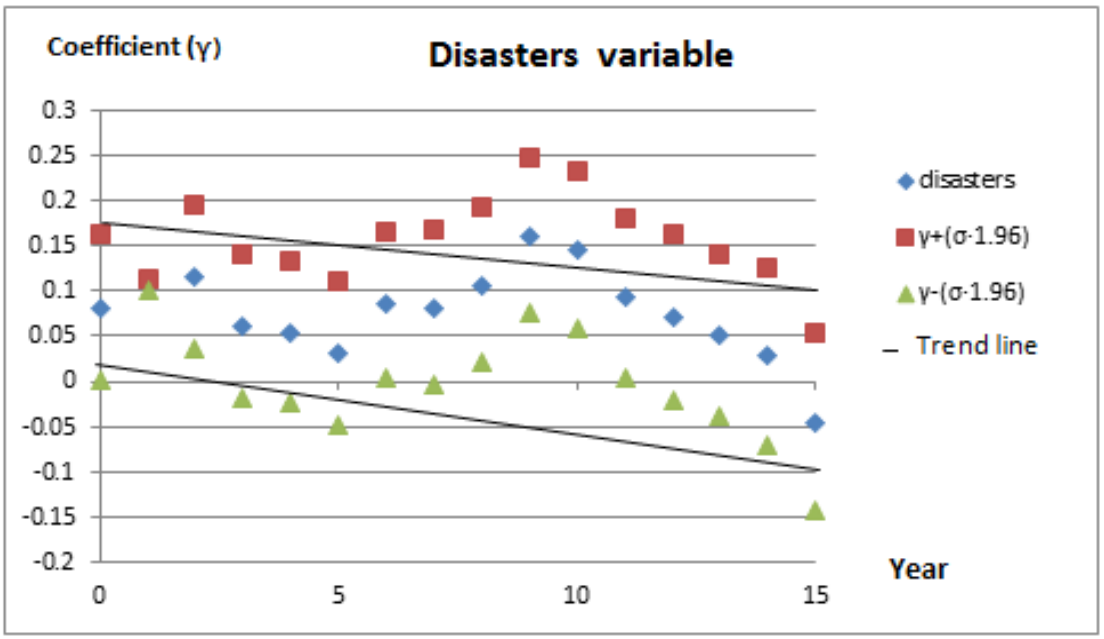


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Table V-6 Estimated result the effect of frequency of each type natural disasters on Import *in low income countries*

Specification	K=0	K=1	K=2	K=3	K=4
variable	Coefficient on import (Standard Error)				
$income_{it}$	0.0112*** (0.003)	0.012*** (0.003)	0.011*** (0.003)	0.012*** (0.003)	0.010*** (0.003)
$fert_{it}$	-0.586*** (0.052)	-0.585*** (0.056)	-0.609*** (0.058)	-0.653*** (0.065)	-0.712*** (0.065)
$govc_{it}$	0.018*** (0.007)	0.016** (0.007)	0.015** (0.007)	0.012* (0.007)	0.011* (0.007)
$climate_{i,t-k}$	0.047 (0.067)	0.023 (0.070)	0.055 (0.068)	-0.016 (0.069)	-0.021 (0.070)
$geo_{i,t-k}$	0.029 (0.043)	0.062 (0.043)	0.071 (0.042)	0.014 (0.042)	0.028 (0.043)
$meteo_{i,t-k}$	0.001 (0.072)	0.038 (0.072)	-0.016 (0.072)	-0.015 (0.074)	-0.037 (0.077)
$hydro_{i,t-k}$	0.163*** (0.049)	0.171*** (0.049)	0.154*** (0.049)	0.160*** (0.049)	0.133*** (0.051)
const	7.693*** (0.328)	7.690*** (0.347)	7.871*** (0.352)	8.189*** (0.374)	8.542*** (0.393)
No of obs.	294	280	266	252	238

Note: ***,**, *Coefficients and Standard error of estimated coefficient in parentheses is significant level at 1%, 5%and 10%

TableV-6 present the impact of most disasters, except Hydrological disasters, on import variable is not significant. Hydrological disasters have a statistically significant on import and present a positive coefficient sign with 1% significant level. When flood increase one percent, import volume in that year increases 0.163 percent and it has slightly more magnitude year by year and end with 10% significant level increase on import on the 12^{th} year, see in FigureV-6. Climatological, Geophysical and Metrological disasters have non-significant positive effect on import volume in the same year. A possible reason might be countries will import commodities to substitute domestic production along with new machinery and equipment for restoration and rebuilding

FigureV-6 Hydrological disasters on import in low income countries

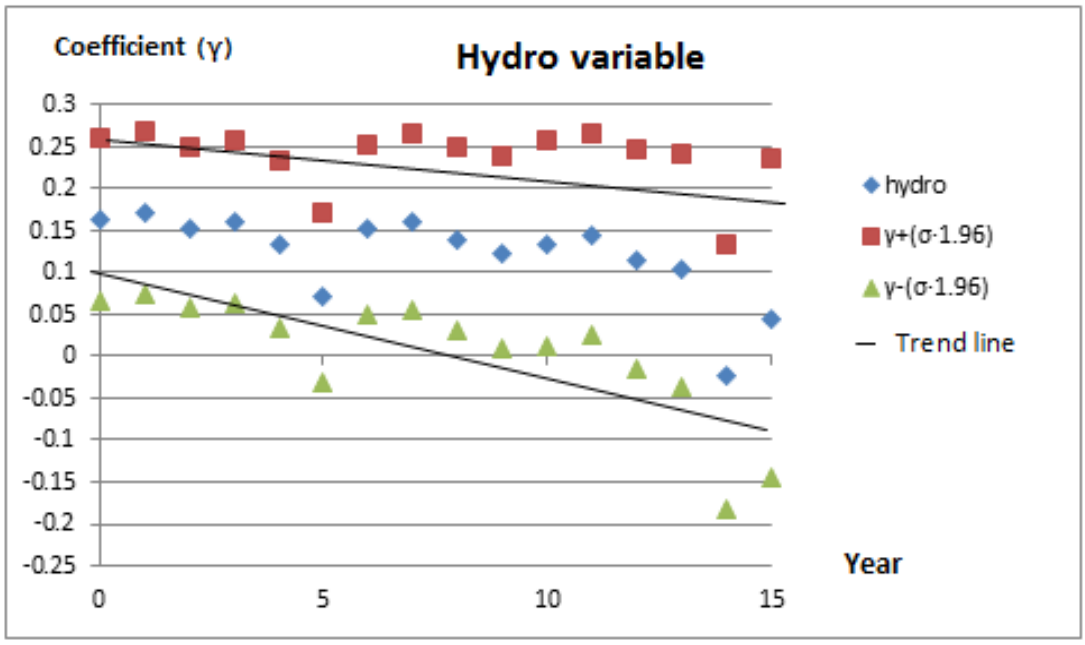


Table V-7 Estimated result the effect of frequency of total natural disasters on import *in middle income countries*

Specification	K=0	K=1	K=2	K=3	K=4
variable	Coefficient on import (Standard Error)				
$income_{it}$	0.029***	0.027***	0.027***	0.027***	0.028***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
$fert_{it}$	-0.846***	-0.869***	-0.882***	-0.884***	-0.894***
	(0.036)	(0.038)	(0.041)	(0.045)	(0.047)
$govc_{it}$	0.018***	0.011*	0.013*	0.013*	0.019*
	(0.006)	(0.007)	(0.007)	(0.007)	(0.008)
$disasters_{i,t-k}$	0.042	0.027	0.029	0.058**	0.047
	(0.030)	(0.030)	(0.030)	(0.030)	(0.030)
constant	7.341***	7.529***	7.560***	7.535***	7.514***
	(0.178)	(0.187)	(0.201)	(0.209)	(0.217)
No of obs.	609	580	511	522	493

Note: ***,**, *Coefficients and Standard error of estimated coefficient in parentheses is significant level at 1%, 5%and 10%

Table V-7estimated result the effect of frequency of total natural disasters on import in middle income countries, a frequency of total natural disasters have a statistically significant positive effect on import volume only in the third year, columns (k=3) around 0.058 percent with 5% significant level after total natural disasters occurred, see in FigureV-7. Countries with higher natural disasters will more import commodities to substitute domestic production along with new machinery and equipment for restoration and rebuilding.

FigureV-7 Total natural disasters on import in middle income countries

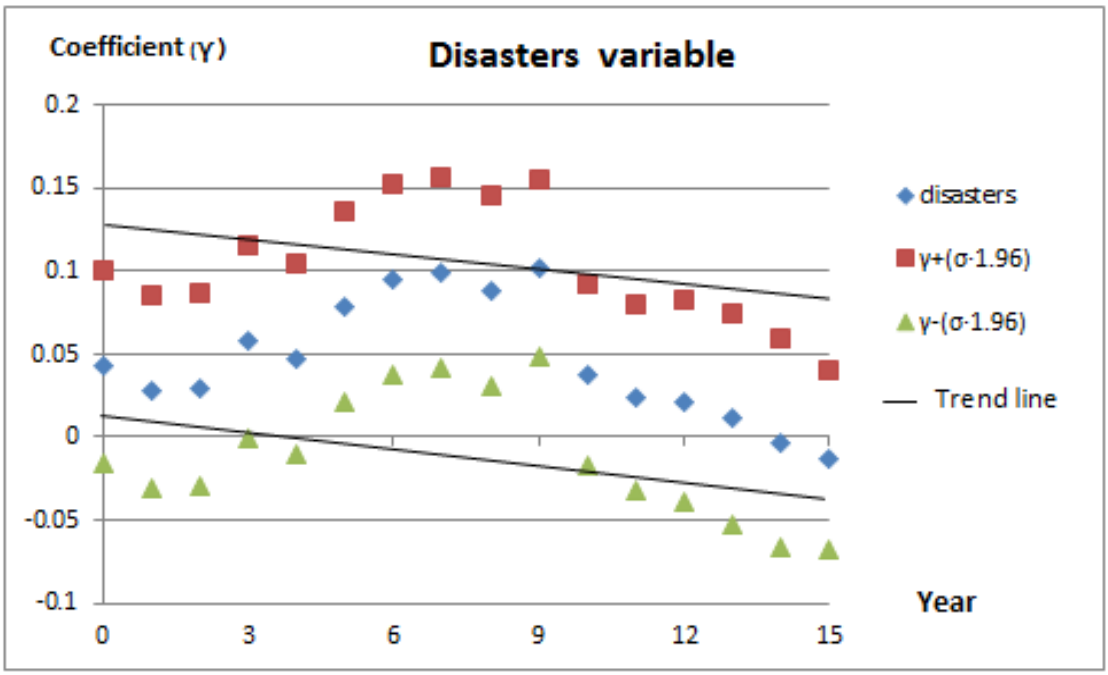


Table V-8 Estimated result the effect of frequency of each type natural disasters on import *in middle income countries*

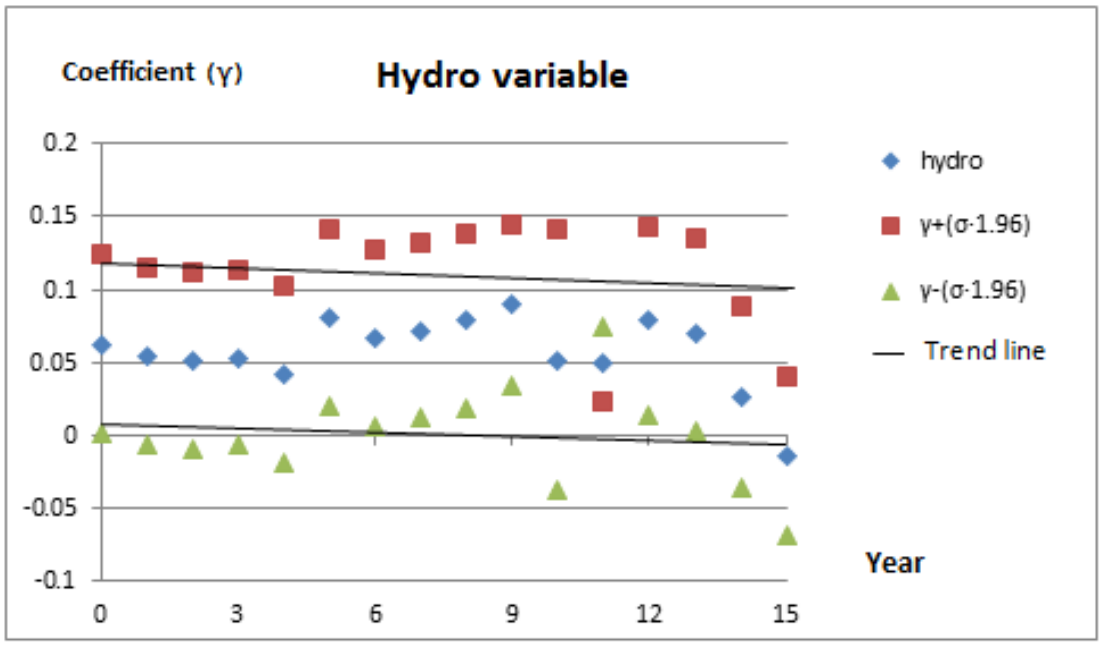
Specification	K=0	K=1	K=2	K=3	K=4
variable	Coefficient on import (Standard Error)				
$income_{it}$	0.029***	0.027***	0.028***	0.026***	0.028***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
$fert_{it}$	-0.838***	-0.864***	-0.881***	-0.888***	-0.899***
	(0.037)	(0.039)	(0.042)	(0.045)	(0.048)
$govc_{it}$	0.017***	0.011*	0.012*	0.013*	0.019**
	(0.007)	(0.007)	(0.007)	(0.007)	(0.008)
$climate_{i,t-k}$	0.018	-0.044	-0.041	-0.022	-0.021
	(0.045)	(0.046)	(0.046)	(0.045)	(0.045)
$geo_{i,t-k}$	0.002	0.010	0.012	0.042	0.036
	(0.031)	(0.031)	(0.031)	(0.031)	(0.031)
$meteo_{i,t-k}$	-0.025	-0.037	-0.046	0.001	-0.004
	(0.045)	(0.045)	(0.045)	(0.046)	(0.046)
$hydro_{i,t-k}$	0.063**	0.054*	0.051*	0.053*	0.042*
	(0.031)	(0.031)	(0.031)	(0.031)	(0.031)
const	7.319***	7.523***	7.572***	7.570***	7.548
	(0.178)	(0.185)	(0.200)	(0.210)	(0.219)
No of obs.	609	580	551	522	493

Note: ***,**, *Coefficients and Standard error of estimated coefficient in parentheses is significant level at 1%, 5%and 10%

Moreover, TableV-8 illustrated the effect of frequency of each type natural disasters on import in middle income countries. The result present that Hydrological disasters, hydro variable, strongly increase import around 0.063 percent at 5% significant level in that same year. After that, the import shows gradually decrease in percent from 0.054 percent to 0.051 percent to 0.042 percent at 10% significant level. The sign of the parameter corresponding to this variable stays significantly

positive end the 9th year, see in FigureV-8, in line with the positive effect of disasters variable on import volume whereas other disasters have no statistically significant on import.

FigureV-8 Hydrological disasters on import in middle income countries



The value of the economic loss of natural disasters on international trade

From the equation that is used in panel data analysis on the impact of value of the economic loss on international trade in 49 countries, the three controlled variables, namely, income variable, fert variable and govc variable, have the same statistically significant and coefficient sign resembling the impact of frequency of natural disasters on international trade in 49 countries.

Furthermore, the dataset on value of the economic loss of natural disasters during 1990-2010 is too small. Because when any natural disasters hit, frequencies as reported by CRED are recorded but value of economic loss is rarely estimated. Even if the value of economic loss was calculated, the result would normally be less than the real value. That is to say although the natural disasters occur; value of the economic loss is seldom recorded. For that reason, value of the economic loss of total natural disasters, denoted totalvalue variable, appears to have no statistically significant on both export volume and import volume. This suggests that value of the economic loss is has no relationship with international trade as opposed to the frequency of natural disaster.

Value of economic loss of each natural disaster type – Climatological, Geophysical, Meteorological, and Hydrological disasters, denoted as value1, value2, value3, value4 respectively- has no statistical significant effect on international trade. at any level-income country.

5.3 Natural disasters on Human capital

Table V-9 Estimated result the effect of frequency of each type natural disasters on human capital accumulation

Specification	K=0	K=1	K=2	K=3	K=4
variable	Coefficient on Secondary school enrollment (Standard Error)				
$income_{it}$	0.002	0.001	0.004	0.002	0.000
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
$climate_{i,t-k}$	-0.069	-0.055	-0.055	-0.024	-0.009
	(0.044)	(0.044)	(0.043)	(0.042)	(0.042)
$geo_{i,t-k}$	-0.042	-0.030	-0.037	-0.022	-0.040
	(0.037)	(0.036)	(0.034)	(0.034)	(0.034)
$meteo_{i,t-k}$	0.009	0.019	0.042	0.049	0.050
	(0.041)	(0.041)	(0.040)	(0.041)	(0.039)
$hydro_{i,t-k}$	0.139***	0.122***	0.121***	0.097***	0.074***
	(0.029)	(0.030)	(0.030)	(0.030)	(0.030)
constant	4.139***	4.156***	4.157***	4.181***	4.217***
	(0.034)	(0.033)	(0.034)	(0.033)	(0.031)
No of obs.	**147**	**140**	**133**	**126**	**119**

Note: ***,**, *Coefficients and Standard error of estimated coefficient in parentheses is significant level at 1%, 5%and 10%

By estimating a panel data frequency of natural disasters on human capital equation in TableV-9, surprisingly, the result shows a positive relationship between growth in secondary school enrollment and Hydrological disasters. It indicates statistically at 1% significant level since the first year onwards demonstrating that when hydrological disasters such as flood increase one percent in a year, it could effect on Human capital, secondary school enrollment or school variable, increase around 0.139 percent in that year. Moreover, this result continues its positive effect but reduce slightly year by year, that is, 0.122 percent, 0.121 percent, 0.097 percent and 0.74 percent respectively. Hydrological disasters keep their significantly positive

effect on Human capital until the 11th year, see in FigureV-9. This is consistent to the findings by Skidmore and Toya in 1960-1990 showing that the frequency of climatic disasters is positively related to human capital accumulation. The empirical study for the period 1990-2010 shows strong evidence support that Hydrological disasters can generate human capital accumulations.

FigureV-9Hydrological disasters on Human capital accumulation in 49 countries

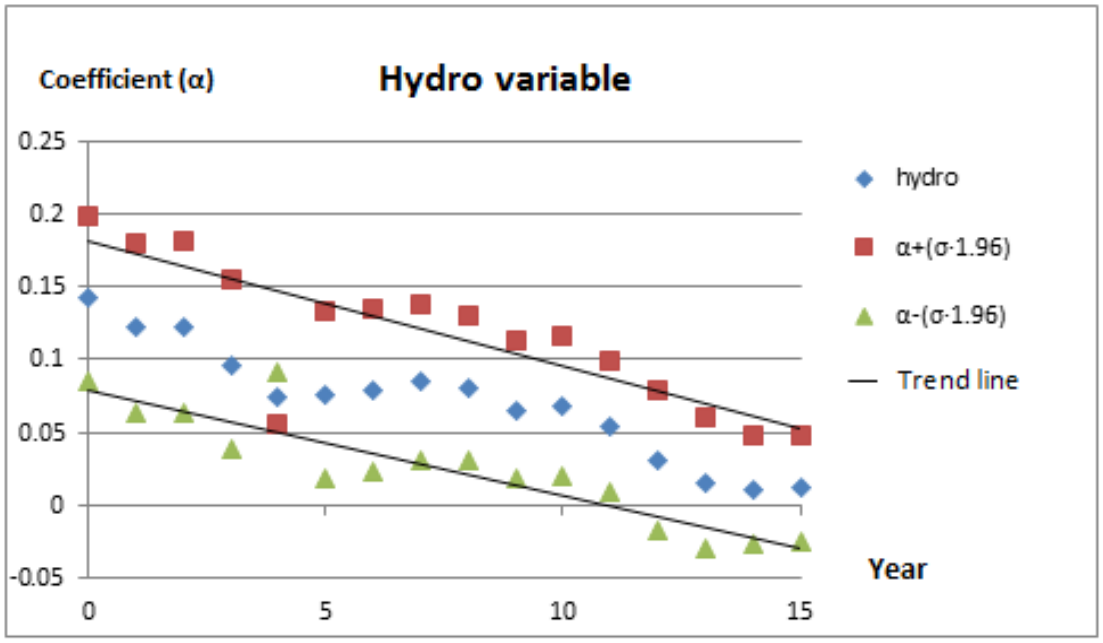


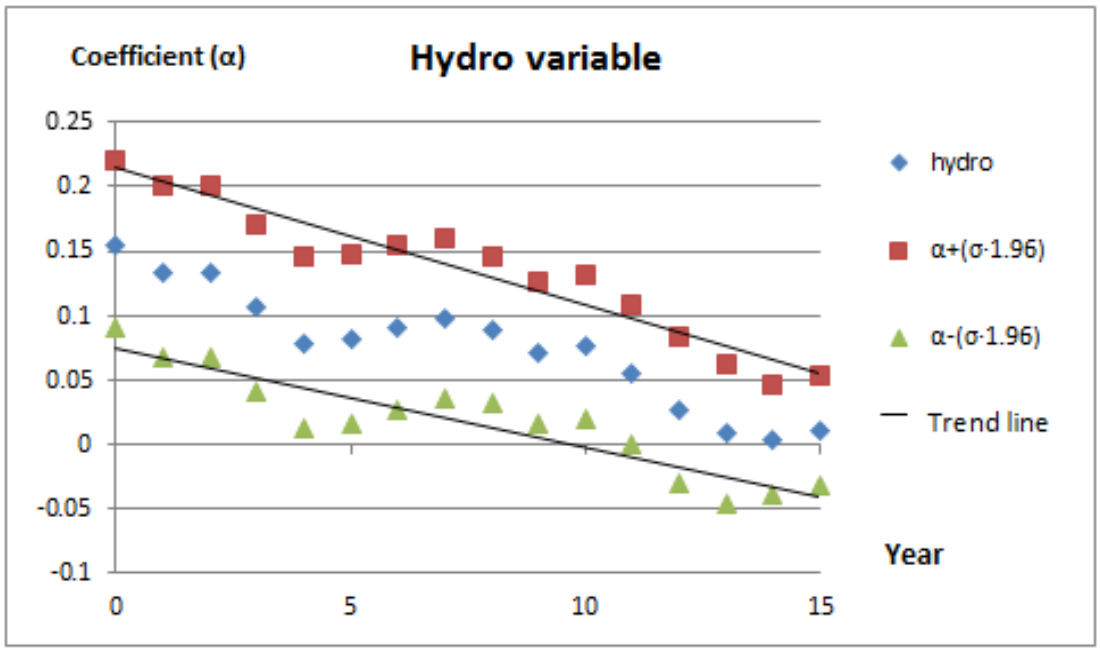
Table V-10 Estimated result the effect of frequency of each type natural disasters on Human Capital in middle income countries

Specification	K=0	K=1	K=2	K=3	K=4
variable	Coefficient on Secondary school enrollment (Standard Error)				
$income_{it}$	0.004	0.000	0.005	0.003	0.000
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
$climate_{i,t-k}$	-0.062	-0.045	-0.044	-0.008	0.004
	(0.051)	(0.051)	(0.050)	(0.050)	(0.049)
$geo_{i,t-k}$	-0.046	-0.036	-0.042	-0.027	-0.043
	(0.040)	(0.039)	(0.038)	(0.038)	(0.038)
$meteo_{i,t-k}$	-0.001	0.016	0.045	0.058	0.063
	(0.053)	(0.054)	(0.052)	(0.051)	(0.050)
$hydro_{i,t-k}$	0.155***	0.134***	0.133***	0.106***	0.079**
	(0.033)	(0.034)	(0.034)	(0.033)	(0.034)
constant	4.067***	4.094***	4.093***	4.116***	4.159***
	(0.040)	(0.037)	(0.038)	(0.037)	(0.035)
No of obs.	**126**	**120**	**114**	**108**	**102**

Note: ***,**, *Coefficients and Standard error of estimated coefficient in parentheses is significant level at 1%, 5%and 10%

By focusing on middle-income countries, TableV-10, these results strongly confirm that Hydrological disasters have statistically significant impact on the accumulation of human capital. These disasters promote 0.155 percent in the year the disasters hit but lessen year by year to a rate of 0.134 percent, 0.133 percent, 0.106 percent and 0.079 in the second year and the third year respectively. Hydrological disasters carry on having a significantly positive effect on Human capital until the 10^{th} year, see in FigureV-10 while other types of natural disasters are not significant. This is consistent to the findings by Skidmore and Toya in 1960-1990 showing that the frequency of climatic-hydrological- disasters is positively related to human capital accumulation.

FigureV-10 Hydrological disasters on Human capital accumulation in middle income countries



When compared frequency to value of the economic loss of natural disasters, this result shows that coefficient of totalvalue variable is also non-significant to secondary school enrollment. It has a positive sign that is similar to the result of frequency natural disasters effect on human capital. The coefficients of four types' natural disasters are unchanged non-significant.

5.4 Natural disasters on Physical capital

The results of natural disasters on physical capital regression show that total natural disaster coefficients are non-significant and generally negative since natural disasters occurred. It is consistent with (Skidmore and Toya 2002) that there is no significant relationship between physical capital investment and disasters. All types' natural disasters are non-significant.

Hence, the results of value of the economic loss (in thousand US dollars) of total natural disasters have a non-significant relationship between Physical capital and total value of the economic losses of natural disasters. Moreover, the results of value of the economic losses of each natural disaster type are not significant. It can be explained that value of the economic losses of Climatological -, Geophysical- , Metrological- and Hydrological disasters are all negative in that year but change to positive the year after. For middle income countries, the result of sign and significance are the same as the outcome in seven countries.

Interpretation

Natural disasters and international trade

Natural disasters have different impacts on the exports and imports of the 49 countries[4]. The frequency of total natural disasters has a positive effect on exports, but a negative effect on imports. Surprisingly, the frequency of total natural disasters has a statistically significant positive impact on imports in low-income countries. This impact increases the import volume in the year the disaster occur and continues to have a statistically significant positive effect on imports for two more years. In the third year, even if positive signs can be seen, it is no longer significant.

For middle-income countries, a significantly positive impact on imports can be found only in one particular year, to be precise, the third year after the disaster. There will be no significant impact in the first two years, as well as the fourth year onward. Middle-income countries will import more commodities to substitute domestic production along with new machinery and equipment for restoration and rebuilding. There is no relationship between total natural disasters and exports. In terms of the level of income, the value of economic loss has no statistically significant impact on exports and imports. Middle-income countries are still expected to export goods and services. Total natural disasters consist of four types of natural disasters, namely climatological, geophysical, meteorological, and hydrological disasters that have a different effect on international trade.

In terms of frequency, the frequency of climatological disasters have an insignificant effect on the international trade of all 49 countries with any level of income. Like disaster frequency, the value of economic loss caused by climatological disasters also has an insignificant effect on exports and imports.

Geophysical disasters, in terms of frequency, affect Export in middle- and high-income countries greatly. Both of them have the same negative sign but with a slightly different time frame. Middle-income countries were negatively affected by Geophysical disasters only in the same year when the disaster happened. However,

[4] They are non-significant at a 1 percent level of significance.

this negative effect can prolong to following year in high-income countries. The value economic losses of Geophysical disasters have no relationship with export in any level-income countries. The same negative trend is shown in trade. Like Export, value economic loss of Geographical disaster has statistically non-significant negative effect on Import in 49 countries at any income level.

Meteorological disasters have no statistically significant effect on exports and imports in all 49 countries, and in terms of the value of economic loss caused by meteorological disasters, this also has no significant effect on the international trade of countries with any income level.

On the other hand, hydrological disasters unexpectedly strongly promote international trade in all 49 countries. The frequency of hydrological disasters has a statistically significant positive impact on both exports and imports in the same year the disasters occur and continues to increase international trade significantly year by year. Hydrological disasters can increase import volumes sizably in the year the disaster occurs and the statistical significance can last for 13 years, after which there is no significant effect. On the export side, the impact is significantly positive for a shorter period; the statistical significance lasts for 8 years after the hydrological disaster occurs.

For low-income countries, the frequency of hydrological disasters only has a significant positive impact on imports for 12 consecutive years. However, hydrological disasters have no significant impact on exports.

For middle-income countries, hydrological disasters have a statistically significant effect on both exports and imports. The coefficient sign of hydrological disasters on export in middle-income countries demonstrates an increasingly significant positive effect on export volume every year until the 6^{th} year and a significant positive effect on import volume until the 9^{th} year. Middle-income countries benefit from the same significant positive effect as international trade in 49 countries.

Natural disasters and countries' capital

The accumulation of human capital has a significant relationship with hydrological disasters from the first year onward. This effect keeps a positive trend in magnitude, but only gradually year by year. This empirical study for the period from 1990 to 2010 finds strong evidence that hydrological disasters lead to the accumulation of human capital. This is consistent with the statement made by (Skidmore and Toya 2002) that natural disasters can increase human capital accumulation. When focusing on countries with different levels of income, the results strongly confirm that hydrological disasters encourage an extensive accumulation of human capital in middle-income countries. However, there is no relationship between the value of economic losses of all natural disasters and human capital.

On the other hand, the accumulation of physical capital has no significant relationship with either the total or all types of natural disasters, not only in terms of frequency, but also the value of economic loss.

CHAPTER VI

CONCLUSION

This study employed the natural disasters panel data collected by the Centre for Research on Epidemiology (CRED) in Brussels and hypothesized that natural disasters can affect countries' exports and imports using a fixed-effect model. By using data from the time period of 1990-2010, the frequency of natural disasters and the value of the economic loss the cause to countries with different levels of income were compared to determine their effect on international trade. The impact of natural disasters on the accumulation of human and physical capital was also included in the estimation. Only hydrological disasters were found to strongly promote international trade in terms of both import and export in 49 countries.

The effect of the frequency of natural disasters on the volume of exports was found to be ambiguous, depending on the type of natural disaster and the income level of the country. Geophysical disasters, such as earthquakes, were found to have a significantly negative effect on the exports of middle-and high-income countries; conversely, hydrological disasters, such as floods, can only strongly promote exports in middle-income countries. Meanwhile, the value of the economic loss caused by natural disasters was found to have no significant effect on the exports of countries with any income level.

Similar to the export volume, the effect of the frequency of natural disasters on the volume of imports was found to be ambiguous, depending on type of natural disaster and the income level of the country. A significant positive relationship was found between the frequency of total natural disasters and the imports of both low- and middle-income countries. Furthermore, hydrological disasters have the same significant positive effect as total natural disasters on low- and middle income countries. Additionally, the value of the economic loss caused by all natural disasters was found to have no significant effect on imports.

It appears that the accumulation of human capital has a strong positive relationship with hydrological disasters. However, neither the frequency of natural disasters nor the value of economic loss is related to the accumulation of physical

capital. These findings match those of (Skidmore and Toya 2002). Strong evidence was also found to support the idea that natural disasters can lead to human capital accumulation. This paper supports an empirical discovery that hydrological disasters can promote both exports and imports, possibly because creative destruction substitutes physical capital and may have a net positive effect on the accumulation of human capital. For example, some regions may have experienced a hydrological disaster and were able to build embankments and/or dams to prevent flood damage when disaster strikes again. Therefore, hydrological disasters cannot reduce the export and import of goods and services.

Limitations and Suggestions

This study has to drop some controlled variables due to unavailable panel dataset. Because of the unavailability of some variables data, particularly, the data on value of the economic loss of natural disasters in the period of 1990-2010, the result does not accurately represent each level-income group and the effect natural disasters on countries' capital cannot be generalized to the level-income countries at large. This study does not take the severity level of disasters, for example, a hurricane intensity scale and an earthquake measuring on the Richer scale, into account. Since CRED records only the frequency of disasters, no data on the severity of disasters available. The severity of disaster could be a good variable to measure the impact on international trade, human capital accumulation, and physical capital investment because one catastrophic disaster could have more impact than many small or moderate disasters. These are some suggestions for further study to be accomplished by obtaining more refined estimates of the severity of disaster and the different characteristics of each country to be put into both theoretical model and empirical analysis.

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APPENDIX

APPENDIX A

Country list I

Part 1. This study use all 49 countries for estimating the effect of natural disasters on international trade.

Low income	Middle Income		High Income
	Lower-middle	Upper-middle	
Bangladesh	Bolivia	Brazil	Chile
Burundi	Cameroon	Colombia	Hong Kong SAR, China
Central African Rep.	Congo, Rep.	Costa Rica	Korea, Rep.
Chad	Egypt, Arab Rep.	Dominican Rep.	Singapore
Gambia, The	Guatemala	Ecuador	United States
Kenya	Honduras	Malaysia	Uruguay
Madagascar	India	Mauritius	
Malawi	Morocco	Mexico	
Mali	Nigeria	Peru	
Mozambique	Pakistan	Thailand	
Niger	Philippines	Tunisia	
Rwanda	Senegal	Turkey	
Uganda	Sri Lanka	Venezuela, RB	
Zimbabwe	Sudan	Zambia	
	Swaziland		

Country list II

Part 2. This study use 7 countries (eg. Morrocco, Costa Rica, Malaysia, Mexico, Peru, Tunisia, Korea,Rep.) from 49 countries for estimating the effect of nautural disasters on both of Human capital accumulation and physical capital base on available panel data.

Middle Income		High Income
Lower-middle	Upper-middle	
Morocco	Costa Rica	Korea, Rep
	Malaysia	
	Mexico	
	Peru	
	Tunisia	

Appendix B

Why we use log (1+ x)?

x = natural disasters ≈ 0.00?? < 1

y = export volume*

$$\ln(y) = \beta_0 + \beta_2 \cdot \ln(1+x) \qquad \text{(ii)}$$

We take (dy/dx) in the equation (ii)

$$(1/y) \cdot (dy/dx) = d(\beta_0) + \beta_2 \cdot d(\ln(1+x))$$

$$(1/y) \cdot (dy/dx) = 0 + \beta_2 \cdot 1/(1+x)$$

$$\beta_2 = [(1+x)/(y)] \cdot [(dy)/(dx)]$$

$$\beta_2 = [(dy)/(y)] \cdot [(dx)/(1+x)]$$

from d(1+x) = dx

$$\beta_2 = (dy/y) \cdot [(d(1+x)/(1+x)]$$

$$\beta_2 = \%\Delta y / \%\Delta(1+x)$$

if (1+x) increase around 1%, percent in y increase or decrease in β_2

In this study would like to interpret the relationship between natural disasters on international trade. For example, the interpretation of the estimated coefficient β_2 is that around one percent increase in total of natural disasters will employ an expected increase in export volume of β_2 percent.

VITA

Name: Ms. Yada Phutaworavong

Gender: Female

Place of Birth: Bangkok, Thailand

Date of birth: January 8, 1988

Educational:

2012- 2014: Master of Arts in International Economics and Finance

Chulalongkorn University

2006-2010 Graduated Economics at Thammasat university

2003-2005 Graduated at Triamudomsuksa School (Science-Math)

Work experience

2010-2011 Research Assistant at APEC Thailand (International Cooperation a Study Center)

2011-2012 Account officer in Credit Department at The Bank of Tokyo-Mitsubishi UFJ, Ltd