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Abstract

This paper uses cross-country data from 1984 to 2008 to examine how institution influences the number of deaths caused by natural disasters. The major findings show that the number of deaths resulting from natural disasters is smaller in countries with less public sector corruption, and for OECD countries with better functioning legal systems, but not for non-OECD countries.

Keywords: Natural disaster, law and order, corruption, economic development.

JEL classification: D73; K10; O1; Q54

1. Introduction

Exogenous shocks in modern society can produce a significant impact. A natural disaster is a prime example of a serious exogenous shock, and since the 2000s researchers have paid close attention to the subject from an economic point of view (e.g., Horwich 2000; Skidmore and Toya 2002). Toya and Skidmore (2007) have provided the following evidence. First, that the level of damage caused by natural disasters depends on the degree of economic development represented by GDP per capita, number of years at school, economic openness, and the comprehensiveness of a country's financial system; and second, the key determinants of damage are different between developing countries and OECD countries. In addition to economic conditions, previous works have found that institution plays a critical role in reducing the damage caused by natural disasters (Kahn 2005; Escaleras et al. 2007; Yamamura 2010). However, prior works have not made comparisons between developing and developed countries with regard to the role of institution in reducing damage from a disaster.

The essential technology to reduce the impact of natural disasters appears to exist in developed countries but not in developing nations. Escaleras et al. (2007) offer an example of public sector corruption where government inspectors allow contractors to ignore building codes. Furthermore, such contractors cannot be made to comply with building codes if they are operating within a poorly functioning legal system. As a result, buildings are seismically insensitive, which increases damage levels caused by a natural disaster. However, if there is a lack of appropriate construction engineering, seismically insensitive buildings will still be constructed even when the public sector is not corrupt and a quality legal system is present. This implies that quality of institution is complementary to technology. Therefore, institution plays a greater role when more

advanced technology exists. Advanced technology is less likely to exist in developing countries. Accordingly, the role of institutions in reducing the damage caused by disasters is considered to vary depending on the degree of a nation's economic development. For the purpose of examining the above inference, I intend to extend the scope of existing works by comparing the effect of institution on reducing the damage caused by natural disasters between OECD and non-OECD countries.

2. Data and Model

Annual data on the number of deaths caused by natural disasters since 1990 were obtained from *EM-DAT (Emergency Events Database).*[1] Measures of public sector corruption and the state of legal systems were collected from the *International Country Risk Guide (ICRG)*, covering 146 countries over a 27-year period (1984–2010).[2] 'Public sector corruption' and 'quality of legal system' values range from 0 to 6. 'Public sector corruption' indicates the likelihood that high government officials would demand special payment in the form of bribes. 'Quality of legal system' reflects the results of assessments regarding (1) the strength and impartiality of the legal system and (2) popular observance of the law. Larger values indicate less corruption and better legal systems. In addition, the World Bank (2010) provides other control variables that capture socio-economic factors, from 1960 to 2008. For the estimations shown in this paper I used annual panel data from 1984 to 2008.[3]

The data regarding technological disasters used in this study can be considered as

[1] This data is available at http://www.emdat.be/explanatory-notes (accessed on June 15, 2011).
[2] The measure for legal system quality is called 'law and order' in the *ICRG.*
[3] A list of countries used in this paper, and a summary of basic statistics (e.g., mean value and standard deviation) are available from the author upon request.

count data. As stated by Escaleras et al. (2007), the available data on the number of deaths caused by natural disasters is over-dispersed and, therefore, the variance is large. Thus, a negative binominal model is preferred rather than a Poisson model (Wooldridge 2002, Ch. 19). From the data used in this study, the mean value for the number of deaths is 437, while its variance is 5062. This clearly suggests that the number of deaths caused by natural disasters is over-dispersed. Hence, I used a negative binominal model to examine the data and the estimated function takes the following form:

$$\text{Number of deaths}_{it} = \alpha_0 + \alpha_1(\text{Corruption})_{it} + \alpha_2(\text{Legal system})_{it} + \alpha_3(\text{Number of disasters})_{it} + \alpha_4 GDP_{it} + \alpha_5(\text{Population density})_{it} + \alpha_6(\text{Size of government})_{it} + \alpha_7(\text{Openness})_{it} + m_i + e_{it},$$

where the dependent variable is the number of deaths caused by natural disasters in country *i* and in year *t*. *m* is the unobservable country-specific fixed-effect and is controlled for by country dummies. *e* is an error term and α represents the regression parameters. As shown by Kahn (2005), the probability of a natural disaster occuring depends on geographical features such as land size and location rather than economic conditions. Geographical location can be considered as a time-invariant feature of a country and is captured by country dummies. Furthermore, estimation results suffer from bias when independent variables are correlated with the time-invariant unobservable features of a country. Existing works investigating damage from natural disasters, however, do not include country dummies as dependent variables (Kahn 2005; Escaleras et al. 2007; Toya and Skidmore 2007). This paper controls for bias by including country dummies, thus, attenuating the bias.

The higher the quality of the institution, the lower the level of damage from natural disasters. Therefore, I predict the coefficients for corruption and legal system to take the negative sign. Toya and Skidmore (2007) produced evidence that the determinants of damage resulting from natural disasters will differ depending on a nation's degree of economic development. Similarly, the sample in this paper is divided into OECD and non-OECD countries. Estimations are then conducted to compare the results between OECD and non-OECD countries. Control variables, included as independent variables, are GDP per capita, population density, size of government (government consumption/GDP), and openness (export + import/GDP). These variables have been regularly used in prior works (Kahn 2005; Escaleras et al. 2007; Toya and Skidmore 2007).[4]

3. Results

The estimation results using the full sample are exhibited in Table 1. The estimation results using non-OECD and OECD countries are set out in Tables 2 and 3, respectively. In each table, results excluding the country dummies as independent variables are presented in column (1), and results including country dummies as independent variables are in column (2).

I purposely focused on the results of the key variables that capture institutional quality, such as corruption and legal system. I see from Table 1 that corruption takes the negative and positive signs in columns (1) and (2), respectively, and they are not statistically significant. Legal system yields the negative sign in columns (1) and (2)

[4] Number of years at school and M3/GDP were incorporated as independent variables by Toya and Skidmore (2007). There is no panel data for number of years at school and is captured by country dummies. The sample size is drastically reduced if M3/GDP is included. Hence, these variables are not included.

although it is not statistically significant in column (2). Hence, the results for institutional factors are not stable, implying that in the full sample, institutional conditions do not have a critical effect on the number of deaths caused by natural disasters. Turning to Table 2, corruption does not yield the predicted negative sign, whereas legal system does produce the predicted negative sign; however it is not statistically significant. In contrast, in Table 3, the signs for corruption and legal system are negative and statistically significant, which is consistent with the prediction. It follows that institution has an important influence on the level of damage caused by natural disasters in developed countries, but not in developing countries.

4. Conclusions

Previous works have suggested that the determinants of damage caused by natural disasters are different between developing and OECD countries. However, little is known as to the effect that institutional conditions have, with regard to damage caused by natural disasters, on developing and OECD countries. This paper used panel data from 1984 to 2008 to compare the effect of institutional conditions on the damage caused by natural disasters. Summarized estimation results are as follows. OECD countries enjoy a lower death rate from natural disasters when the country has lower levels of corruption within its public sector. In addition, a better functioning legal system also results in a lower death rate caused by natural disasters in OECD countries, but not in non-OECD countries. Thus, institutional conditions become important in the reduction of damage caused by disasters once countries are considered to be developed nations.

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Table 1 Number of deaths by natural disaster and institutional quality (negative binominal model): all countries

	(1)	(2)
Corruption	–0.23	0.16
	(–0.94)	(0.98)
Law and order	–0.27*	–0.14
	(–1.72)	(–0.89)
Number of natural disasters	0.35***	0.39***
	(2.87)	(3.44)
GDP per capita	0.15	0.23
	(0.75)	(0.33)
Population density	0.01	0.005
	(0.95)	(0.03)
Size of government	–0.02	–0.09**
	(–0.58)	(–2.35)
Openness	–0.009***	0.01
	(–2.69)	(1.14)
Constant	6.58***	4.91***
	(6.56)	(3.51)
Country dummies	Not included	Included
Log pseudo-likelihood	–8108	–7744
Observations	1931	1931

Note: Values in parentheses are z-statistics calculated using robust standard errors clustered within a country. Country dummies are included in column (2) but the results are not reported because of space limitations. *, **, and *** denote significance at the 10%, 5%, and 1 % levels, respectively.

Table 2 Number of deaths by natural disaster and institutional quality (negative binominal model): non-OECD countries

	(1)	(2)
Corruption	0.30	0.30*
	(1.59)	(1.76)
Law and order	–0.08	–0.04
	(–0.52)	(–0.28)
Number of natural disasters	0.36***	0.41***
	(2.85)	(3.62)
GDP per capita	–1.56**	–1.03
	(–2.54)	(–0.79)
Population density	0.07***	0.03
	(3.04)	(0.11)
Size of government	–0.09**	–0.11***
	(–2.44)	(–2.88)
Openness	–0.01***	0.01
	(–4.36)	(1.60)
Constant	6.05***	4.32***
	(6.58)	(2.92)
Country dummies	Not included	Included
Log pseudo-likelihood	–6936	–6170
Observations	1444	1444

Note: Values in parentheses are z-statistics calculated using robust standard errors clustered within a country. Country dummies are included in column (2) but the results are not reported because of space limitations. *, **, and *** denote significance at the 10%, 5%, and 1 % levels, respectively.

Table 3 Number of deaths by natural disaster and institutional quality (negative binominal model): OECD countries

	(1)	(2)
Corruption	–1.31***	–0.74*
	(–3.93)	(–1.71)
Law and order	–0.51**	–0.70***
	(–2.28)	(–3.60)
Number of natural disasters	0.28**	0.24
	(2.01)	(0.93)
GDP per capita	–0.0001	–0.55
	(–0.01)	(–0.67)
Population density	0.70***	10.5***
	(4.03)	(2.91)
Size of government	–0.01	0.34**
	(–0.20)	(2.21)
Openness	–0.003	0.006
	(–0.59)	(0.18)
Constant	11.3***	2.46
	(6.55)	(0.49)
Country dummies	Not included	Included
Log pseudo-likelihood	–1599	–1533
Observations	487	487

Note: Values in parentheses are z-statistics calculated using robust standard errors clustered within a country. Country dummies are included in column (2) but the results are not reported because of space limitations. *, **, and *** denote significance at the 10%, 5%, and 1 % levels, respectively.