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Yamamura, Eiji

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THE CHANGING EFFECT OF LEGAL ORIGIN ON DEATH TOLLS IN NATURAL DISASTERS FROM 1960 TO 2008

Eiji Yamamura

Department of Economics, Seinan Gakuin University

6-2-92 Sawara-ku, Nishijin, Fukuoka 814-8511, Japan

Tel: +81-(0)92-823-4543, Fax: +81-(0)92-823-2506, E-mail: yamaei@seinan-gu.ac.jp

Abstract

Persistent institutions, which are captured by legal origin, are considered to influence the occurrence and intensity of economic crises. However, little is known about how changes in legal origin affect processes of economic development. Using non-European country data, this paper investigates the effect of legal origin on natural disaster death tolls from 1960 to 2008, and on the two periods 1960–1989 and 1990–2008. The key findings are that natural disaster death tolls are higher in French legal origin countries than in other countries in 1990–2008, but not in 1960–1989. This implies that the role of legal origin, in reducing the level of damage in a disaster, changes according to technological progress.

Keywords: Deaths, Natural Disaster, Legal origin, Institution.

JEL classification: D81; O11; Q54

I. Introduction

It is certain that human society will experience unexpected events and therefore coping with risk is a central issue of modern economics. In more primitive times, societies were significantly affected by natural disasters, partly because of a lack of disaster prevention technology. This strengthened the incentive to generate such technology, enabling humankind with a greater ability to withstand natural disasters. However, even in modern times, recent natural disasters, Hurricane Katrina, the Haiti earthquake, and the Kanto-Tohoku earthquake in Japan, have resulted in tremendous economic loss. Thus, economists are paying greater attention to issues surrounding natural disasters (Cavallo and Noy, 2009). The likelihood of a natural disaster depends considerably on geographical characteristics rather than the degree of economic development. The resulting damage from natural disasters, however, differs between developed and developing countries (Kahn, 2005; Toya and Skidmore, 2007).[1] The damage caused by natural disasters is influenced by economic factors such as economic openness, human capital and GDP per capita, and income inequality (Anbarci et al., 2005; Toya and Skidmore, 2007). In addition, quality of institution is an important determinant in reducing the damage caused, not only by external economic shocks (e.g., Rodrik, 1999; Johnson et al., 2000; Acemoglu et al., 2003), but also by natural disasters (e.g., Kahn, 2005; Escaleras et al., 2007).[2]

Institutions are captured by various measures and so can be characterised in numerous ways. Some institutions are formed as a consequence of historical events and continue today to be a key determinant of socio-economic conditions (Acemoglu et al., 2001; 2002). As stated by Du

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[1] The effect of natural disasters on growth has also been explored. Skidmore and Toya (2002) used cross-country data to find a positive relationship between natural disasters and growth. In contrast, Strobl (2011) suggested that hurricanes have a detrimental impact on the annual growth rate of coastal counties in the United States. Kellenberg and Mobarak (2008) showed that the relationship between the level of GDP and the damage caused by natural disasters takes an inverted U shape, rather than being monotonically negative.

[2] Acemoglu and Robinson (2001) found that quality of institution is the key factor in encouraging coups and revolutions, resulting in political and economic instability.

(2010), a persistent institution, such as legal origin, has a greater effect on the occurrence and intensity of a crisis compared with time-varying institutions such as corruption and autocracy.[3] Acemoglu et al. (2002) argued that the various institutions introduced by Europeans into their former colonies resulted in a reversal, and subsequent divergence, of income between countries because of the emergence of industrialisation during the nineteenth century. Societies with strong historical institutions took advantage of the opportunity to industrialise, although not until the mid-nineteenth century. Similarly, Rajan and Zingales (2003) found that French civil law countries had more developed financial markets than common law countries at the beginning of the twentieth century. However, common law countries became more developed in terms of financial markets than civil law countries in the mid-twentieth century. This phenomenon was termed by Rajan and Zingales (2003) as the Great Reversal. While Bozio (2002) and Michie (1999) argued that civil law countries were more developed at the turn of the twentieth century, La Porta et al. (2008) disagreed, stating that common law countries were more financially developed than civil law countries at that time. La Porta et al. (2008) confirmed that over the course of the twentieth century, the differences between civil law and common law countries widened, leading to a divergence between the two after the mid-twentieth century. Thus, the effect of persistent institutions does change over time, and depends on circumstance.

Toya and Skidmore (2008) assumed that "greater openness servers as a proxy for the degree of competition and the transferral of technological knowledge from abroad that reduces risk.[4] A more highly developed financial sector may reduce disaster impacts because an efficient information based financial system is less likely to finance projects in inherently risky locations" (Toya and Skidmore 2003, p.22). They then hypothesised that "greater openness and a more highly developed financial sector will experience fewer deaths" (Toya and Skidmore 2003, p.22),

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3 Cavallo and Cavallo (2010) investigated how political institutions affect growth through their interaction with economic crises.

4 For example, "'the Maldives was spared from severe damage that might have resulted from the Southeast Asian Tsunami because Japan provided the technology and assistance to construct a massive sea wall around the capital of Male'" (Toya and Skidmore, 2007, p.22).

and presented evidence supporting their hypothesis based on annual data regarding recorded disasters in 151 countries, from 1960 to 2003. The construction of buildings involves many steps, crucial to its strength and safety. During this process, however, there is a major incentive for the developer to engage in poor construction work: the reduction of costs. While there are strict building codes to ensure that poor construction does not occur, corruption within the public sector enables such shoddy construction, resulting in the failure of buildings in the face of major earthquakes (Escaleras et al., 2007). That is, corruption within the public sector increases the level of damage caused by natural disasters. These determinants of damage resulting from natural disasters are influenced by legal origin (La Porta et al., 2003): French civil law is associated with (1) weak investor protection, which in turn is associated with less financial development and impediments in obtaining finance (La Porta et al., 1997, 1998), and (2) with greater entry regulation, which in turn leads to corruption and larger unofficial economies (Djankov et al., 2002). Entry regulation also results in lower trade openness (Helpman et al., 2008). Because of the above limitations, French civil law countries are expected to suffer greater levels of damage in natural disasters than other countries.

Greater openness has failed to encourage the transference of imported technological knowledge into developing countries to reduce their risk, if such knowledge exists at all. Financial development does not influence the choice of locations according to inherent risk, if there is inherent risk it cannot be precisely calculated because of the lack of technology to predict the disaster. Furthermore, a lack of seismically-sensitive engineering results in buildings that will not withstand earthquakes even when the public sector has low-level corruption. Hence, legal origin does not make a significant contribution to the reduction of the damage caused by natural disasters if the disaster prevention technology has not been developed in that society. In other words, legal origin becomes a key determinant in reducing the level of damage only if disaster prevention technology exists. Accordingly, the role played by legal origin in mitigating the resulting damage of natural disasters is likely to be influenced by the presence of disaster prevention technology. This dynamic aspect of the influence of persistent institutions, such as legal origin, has not been previously explored, despite the fact that it is important to understand the interaction between institution and circumstance. To examine this relationship, annual data regarding recorded disasters in 156 countries, excluding European countries, from 1960 to 2008, was used to compare the effect of legal origin on death tolls in natural disasters for two periods, 1960–1989 and 1990–2008. The key findings of this paper are that the death tolls in French legal origin countries are almost identical to those in other countries for 1960–1989, and greater than in other countries for 1990–2008.

This paper is organised as follows: Section 1 describes the data, Section 2 presents the econometric specifications, Section 3 exhibits the estimation results, and Section 4 concludes.

1. Data

For the estimations in this paper, I used annual data regarding natural disasters in 156 countries, from 1960 to 2008. Du (2010) argued that persistent institutions are more closely related to the occurrence of crises than time-varying institutions captured by corruption or autocracy indexes. Furthermore, proxies for time-varying institutions are considered to be endogenous variable, causing estimation bias (Kahn, 2005; Escaleras et al., 2007). As pointed out by Beck et al. (2003), legal traditions are thought to be endogenous to their birthplace. However, the traditions are exogenous in former colonies, because the legal origin of a colony, obtained via colonisation, is largely a coincidental event. In other words, "legal traditions were typically introduced into various countries through conquest and colonization and, as such, were largely exogenous" (La Porta et al., 2008, p.286). Hence, as exhibited in Table A1, the 156 countries do not include European countries and so helps to generate exogenous measures for the institutions.

This paper restricts the sample to non-European countries and therefore estimation results do not suffer from bias.

Table 1 presents the definition and the source of each variable used in this paper. The dependent variable is the number of deaths caused by natural disasters. The data for DEAT (death toll in natural disasters) and NDIS (number of disasters) were gathered from EM-DAT (Emergency Events Database).[5] GDP (GDP per capita), POP (population), GOVSIZ (government size), and AGRAT (value-added of agriculture /GDP) were collected from the World Bank (2010). The available data for these variables covered the period 1960 to 2008. Thus, the data used in the estimations do not include 2009. GINI (income Gini coefficients) is collected from the Standardized Income Distribution Database (SIDD) developed by Salvatore (2008).[6]

Figure 1 demonstrates the trends in the log of deaths per disaster for 1960–2008, whereas Figure 2 illustrates the trends in GDP per capita for 1960–2008. A cursory examination of Figure 1 reveals that deaths per disaster decreased over time. The improvement of disaster prevention technologies, such as earthquake-strengthened buildings and early warning systems, are considered a key factor in reducing the damage caused by natural disasters (Escaleras and Register, 2008; United Nations, 2010). I interpret the declining trend illustrated in Figure 1 as suggesting that progress in disaster prevention technology has reduced the death tolls in disasters. I see from Figure 2 that GDP per capita has increased over time, suggesting that countries experienced economic growth after 1960. Jointly considering Figures 1 and 2 leads me to assume that the progress in disaster prevention technology, accompanied by economic development, reduces the level of damage caused by natural disasters. However, low-quality institutions appear to impede the diffusion of new technology in developing countries, even where new technology is available. For instance, buildings may not be adequately constructed because of corruption within

[5] Data was obtained from http://www.emdat.be. (accessed on June 1, 2011).

[6] Data was obtained from http://salvatorebabones.com/data-downloads. (accessed on June 1, 2011). The paper used SIDD-3, which is an interpolated and extrapolated version of SIDD-2 incorporating in-sample and out-of-sample estimates for 1955–2005. To extend the data, I made the values for 2006–2008 the same as the values for 2005.

the public sector, even when earthquake-resistant/anti-earthquake design has been developed (Escaleras et al., 2007). This is supported by evidence that French legal origin countries have low-quality infrastructure (La Porta et al., 1999). In contrast, institutional conditions play a minor role in determining the level of damage in a disaster if disaster prevention technology does not exist. In other words, the degree of adaptation of technology appears to depend on the quality of institution after the disaster prevention technology has been developed.

Table 2 exhibits the difference of the log of deaths per disaster and GDP per capita between French legal origin countries and other countries. Table 2 suggests that the death tolls in disasters in French legal origin countries are significantly higher than other countries during the period 1960–2008. After splitting the period into two, 1960–1989 and 1990–2008, a significant difference between the French legal origin countries and the other countries for the two periods continues. Furthermore, it is interesting to observe that the difference between the two country types for 1990–2008 (0.27) is approximately four times greater than the differences for 1960–1989 (0.07). In contrast, GDP per capita in the French legal origin countries is significantly greater than that of the other countries for the period 1960–2008. The level of GDP per capita increased over time in both the French legal origin countries and the other countries, suggesting that both have experienced economic development in both periods. The difference between French legal origin countries and the other countries for GDP per capita in 1990–2008 (US$2,018) is smaller than that for 1960–1989 (US$4,049). The role of legal origin in the reduction of death tolls caused by disasters increased over time even though the influence of legal origin on economic development has decreased. Thus, I raise the following hypothesis:

HYPOTHESIS. *Legal origin plays a greater role in the reduction of deaths caused by natural disasters where there are improvements in disaster prevention technology.*

2. Econometric Specifications

To test the hypothesis, I estimated a model that follows a form used in previous research (e.g., Kahn, 2005; Toya and Skidmore, 2007; Cavallo et al., 2010):

$$DEAT_{it} = \alpha_0 + \alpha_1 FRLEGA_i + \alpha_2 NDIS_{it} + \alpha_3 GDP_{it} + \alpha_3 OPEN_{it} + \alpha_4 AGRAT_{it} + \alpha_5 GINI_{it} + \alpha_6 GOVSIZ_{it} + \alpha_7 DENS_{it} + \alpha_8 LAND_{it} + \alpha_9 AFRI_i + \alpha_{10} LAMRI_i + \alpha_{11} EASIA_i + u_t + \varepsilon_{it},$$

where the dependent variable is $DEAT_{it}$ in country *i*, for year *t*. The regression parameters are denoted by α, and u_t represents the unobservable year effects of year *t*. The effects of u_t *are* controlled for by including year dummies. The error term is denoted by ε_{it} and *FRLEGA* is the dummy variable for the French legal origin, as defined by La Porta et al. (1999). Among the 156 countries included in the sample, 86 are French legal origin countries. Thus, approximately half of the countries' legal origin is from French civil law. *DEAT* is the number of deaths in disasters, which does not take a negative value. In this study, the Poisson model is used as the basic method of estimation. However, the Poisson model assumes that the mean of a dependent variable is equal to its variance. As commented in previous research (Kahn, 2005; Escaleras et al., 2007), *DEAT* is over-dispersed and its variance is large. The use of the Poisson model here causes a downward bias and inflates the z-statistics, and as such, the negative binominal model is preferred (Wooldridge, 2002, ch.19). The negative binominal model is used in empirical analysis to examine the effect of disasters in existing research (e.g., Anbarci et al., 2006; Escaleras et al., 2007; Kellenberg and Mobarak, 2008), because the damage caused by natural disasters is characterised by over-dispersion. Following previous studies, the negative binominal model is also used in this paper.

The main purpose of this paper is to examine how and the extent to which the death toll in French civil law countries differs from other countries and whether that difference changes because of progresses in technology. The hypothesis proposed in the previous section leads me to expect that the coefficient for *FRLEGA* will take the negative sign when well-developed anti-disaster technology exists. To test the hypothesis, I assumed that disaster prevention technology has progressed over time in the process of technological development. Under this assumption, I divided the study period 1960–2008 into a period of less technological development (1960–1989) and one with greater technological advancements (1990–2008). I conducted separate estimations for each sample and compared the coefficients for *FRLEGA* between the two periods to test the hypothesis.

Other control variables were included to control for economic conditions such as GDP (GDP per capita), OPEN (trade openness), AGRAT (ratio of agricultural sector), and GINI (income inequality). These variables are used because individuals with higher levels of income can respond to risks such as natural disasters by using additional costly precautionary measures. As exhibited in previous research (Kahn, 2005, Toya and Skidmore, 2007), GDP leads to a reduction in the level of damage caused by natural disasters.[7] As explained earlier, trade openness was found to reduce the damage caused by natural disasters through the transfer of technology from abroad (Toya and Skidmore, 2007). GINI is found to increase the damage level in natural disasters (Anbarci et al., 2005). The shock of natural disasters appears to differ between agricultural and other sectors because farmers are directly affected to a greater extent by natural circumstances. GOVSIZ (government size) is used to capture the presence of government. Greater numbers of people are exposed to natural disasters in more densely populated areas. Thus, when natural disasters occur, countries with greater population density suffer greater numbers of deaths than less densely populated ones. Furthermore, countries with larger land areas appear to experience natural disasters more frequently, leading to an increase in the possibility of deaths caused by natural disaster. DENS (population density) and LAND (land area) are incorporated to control for these situations. Furthermore, area dummies such as AFRI, LAME, and EASIA are

[7] Cavallo et al. (2010) exhibited the opposite result, where GDP per capita increased the level of damage caused by disasters.

included to control for geographical locations that are closely related to the occurrence of natural disasters (Kahn, 2005).

Financial development (Toya and Skidmore, 2007) and corruption (Escaleras et al., 2007) are considered to be key determinants in the level of damage caused by natural disasters. However, an index for financial development is not included here because the sample size would be reduced considerably if the index was included as an independent variable. A corruption index is also excluded because one could not be obtained for the 1960s and 1970s.[8] Furthermore, "public sector corruption is commonly known to be highly correlated with … omitted institutional factors" (Escaleras et al., 2007, p.219). Thus, a corruption index is regarded as an endogenous variable, causing the estimation results to suffer from bias. The aim of this paper is to focus on changes in the effect of legal origin, which is historically and externally determined.

3. Results

The estimation results for the entire study period 1960–2008 are presented in Table 3. The results for 1960–1989 are exhibited in Table 4 while those for 1990–2008 are in Table 5. As shown in Table 1, the standard deviation of DEAT is 27,020, which is almost 27 times greater than its mean value. Hence, there is the possibility that outliers regarding the death tolls from natural disasters have significantly influenced the estimation results. That is, the results may be driven by outliers. In ascertaining the determinants of damage caused by natural disasters, Escaleras et al. (2007) conducted additional estimations using a sub-sample that excluded outliers to alleviate their influence. Thus, this paper also conducted estimations using sub-sample data. Table 1 shows

[8] As used by Escaleras et al. (2007), the popular indexes for public sector corruption are constructed by International Country Risk Guide (ICRG) and Transparency International (TI). However, ICRG provides the corruption index from 1984 to 2010, while TI provides the same from 1995 to 2010.

that the mean value of DEAT is 992. Thus, the exclusion of observations where DEAT is greater than 1,000 is considered to control for the effect of outliers. In each table, results based on the sample that includes the entire range of death rates are presented in columns (1)–(4), while results based on the sub-sample restricted to number of deaths smaller than 1,000 are shown in columns (5)–(8). The robust standard errors were calculated using clusters for each country. Then, z-values were obtained from the cluster–robust standard errors. In each column, the sample size may vary across the different specifications because of data availability.

In Table 3, the coefficient for FRLEGA takes the negative sign in all estimations. In addition, it is statistically significant in columns (1)–(7). It follows then, that the significant positive sign for FRLEGA is observed not only in the full sample but also in the sub-sample without outliers. Hence, the results are unchanged in the various specifications and for different samples. This implies that the death tolls caused by natural disasters in French legal origin countries are greater than for other countries, which is in line with the prediction. Concerning the other control variables, the significant negative signs for the coefficient for GDP and OPEN are congruent to previous research (e.g., Kahn, 2005; Toya and Skidmore, 2007). Considering FRLEGA and OPEN jointly reveals that French regal origin countries suffer a greater number of deaths even when the transfer of imported technology via international trade is controlled for.

Turning to Table 4, it is surprising to observe that the sign of the coefficient for FRLEGA varies according to the specifications, and that the coefficient is not statistically significant with the exception of column (1). This indicates that the death toll in French legal origin countries did not differ with that of other legal origin countries for 1960–1989. That is, legal origin does not influence the number of deaths in natural disasters when there is a high death toll per disaster. I interpret this to mean that legal origin plays a minor role when disaster prevention technology has not been sufficiently developed. In contrast, GDP continues to take the negative sign and be statistically significant in all estimations. The significant negative sign of OPEN is observed even in the period of technological development (1990–2008), suggesting that the effect of trade openness does not come via the transfer of technology, contrary to the conjecture. AGRAT yields the negative sign and is statistically significant in all estimations. That is, the larger the agricultural sector is, the smaller the number of deaths in a natural disaster. The sampled countries do not include European countries, with agriculture considered as a labour-intensive industry. Hence, a large agricultural sector means a small capital-intensive industry. Disaster prevention technology appears to make capital stock more durable in a natural disaster. Therefore, I interpret the significant negative sign of AGRAT as suggesting that capital-intensive industries are more likely to suffer damage in a natural disaster due to a lack of disaster prevention technology. In addition to AGRAT, AFRI also produces negative signs in all estimations and is statistically significant in columns (1), (3), (4), (7), and (8). Similar to the results for AGRAT, a scarcity of capital stock in African countries reduces the level of damage in natural disasters.

With respect to Table 5, FRLEGA yields the positive sign and is statistically significant in all estimations, suggesting that the results for FRLEGA are robust in the alternative specifications and are not driven by outliers. In contrast with the results in Table 4, the death tolls in French legal origin countries are larger than in other countries. That is, legal origin is effective in reducing the number of deaths caused by natural disasters in the period when the death toll per disaster is lower. The combined results for FRLEG shown in Tables 4 and 5 lead me to argue that the importance of legal origin depends on circumstances, strongly supporting the hypothesis proposed previously. That is, legal origin becomes a greater determinant of the number of deaths caused by natural disasters as disaster prevention technology progresses. Furthermore, AGRA yields the positive sign and statistically significant in all estimations. AFRI produces the positive sign and statistically significant in columns (1), (2), (5), and (6).[9] The results for AGRA and

[9] A further interpretation regarding the positive sign for AFRI is as follows. Collier (2009) argued that after the 1990s, democracy resulted in political instability and conflict in African countries. This may reduce long-term investment and lead to poorly constructed buildings. This in turn resulted in a greater number of deaths caused by natural disasters in African countries.

AFRI in Table 5 are converse to those in Table 4. As disaster prevention technology progresses, capital-intensive industries are better able to withstand natural disasters in 1990–2008 than in 1960–1989. Hence, the larger the capital-intensive industry, the smaller the level of damage caused by natural disasters. These results provide supporting evidence for the hypothesis.

4. Conclusions

Even in modern society, natural disasters continue to wreck devastating damage to socio-economic stability. However, deaths per natural disaster have decreased over time. This may be, in part, because of the progress made in disaster prevention technology. In addition, institutional conditions are considered to play an important role in reducing the damage suffered in natural disasters. The effectiveness of technology is believed to depend on the institution. In other words, the interaction between technology and institution can be considered a key determinant in reducing the damage caused by natural disasters.

However, little is known about how the emergence of technology can change institutional effect. Using non-European country data, this paper investigated the effect of legal origin on the death tolls in natural disasters over a significant period, and then compared that effect between two periods, 1960–1989 and 1990–2008. The key findings are that the number of deaths in natural disasters is higher in French legal origin countries than in other countries for the period 1990–2008. However, this tendency is not observed in the earlier period, 1960–1989. Thus, weak institutions, captured by French legal origin, reduce the effectiveness of technology, resulting in larger numbers of deaths even after progresses in technology. The effect of legal origin on outcomes in disasters has increased over time rather than decreased. That is, the institution formed externally, long ago, did not affect the level of damage caused by a natural disaster if there had been little progress in technology. Institution is only important when there has been sufficient technological advancements and, therefore, it is effective in reducing the level of damage. Previous works (e.g., Acemoglu et al., 2002; La Porta et al., 2008; Rajan and Zingales, 2003) showed that persistent institutions lead to different economic outcomes because of changes in circumstances. The contribution of this paper is to provide additional evidence to understand how the role of persistent institutions change over time and are dependent on circumstance.

This paper has explored the change in the role of legal origin with regard the damage caused by natural disasters in the process of economic development. Here, I have simply assumed that technology has increasingly emerged or improved over time and hence there is a significant difference in the level of the technology between the two periods studied in this paper. This assumption is, however, not investigated directly and so open to debate. An index of technological improvement should be used to directly examine how and the extent to which interaction between technology and institution is important to reduce the level of damage caused by disasters. Furthermore, in the introduction, the effect of legal origin is assumed to be via three channels: financial development, trade openness, and the level of corruption within the public sector. However, it is likely that legal origin affects death tolls via other channels too. The estimation results are unchanged even after controlling for trade openness. However, this paper does not distinguish between other channels linking to legal origin and the damage caused by natural disasters. It would also be worthwhile gaining a deeper understanding of the relative importance of those various channels. These remaining issues should be addressed in future work.

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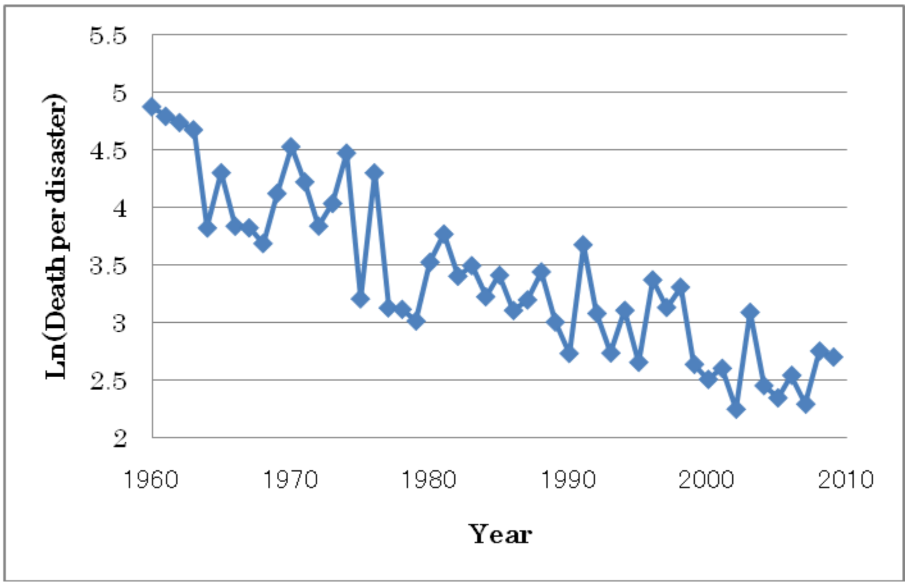

Fig. 1. *Trends in Log of Deaths per Disaster 1960–2008*

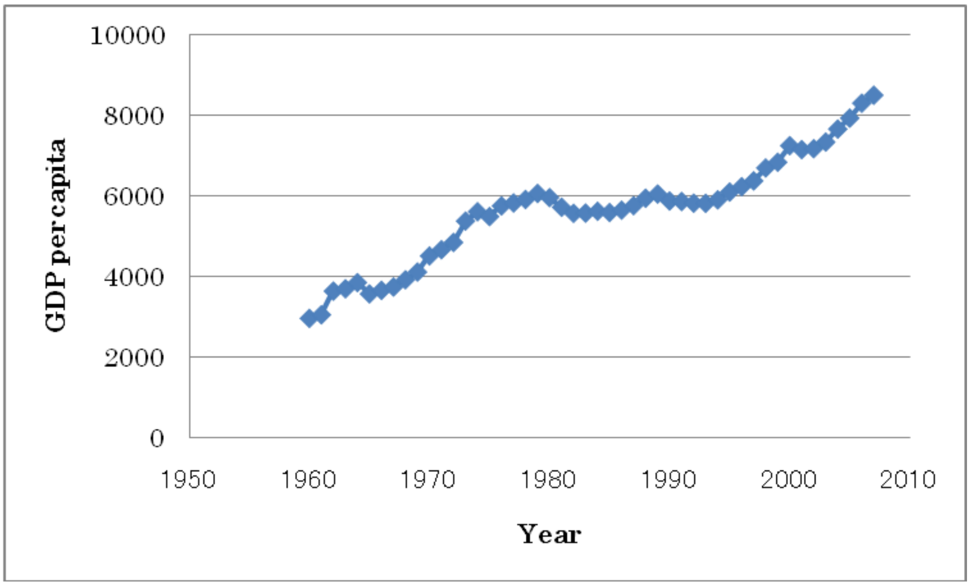

Fig. 2. *Trends in GDP per Capita 1960–2008*

Table 1.

Definition of Variables, Mean, Standard Deviation and Data Source

	Definition	Observations	Mean	Standard deviation	Source
DEAT	Deaths caused by natural disaster	3282	992	27020	Emergency Events Database (EM-DAT)[a]
FRLEGA	French legal origin dummy	3282	0.5	---	La Porta et al. (1999)[b]
NDIS	Total number of disasters	3282	1.90	3.55	Emergency Events Database (EM-DAT)[a]
GDP	GDP per capita (thousand US$: constant 2,000 US$)	3282	0.30	0.58	World Development Indicators 2010
OPEN	Trade (% of GDP)	3282	69.2	45.5	World Development Indicators 2010
AGRAT	Agriculture, value added (% of GDP)	3282	22.8	15.6	World Development Indicators 2010
GINI	Income Gini coefficients	3282	0.47	0.09	Standardized Income Distribution Database (SIDD)[c]
GOVSIZ	General government final consumption expenditure (% of GDP)	3282	14.5	6.16	World Development Indicators 2010
DENS	Population density (thousand people per sq km)	3282	0.14	0.57	World Development Indicators 2010
LAND	Land area (Million sq km)	3282	1.09	2.27	World Development Indicators 2010
AFRI	Africa dummy	3282	0.33	---	World Development Indicators 2010
LAME	Latin America dummy	3282	0.24	---	World Development Indicators 2010
EASIA	East Asia dummy	3282	0.16	---	World Development Indicators 2010

Notes: Sample is the same as that used for estimation results shown in column (4) of Table 2.

a. Data obtained from http://www.emdat.be. (accessed on June 1, 2011).

b. Data is available from http://www.economics.harvard.edu/faculty/shleifer/dataset (accessed on June 1, 2011).

c. Data is available from http://salvatorebabones.com/data-downloads (accessed June 2, 2011).

Table 2.

Comparison between French Legal Origin Countries and Other Countries

(results of mean difference test)

Variable: Ln (deaths per disaster)	(1) French legal origin countries	(2) Other countries	Difference between (1) and (2) t-statistics
1960–2008	3.35	2.11	0.22*** (2.84)
1960–1989	3.78	3.70	0.07 (0.58)
1990–2008	3.04	2.76	0.27*** (3.03)
Variable: GDP per capita			
1960–2008	3183	6144	–2960*** (–13.7)
1960–1989	2573	5604	–4049*** (–12.1)
1990–2008	3940	6659	–2718*** (–7.54)

Note: Values in parentheses are t-statistics. *, ** and *** denote significance at the 10%, 5% and 1% levels, respectively.

Table 3.

Determinants of Annual National Death Rates in Natural Disasters: 1960–2008 (negative-binominal regressions)

	All observations				Number of deaths < 1000			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
FRLEGA	0.74***	0.58**	1.01***	0.87***	0.49**	0.36*	0.50*	0.31
	(2.98)	(2.55)	(3.77)	(3.11)	(2.19)	(1.74)	(1.83)	(1.24)
NDIS	1.59***	1.29***	0.79***	0.74***	1.52***	1.28***	0.81***	0.78***
	(4.20)	(3.49)	(3.36)	(2.98)	(4.04)	(3.76)	(3.27)	(3.16)
GDP	–0.94***	–0.78***	–0.30	–0.36**	–0.74***	–0.47***	–0.12	–0.26
	(–5.98)	(–4.32)	(–1.56)	(–2.02)	(–5.74)	(–2.83)	(–0.67)	(–1.55)
OPEN		–0.01***	–0.01***	–0.01***		–0.01***	–0.01***	–0.01***
		(–4.97)	(–6.70)	(–5.10)		(–4.56)	(–6.22)	(–3.90)
AGRAT			0.01**	0.01			0.01*	–0.01
			(2.70)	(1.48)			(1.74)	(–0.14)
GINI			–0.28	0.10			0.29	0.60
			(–0.26)	(0.10)			(0.28)	(0.59)
GOVSIZ				–0.07***				–0.08***
				(–3.20)				(–4.79)
DENS	–0.19*	0.17	0.42***	0.24*	–0.21**	0.01	0.29**	0.05
	(–1.89)	(0.70)	(3.13)	(1.70)	(–2.37)	(0.10)	(2.25)	(0.49)
LAND	0.13*	0.03	0.03	0.03	0.05	–0.03	–0.06	–0.03
	(1.69)	(0.43)	(0.47)	(0.53)	(1.28)	(–0.66)	(–1.23)	(–0.78)
AFRI	0.07	0.05	–0.59**	–0.54*	0.10	0.08	–0.36	–0.28
	(0.26)	(0.21)	(–2.01)	(–1.86)	(0.37)	(0.36)	(–1.31)	(–1.17)
LAME	–0.58*	–0.34	–0.53	–0.80**	–0.60*	–0.44	–0.49	–0.78**
	(–1.65)	(–1.09)	(–1.42)	(–2.09)	(–1.91)	(–1.60)	(–1.38)	(–2.34)
EASIA	0.19	0.46	0.51*	0.25	0.32	0.44	0.40	0.06
	(0.49)	(1.45)	(1.73)	(0.87)	(0.89)	(1.39)	(1.26)	(0.23)
Constant	1.61*	2.38**	1.60	2.69**	1.55**	1.95**	1.51	3.03**
	(1.92)	(2.29)	(1.42)	(2.20)	(2.24)	(2.58)	(1.19)	(2.41)
Ln α	2.46	2.40	2.24	2.23	2.25	2.19	2.06	2.04
Observations	5750	5344	3363	3282	5549	5147	3191	3120
Log likelihood function	–17060	–16493	–11891	–11654	–14371	–13878	–9842	–9599

Note: Year dummies are included in all estimations but not reported to save space. Values in parentheses are z-statistics calculated using robust standard errors adjusted for within-nation clustering. *, ** and *** denote significance at the 10%, 5% and 1% levels, respectively. In each column, the sample size may vary across different specifications due to data availability.

Table 4.

Determinants of Annual National Death Rates in Natural Disasters: 1960–1989 (negative-binominal regressions)

	All observations				Number of deaths < 1000			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
FRLEGA	0.53*	–0.04	0.08	0.02	–0.06	–0.38	–0.53	–0.56
	(1.84)	(–0.13)	(0.21)	(0.07)	(–0.28)	(–1.52)	(–1.47)	(–1.56)
NDIS	4.21***	3.40***	2.00**	2.06**	4.28***	3.69***	2.67***	2.58***
	(4.41)	(2.93)	(2.56)	(2.59)	(6.11)	(4.67)	(2.95)	(2.83)
GDP	–2.24***	–2.32***	–2.21***	–2.08**	–1.29***	–1.05***	–1.07***	–1.12***
	(–7.81)	(–9.40)	(–6.32)	(–6.21)	(–6.26)	(–5.18)	(–3.60)	(–3.83)
OPEN		–0.02***	–0.03***	–0.01**		–0.01***	–0.02***	–0.01***
		(–4.04)	(–5.03)	(–2.49)		(–5.09)	(–4.94)	(–3.11)
AGRAT			–0.02**	–0.02**			–0.02***	–0.03***
			(–2.15)	(–2.50)			(–3.01)	(–3.19)
GINI			0.14	0.32			0.01	0.59
			(0.06)	(0.14)			(0.39)	(0.27)
GOVSIZ				–0.10**				–0.05*
				(–2.55)				(–1.72)
DENS	–0.59**	0.15	0.18	0.40	–0.55**	–0.01	–0.41	–0.66
	(–2.37)	(0.67)	(0.36)	(0.69)	(–2.36)	(–0.08)	(–0.83)	(–1.34)
LAND	0.12*	0.02	–0.04	–0.01	0.06	–0.05	–0.16**	–0.11*
	(1.96)	(0.41)	(–0.67)	(–0.21)	(1.48)	(–1.28)	(–2.43)	(–1.71)
AFRI	–0.91**	–0.57	–1.33***	–1.26***	–0.47	–0.43	–1.16***	–1.02***
	(–2.39)	(–1.64)	(–4.52)	(–4.21)	(–1.62)	(–1.61)	(–3.27)	(–3.11)
LAME	–0.32	0.37	–0.47	–0.91*	–0.34	–0.07	–0.88*	–0.96**
	(–0.74)	(0.90)	(–1.05)	(–1.93)	(–1.12)	(–0.26)	(–1.83)	(–2.01)
EASIA	0.58	0.51	0.17	–0.05	0.28	0.11	–0.58	–0.59*
	(1.20)	(1.28)	(0.37)	(–0.11)	(0.75)	(0.35)	(–1.65)	(–1.69)
Constant	–1.07	0.22	2.99	4.21**	–0.80	0.33	2.95*	3.71**
	(–1.08)	(0.17)	(1.55)	(2.20)	(–1.04)	(0.34)	(1.68)	(2.03)
Ln α	2.65	2.59	2.49	2.48	2.39	2.33	2.26	2.26
Observations	2931	2651	1725	1693	2836	2559	1647	1615
Log likelihood function	–6837	–6592	–5038	–4937	–5525	–5329	–4016	–3922

Note: Year dummies are included in all estimations but not reported to save space. Values in parentheses are z-statistics calculated using robust standard errors adjusted for within-nation clustering. *, ** and *** denote significance at the 10%, 5% and 1% levels, respectively. In each column, the sample size may vary across different specifications due to data availability.

Table 5.

Determinants of Annual National Death Rates in Natural Disasters: 1990–2008 (negative-binominal regressions)

	All observations				Number of deaths < 1000			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
FRLEGA	0.81***	0.69**	1.03***	0.87***	0.67***	0.63***	0.80***	0.56**
	(2.89)	(2.44)	(3.50)	(2.74)	(2.90)	(2.63)	(3.06)	(2.21)
NDIS	0.95***	0.83***	0.65***	0.61***	0.85***	0.78***	0.56***	0.51***
	(4.73)	(4.11)	(4.47)	(3.89)	(4.90)	(4.56)	(3.74)	(3.33)
GDP	–0.46***	–0.36**	–0.10	–0.09**	–0.54***	–0.47***	–0.23	–0.26*
	(–5-3.62)	(–2.54)	(–0.67)	(–0.63)	(–4.75)	(–3.52)	(–1.37)	(–1.76)
OPEN		–0.01***	–0.01***	–0.01***		–0.004*	–0.01***	–0.01***
		(–2.64)	(–4.25)	(–3.88)		(–1.81)	(–3.23)	(–2.61)
AGRAT			0.02***	0.03**			0.02***	0.01**
			(2.67)	(2.41)			(2.92)	(2.31)
GINI			0.51	0.66			–0.11	0.27
			(0.52)	(0.62)			(–0.13)	(0.30)
GOVSIZ				–0.04*				–0.06***
				(–1.81)				(–3.61)
DENS	–0.20*	–0.01	0.28**	0.20*	–0.15	–0.06	0.20*	0.07
	(–1.95)	(–0.03)	(2.16)	(1.65)	(–1.47)	(–0.37)	(1.92)	(0.82)
LAND	–0.11***	–0.12***	–0.09***	–0.08**	–0.06**	–0.07**	–0.05	–0.02
	(–3.52)	(–3.63)	(–2.69)	(–2.25)	(–2.11)	(–2.38)	(–1.62)	(–0.84)
AFRI	0.83***	0.74**	0.08	0.10	0.83***	0.79***	0.39	0.35
	(2.73)	(2.34)	(0.23)	(0.27)	(3.10)	(2.86)	(1.28)	(1.25)
LAME	–0.34	–0.30	–0.40	–0.48	–0.46	–0.44	–0.36	–0.55
	(–0.93)	(–0.83)	(–0.99)	(–1.18)	(–1.43)	(–1.39)	(–1.03)	(–1.59)
EASIA	0.14	0.35	0.48	0.31	0.33	0.48	0.66*	0.34
	(0.38)	(0.94)	(1.42)	(0.88)	(0.86)	(1.27)	(1.84)	(0.99)
Constant	1.92**	2.77***	2.77***	3.50***	1.31***	1.68***	1.84***	2.88***
	(2.17)	(2.73)	(2.63)	(2.93)	(2.67)	(2.97)	(3.11)	(4.35)
Ln α	2.05	2.03	1.84	1.83	1.88	1.86	1.68	1.66
Observations	2819	2693	1628	1589	2713	2588	1544	1505
Log likelihood function	–9862	–9597	–6664	–6534	–8506	–8265	–5639	–5504

Note: Year dummies are included in all estimations but not reported to save space. Values in parentheses are z-statistics calculated using robust standard errors adjusted for within-nation clustering. *, ** and *** denote significance at the 10%, 5% and 1% levels, respectively. In each column, the sample size may vary across different specifications due to data availability.

Appendix

Table A1
List of countries

	Sample in column (1)	Sample in column (2)	Sample in column (3)	Sample in column (4)
1	Albania	Albania	.	.
2	Algeria	Algeria	Algeria	Algeria
3	Angola	Angola	.	.
4	Antigua and Barbuda	Antigua and Barbuda	.	.
5	Argentina	Argentina	Argentina	Argentina
6	Armenia	Armenia	Armenia	Armenia
7	Australia	Australia	Australia	Australia
8	Azerbaijan	Azerbaijan	Azerbaijan	Azerbaijan
9	Bahamas	Bahamas	Bahamas	Bahamas
10	Bahrain	Bahrain	.	.
11	Bangladesh	Bangladesh	Bangladesh	Bangladesh
12	Barbados	Barbados	Barbados	Barbados
13	Belarus	Belarus	Belarus	Belarus
14	Belize	Belize	.	.
15	Benin	Benin	.	.
16	Bermuda	.	.	.
17	Bhutan	Bhutan	.	.
18	Bolivia	Bolivia	Bolivia	Bolivia
19	Bosnia and Herzegovina	Bosnia and Herzegovina	Bosnia and Herzegovina	.
20	Botswana	Botswana	Botswana	Botswana
21	Brazil	Brazil	Brazil	Brazil
22	Brunei	Brunei	.	.
23	Burkina Faso	Burkina Faso	Burkina Faso	Burkina Faso
24	Burundi	Burundi	Burundi	Burundi
25	Cambodia	Cambodia	Cambodia	Cambodia
26	Cameroon	Cameroon	Cameroon	Cameroon
27	Canada	Canada	Canada	Canada
28	Cape Verde	Cape Verde	.	.
29	Central Africa	Central Africa	Central Africa	Central Africa
30	Chad	Chad	.	.
31	Chile	Chile	Chile	Chile
32	China	China	China	China
33	Colombia	Colombia	Colombia	Colombia
34	Comoros	Comoros	.	.
35	Congo, Dem. Rep	Congo, Dem. Rep	.	.
36	Congo, Rep	Congo, Rep	.	.
37	Costa	Costa	Costa	Costa
38	Cote d'Ivoire	Cote d'Ivoire	Cote d'Ivoire	Cote d'Ivoire
39	Croatia	Croatia	Croatia	Croatia
40	Cyprus	Cyprus	.	.
41	Czech Republic	Czech Republic	Czech Republic	Czech Republic
42	Djibouti	Djibouti	Djibouti	Djibouti
43	Dominica	Dominica	.	.

44	Dominican Republic	Dominican Republic	Dominican Republic	Dominican Republic
45	Ecuador	Ecuador	.	.
46	Egypt	Egypt	Egypt	Egypt
47	El Salvador	El Salvador	El Salvador	El Salvador
48	Equatorial Guinea	Equatorial Guinea	.	.
49	Eritrea	Eritrea	.	.
50	Estonia	Estonia	Estonia	Estonia
51	Ethiopia	Ethiopia	Ethiopia	Ethiopia
52	Fiji	Fiji	Fiji	Fiji
53	French Polynesia	French Polynesia	.	.
54	Gabon	Gabon	Gabon	Gabon
55	Gambia	Gambia	Gambia	Gambia
56	Georgia	Georgia	Georgia	Georgia
57	Ghana	Ghana	Ghana	Ghana
58	Grenada	Grenada	.	.
59	Guatemala	Guatemala	.	.
60	Guinea	Guinea	Guinea	Guinea
61	Guinea-Bissau	Guinea-Bissau	Guinea-Bissau	Guinea-Bissau
62	Guyana	Guyana	Guyana	Guyana
63	Haiti	Haiti	Haiti	Haiti
64	Honduras	Honduras	.	.
65	Hong Kong	Hong Kong	Hong Kong	Hong Kong
66	Iceland	Iceland	Iceland	Iceland
67	India	India	.	.
68	Indonesia	Indonesia	Indonesia	Indonesia
69	Iran	Iran	Iran	Iran
70	Iraq	.	.	.
71	Israel	Israel	.	.
72	Jamaica	.	.	.
73	Japan	Japan	Japan	Japan
74	Jordan	Jordan	Jordan	Jordan
75	Kazakhstan	Kazakhstan	Kazakhstan	Kazakhstan
76	Kenya	Kenya	Kenya	Kenya
77	Kiribati	Kiribati	.	.
78	Korea, Republic	Korea, Republic	Korea, Republic	Korea, Republic
79	Kuwait	Kuwait	.	.
80	Kyrgyzstan	Kyrgyzstan	Kyrgyzstan	Kyrgyzstan
81	Laos	Laos	Laos	Laos
82	Latvia	Latvia	Latvia	Latvia
83	Lebanon	Lebanon	Lebanon	Lebanon
84	Lesotho	Lesotho	Lesotho	Lesotho
85	Liberia	Liberia	Liberia	Liberia
86	Libya	Libya	.	.
87	Lithuania	Lithuania	Lithuania	.
88	Luxembourg	Luxembourg	Luxembourg	Luxembourg
89	Macao	Macao	.	.
90	Macedonia	Macedonia	Macedonia	Macedonia
91	Madagascar	Madagascar	Madagascar	Madagascar
92	Malawi	Malawi	Malawi	Malawi

93	Malaysia	Malaysia	Malaysia	Malaysia
94	Maldives	Maldives	.	.
95	Mali	Mali	Mali	Mali
96	Marshall Islands	.	.	.
97	Mauritania	Mauritania	Mauritania	Mauritania
98	Mauritius	Mauritius	Mauritius	Mauritius
99	Mexico	Mexico	Mexico	Mexico
100	Micronesia	.	.	.
101	Moldova	Moldova	Moldova	Moldova
102	Mongolia	Mongolia	Mongolia	Mongolia
103	Morocco	Morocco	.	.
104	Mozambique	Mozambique	.	.
105	Namibia	Namibia	.	.
106	Nepal	Nepal	Nepal	Nepal
107	New Caledonia	.	.	.
108	New Zealand	New Zealand	New Zealand	New Zealand
109	Nicaragua	Nicaragua	Nicaragua	Nicaragua
110	Niger	Niger	Niger	Niger
111	Nigeria	Nigeria	.	.
112	Oman	Oman	.	.
113	Pakistan	Pakistan	Pakistan	Pakistan
114	Panama	Panama	Panama	Panama
115	Papua New Guinea	Papua New Guinea	Papua New Guinea	Papua New Guinea
116	Paraguay	Paraguay	Paraguay	Paraguay
117	Peru	Peru	Peru	Peru
118	Philippines	Philippines	Philippines	Philippines
119	Puerto Rico	Puerto Rico	Puerto Rico	Puerto Rico
120	Russian Federation	Russian Federation	Russian Federation	Russian Federation
121	Rwanda	Rwanda	Rwanda	.
122	Saudi Arabia	Saudi Arabia	.	.
123	Senegal	Senegal	Senegal	Senegal
124	Seychelles	Seychelles	Seychelles	Seychelles
125	Sierra Leone	Sierra Leone	Sierra Leone	Sierra Leone
126	Singapore	.	.	.
127	Solomon Islands	Solomon Islands	.	.
128	South Africa	South Africa	South Africa	South Africa
129	Sri Lanka	Sri Lanka	Sri Lanka	Sri Lanka
130	St. Kitts and Nevis	St. Kitts and Nevis	.	.
131	St. Lucia	St. Lucia	.	.
132	St. Vincent and the Grenadines	St. Vincent and the Grenadines	.	.
133	Sudan	Sudan	Sudan	Sudan
134	Suriname	Suriname	Suriname	Suriname
135	Swaziland	Swaziland	Swaziland	Swaziland
136	Syria	Syria	.	.
137	Tajikistan	Tajikistan	Tajikistan	Tajikistan
138	Tanzania	Tanzania	Tanzania	Tanzania
139	Thailand	Thailand	Thailand	Thailand

140	Togo	Togo	.	.
141	Tonga	Tonga	.	.
142	Trinidad	Trinidad	Trinidad	Trinidad
143	Tunisia	Tunisia	Tunisia	Tunisia
144	Turkey	Turkey	Turkey	Turkey
145	Turkmenistan	Turkmenistan	Turkmenistan	Turkmenistan
146	Uganda	Uganda	Uganda	Uganda
147	Ukraine	Ukraine	Ukraine	Ukraine
148	United States	United States	United States	United States
149	Uruguay	Uruguay	Uruguay	Uruguay
150	Uzbekistan	Uzbekistan	Uzbekistan	Uzbekistan
151	Vanuatu	Vanuatu	.	.
152	Venezuela	Venezuela	Venezuela	Venezuela
153	Vietnam	Vietnam	Vietnam	Vietnam
154	Yemen	Yemen	Yemen	Yemen
155	Zambia	Zambia	Zambia	Zambia
156	Zimbabwe	Zimbabwe	Zimbabwe	Zimbabwe

Note: List shows countries used for estimations in each column of Tables 3, 4, and 5.