The Death Toll From Natural Disasters: The Role of Income, Geography, and Institutions[1]

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ABSTRACT

Using a new data set on annual deaths from disasters in 57 nations from 1980 to 2002, this paper tests several hypotheses concerning natural disaster mitigation. While richer nations do not experience fewer natural disaster events than poorer nations, richer nations do suffer less death from disaster. Economic development provides implicit insurance against nature's shocks. Democracies and nations with higher quality institutions suffer less death from natural disaster. The results are relevant for judging the incidence of a Global Warming induced increase in the count of natural disaster shocks.

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I. Introduction

Between 1980 and 2002, India experienced fourteen earthquakes that killed a total of 32,117 people while the United States experienced eighteen earthquakes that killed only 143 people. A disproportionate share of the deaths caused by such environmental shocks as earthquakes, floods, cyclones, hurricanes, and extreme temperature events are borne by people in developing countries. The Intergovernmental Panel on Climate Change reports that 65% of world deaths from natural disasters between 1985 and 1999 took place in nations whose incomes were below $760 per-capita (IPCC 2001).[2]

Using a new data set on annual deaths from natural disasters in 57 nations from 1980 to 2002, this paper tests four disaster hypotheses. First, do richer nations experience fewer natural disaster shocks? Second, when natural disasters take place how many fewer fatalities do they cause in richer nations versus poorer nations? Third, what role does national geography play in determining the death toll from natural disasters? Fourth, controlling for other national attributes, do institutions matter in mitigating the consequences of natural disasters?

Determining the relative importance of income, geography and institutions in insulating nations from nature's shocks is important for three reasons. First, if richer nations are sufficiently insulated from nature's shocks relative to poorer countries, then this finding contributes to cross-national living standards comparisons. Second, the

[2] "Ninety percent of the disaster victims worldwide live in developing countries where poverty and population pressures force growing numbers of poor people to live in harm's way on flood plains, in earthquake prone zones and on unstable hillsides. Unsafe buildings compound the risks. The vulnerability of those living in risk prone areas is perhaps the single most important cause of disaster casualties and damage" (Secretary General of the United Nations, Kofi Annan 1999).

comparative economics literature has attempted to measure the quantitative importance of "good institutions" in explaining differences in cross-national economic performance (Acemoglu, Johnson and Robinson 2001, 2002, Easterly and Levine 2001, and Rodrik, Subramanian, and Trebbi 2002). Death from natural disaster offers a new outcome measure for testing hypotheses. Finally, many environmentalists care about the equity consequences of Global Warming. Scientists have predicted that Global Warming will accelerate the count of natural disaster shocks. It is important to have estimates of what is the human toll caused by such events and how these death counts differ across nations. The political economy of who supports costly climate change policy hinges on the expected benefits of mitigating climate change.

To preview the paper's results, national income plays little role in explaining which nations experience a natural disaster. But, richer nations suffer less death from natural disaster. Geography and institutional quality also play an important role in explaining cross-national patterns. Nations in Asia and the Americas suffer more deaths from natural disaster than nations in Africa. Democracies and nations with less income inequality suffer less deaths from disasters. Ordinary least squares and instrumental variables estimates indicate that a host of institutional quality measures are negatively correlated with national disaster death counts. These findings add to a literature that has investigated how natural disaster shocks affect long run growth rates and natural resource prices (Skidmore and Toya 2002, Prestemon and Holmes 2000).

The paper's next section presents the data sources used in the empirical analysis. Section III examines which nations experience the most natural shocks. Section IV presents the empirical framework and the main results concerning deaths from disaster.

II. Data

The raw data on deaths from natural disasters comes from the Centre for Research on the Epidemiology of Disasters (CRED) (see World Disasters Report 2002). Since 1988, CRED has maintained the Emergency Events Database (EM-DAT) accessible at http://www.cred.be/emdat/. This web page provides the rationale for why the data set has been collected.

"In recent years, natural and man-made disasters have been affecting increasing numbers of people throughout the world. Budgets for emergency and humanitarian aid have sky-rocketed. Efforts to establish better preparedness for and prevention of disasters have been a priority concern of donor agencies, implementing agencies and affected countries. For this reason, demand for complete and verified data on disasters and their human and economic impact, by country and type of disaster has been growing. ….The database is compiled from various sources, including UN agencies, non-governmental organizations, insurance companies, research institutes and press agencies."

In the raw data, the unit of analysis is a disaster. The CRED uses specific criteria for determining whether an event is classified as a natural disaster. These include: ten or more people killed, 100 or more people were affected/injured/homeless, significant damages were incurred, a declaration of a state of emergency and/or an appeal for international assistance was made (http://www.cred.be/emdat/). I am unable to study disasters that are not recorded in the CRED data.[3]

The data set provides indicators of disaster type. I focus on five types of environmental disasters. Earthquakes are sudden breaks within the upper layers of the earth, sometimes breaking the surface, resulting in the vibration of the ground. Extreme temperature events are heat waves and cold waves. Floods are the significant rise of the

[3] In the U.S, politics plays a key role in determining when a "disaster" has taken place. Garrett and Sobel (2003) report that an area is more likely to be designated as a "disaster area" if it is represented by powerful congressmen or if the state's voters support the President.

water level in a stream, lake, reservoir or coastal region. Slides represent avalanches and landslides. Wind storms consist of cyclones, hurricanes, storms, tornados, tropical storms and typhoons and winter storms. I chose to exclude such rare events as tidal waves because there were only 19 of these disasters recorded across the whole world during the years 1980 to 2002. In the EM-DAT data, earthquakes account for 12% of the natural disasters shocks, while 4% are extreme temperature events, 38% are floods, 8% are slides and 37% are wind storms.

After examining the raw disaster data, I chose to focus on disaster death counts for 57 nations. In the EM-DAT data, there are a suspicious number of zero deaths for certain nations. For example, the EM-DAT data reports that nobody died from a natural disaster in Bhutan or Guyana during the years 1980 to 1993. I chose to drop from the sample those nations that report zero deaths from natural disaster in almost every year. Between 1980 and 2002, there has been an increase in the reported events in the EM-DAT data base. For the set of 57 nations, there were 105 events reported in 1980, and 144 events reported in 1995. Between the years 2000 and 2002, there has been a further increase in reported events such that 242 natural disasters were recorded in the year 2002.

Table One reports the three biggest disasters by disaster type for the 57 nations. Iran suffered the largest earthquake deaths in 1990 while Bangladesh suffered the largest count of deaths from wind storms in 1991. The bottom row of the table reports the top three deaths from industrial disasters with the India, Bhopal disaster of 1984 causing the most death. Relative to earthquakes, floods, and wind storms, the industrial death counts are much lower. Across my sample, the average death count from earthquakes was 365. The average deaths from extreme temperature events was 117, from floods was 118, from slides was 59 and the average death count from wind storms was 215. In the United States, the average earthquake killed 10 people while the average extreme temperature event killed 123 people.

Two different data sets are constructed using the EM-DAT data. They differ with respect to their unit of analysis. One data set's unit of analysis is the disaster. This sample includes earthquakes, floods, and windstorms. For these three categories the EM-DAT data reports a measure of the severity of the shock. In the case of earthquakes, the data reports the Richter scale reading, for floods (kilometers), and wind storms are measured in kilometers per hour.[4] The second data set includes annual total death counts for the five types of natural disasters (earthquakes, extreme temperature, floods, slides and wind storms), for 57 nations during the years 1980 to 2002.

Both data sets are used to test how death from natural disasters depends on a nation's geography, institutions and income. The explanatory variables are merged in by nation/year from several separate data sources. National data on annual population and real GDP per-capita (1996 dollars) based on the Laspeyres index is from the Penn World Tables version 6.1 (Heston, Summers and Aten 2002). The data are available through the year 2000.[5] National geography data and population density is from Gallup, Sachs, and Mellinger (1999). I use data on each nation's elevation and the absolute value of its latitude.

[4] For these three categories, information on the severity of the shock is often missing. The data set is missing the severity of the earthquake shock in 10% of the cases, 82% of the flood events and 71% of the wind storm cases.
[5] Since the EM-DAT data continues to the year 2002, I use the year 2000 Penn World Tables data for the values in the years 2001 and 2002.

Institutional quality is proxied for using several data sets. The first data source is Polity 4 (http://www.bsos.umd.edu/cidcm/polity/index.html). This data set includes a variable called "democracy" which takes on the values 0-10 that represents a nation's general openness of political institutions. The second set of institutional quality variables are heterogeneity measures. As discussed in Alesina, Baqir and Easterly (1997) and Knack and Keefer (1997), in more heterogeneous communities the ability of government to supply productive public goods may suffer. The Nation's Gini coefficient for income is from the World Bank (see http://www.worldbank.org/research/growth/dddeisqu.htm). For each nation, I use the Gini measure from the earliest year available in their data set. Within nations, Gini measures are very highly correlated across years. As a second measure of national heterogeneity, I use the ethnic fragmentation measure reported in Alesina, Devleeschauwer, Easterly, Kurlat, and Wacziarg (2003). The final set of government institutional quality measures are from Kaufmann, Kraay, and Mastruzzi (2003). These indicators are based on several hundred variables measuring perceptions of governance drawn from 25 separate data sources constructed by 18 different organizations. I use their data from the year 1996. Within nations, the 1996 data is highly correlated with the 2002 data.

Recent comparative economics papers have used historical variables to instrument for institutional quality today. Following this literature, I use the settler mortality risk variable reported in Acemoglu, Johnson and Robinson (2001). I can use their data for 36 former colonies in my data set. I also use the legal origins variables reported in La Porta, Lopez-de-Silanes, Shleifer, and Vishny (1997).

Table Two reports the national summary statistics. Each year, the average nation experiences 2.6 natural disasters per year and suffers 451 deaths from natural disaster. Roughly half of these deaths are from wind storms. Floods and earthquakes also represent a large fraction of deaths while land slides and extreme temperature events cause relatively few deaths. The sample nations in my sample are roughly $1,000 richer than the average nation in the Penn World Tables sample (1/7 of a standard deviation higher based on the Penn World Tables data) and the average population of the nations in my sample is twice as large as the average nation in the Penn World Tables.

Table Three lists the 57 nations studied in this paper. For each nation, I report the total annual average count of natural disasters and annual total deaths per million people. Relative to their population size, Honduras, Venezuela, Nigeria and Bangladesh suffer the most death from disaster. The right five columns in Table Three report average deaths per disaster by disaster type. The table highlights the heterogeneity in deaths from disasters. For example, the correlation between average deaths from earthquakes and average deaths from wind storms is –0.04.

III. What Types of Nations Suffer Natural Disasters?

The death toll from disasters could be higher in poor nations because they suffer more shocks or experience more death per shock. To test the first hypothesis, I estimate probit models of the form:

$$\text{Prob}(\text{Disaster}_{ijt}) = f(\text{Geography}_j, \text{Land Area}_{jt}, \text{GDP Per-Capita}_{jt}, \text{Trend}_t) \quad (1)$$

In equation (1), "Disaster" is a dummy variable that equals one if a natural disaster in category i in nation j in year t took place. The explanatory variables in these probits include national geography variables, the nation's per-capita income level and its land area. All else equal, larger nations should be more likely to experience a given shock.

Table Four presents seven estimates of equation (1). To ease the interpretation of the probit models, each column presents estimates of the marginal probabilities. Aggregating all disaster categories, an extra $1,000 in GDP per-capita lowers the probability of experiencing a disaster by .6 percentage points. This estimate is borderline significant. As shown in columns (2-7), this finding is driven by floods. For floods, there is a much larger income effect. An extra $1,000 in GDP per-capita lowers the probability of a flood taking place by 1.5 percentage points. Whether heavy rains leads to a flood depends on such factors as drainage capacity. Richer nations will have the resources to make such investments to preempt such events. In specification (7), I drop floods from the specification. In this case the dependent variable equals one if the nation experiences at least one earthquake, or extreme temperature event or slide or wind storm in a given year. In this case, the coefficient on GDP per-capita is small in quantitative terms and statistically insignificant. The finding that richer nations are exposed to roughly the same number of natural shocks as poorer nations stands in contrast to a pure geographic theory of development that would state that certain areas are "cursed" due to their physical location. This theory would posit that certain areas suffer from poor endowments, higher disease exposure and suffer more natural disaster shocks.

The results in Table Four do indicate statistically significant differences in shock risk as a function of geography. Relative to Africa, Asia is 32 percentage points more likely to experience a natural disaster in any given year. Overall, specification (1) shows that a nation's physical attributes (elevation and distance from the equator) do not have a statistically significant effect on disaster probabilities.[6]

IV. The Role of Income, Geography and Institutions in Minimizing Death Counts

This section analyzes two different data sets to test for the importance of national income, geography and institutions in mitigating the consequences of natural disasters. The first data set's unit of analysis is a natural disaster broken out for earthquakes, floods and windstorms. Using this data set, I estimate equation (2) using OLS;

$$\text{Log}(1+\text{Death}_{ijt}) = \text{controls} + b1*\log(\text{income}_{jt}) + b2*\text{Shock Quality}_{ijt} + U_{ijt} \qquad (2)$$

The data set is not a balanced panel. Some nations might experience multiple shocks in the same year while others will experience none. If a nation in a given year does not experience a shock, it is not in the data set. Estimates of equation (2) allow me to study the role of income, geography and institutions while holding a shock's quality constant. Separately estimating this equation for earthquakes, floods and wind storms yields a test

[6] The estimated time trend in Table Four is worth noting. Natural disaster probabilities are increasing by 1.4 percentage points per year. While earthquake probabilities are falling over time, land slides, floods and extreme temperature events are increasing over time. These trends may reflect reporting to the EM-DAT data base rather than climate change.

of whether geography and income have different effects for different types of natural disasters.

The second data set is a balanced panel. For each of the 57 nations during the years 1980 to 2002, I calculate total deaths from natural disaster. As I will discuss below, I use this data set to compare OLS estimates with instrumental variables estimate. I also use the data to estimate count models. Annual national total death from natural disasters is a non-negative count. A poisson model is not used due to the over-dispersion of the death data. In 37% of the nation/year observations, total death from natural disaster equals zero. To take into account these observations, I estimate a zero inflated negative binomial (ZINB) model where the log-likelihood function L is defined by:

$$L = \Sigma_{i \in S} \ln[F(z_i\gamma)+\{1- F(z_i\gamma)\}p_i^{m}] + \Sigma_{i \notin S}[\ln\{1-F(z_i\gamma)\}+ \ln\Gamma(m+y_i) - \Gamma(y_i+1) - \ln\Gamma(m) + m\ln p_i + y_i \ln(1-p_i) \qquad (3)$$

$m = 1/\alpha$

$p_i = 1/(1+\alpha \exp(x_i\beta))$

where F is the logit link and Γ is the gamma distribution and S is the set of nation/year observations where nobody died from natural disaster.

The ZINB model allows for over dispersion in death counts by introducing a splitting process which models the outcomes as a zero or non-zero death count.[7] The zero death count model is estimated using a logit where the dependent variable equals one if nobody died from a natural disaster in nation j in year t. The logistic model includes as explanatory variables the count of natural disasters that a nation experiences

[7] For a recent application of this approach to studying the count of new plant openings across U.S states see Keller and Levinson (2002).

in year t and the interaction of this count with the nation's population and income. A nation can only suffer a death if a natural disaster takes place. Interacting a nation's disaster count with the nation's population and income allows for the possibility that nations with smaller populations and higher incomes are less likely to suffer death from the disaster and a nation with a large population and low national income will suffer no death if no disasters take place. The likelihood of a non-zero death count for nation j in year t is modeled as a function of a quadratic in the number of shocks a nation experiences each year, national income, geography and institutions and other national controls.

Both of the empirical approaches presented in equations (2) and (3) do not include nation fixed effects. To test how within nation improvements in "good governance" and rising per-capita incomes affects a nation's disaster death count would require both data that does not exist and economic adjustment that is unlikely to quickly take place. As discussed in Kaufman, Kraay, and Mastruzzi (2003), it is quite difficult to create a within nation governance data base to test what are the benefits of improved national governance. While rising national incomes can be measured, there is likely to be a long latency period between economic development and improved average quality infrastructure as new homes, and new infrastructure are built of higher quality than the existing capital stock.

To organize this section's empirical findings, I report the results organized by major hypothesis focusing on the role of income, geography and institutions.

Hypothesis #1 Richer Nations Suffer Less Death from Disaster

Richer people can self protect through a number of strategies to reduce their natural disaster risk exposure. Richer governments can provide implicit disaster insurance through a number of regulatory strategies and by providing quality infrastructure. After a disaster has struck, richer economies are able to provide high quality emergency care to protect the population against death from disaster.

Within a nation some areas are more prone to experience natural disasters than others. Compensating differential theory predicts that land will be cheaper in areas at greater risk to experience a disaster. Hedonic real estate studies have documented this fact using data on earthquake zones (Brookshire, Thayer, Tschirhart and Schulze 1985) and hurricanes (Hallstrom and Smith 2003).[8] Richer people will demand homes located in safer communities and homes that are built out of stronger more durable materials. Once the shock has taken place, death counts can be higher if the nation does not have access to good medical care and emergency treatment and crisis management (Athey and Stern 2002).

There are several pathways through which richer nations are insured against death from shocks. Richer nations will be able to invest and enforce zoning codes. For certain natural disasters such as hurricanes, richer nations have invested in computer modeling of storms. Spreading this early warning information before the storm hits shore leads to

[8] Information concerning natural disaster risk exposure is needed for households to sort on this attribute. In 1974, California law provided such information designating areas as special study zones (SSZ). Brookshire,Thayer, Tschirhart and Schulze (1985) estimate housing hedonic regressions and find that all else equal, homes in the SSZ area in Los Angeles sell at a 6% discount relative to other homes in Los Angeles while in San

mass evacuation and this saves lives (Sheets and Williams 2001). Based on a range of good governance indicators, government quality rises as national income increases (La Porta, Vishny and Shleifer Lopez-de-Silanes and Vishny 1999). In this sense, "good institutions" and national income are positively correlated.

To begin to study the relationship between national income and deaths from disaster, Figure One graphs for each of the 57 nations listed in Table Three, its average death per natural disaster with respect to the log of GDP per-capita. The three largest positive outliers are Bangladesh, Honduras and Venezuela.

Earthquakes are a major cause of death. To measure the insulating effects of income, in Table Five I use the earthquake sample and report estimates of equation (2). Controlling for national geography and population, specification (1) shows that a 10% increase in per-capita GDP decreases national earthquake deaths by 5.3%. As shown in specification (3), this income elasticity is robust to controlling for the Richter scale reading. All else equal, more powerful earthquakes kill many more people. As shown in specification (2), it is not the case that richer countries experience less severe earthquakes. Thus, based on the results in Tables Four and Five, it is clear that richer nations and poorer nations are shocked with the same quantity and quality of natural shocks. In specifications (4) and (5), I switch the dependent variable from deaths to the count of injured and homeless. The income elasticities are roughly comparable to those reported in specification (3). Deaths appear to be a good indicator of overall physical damage to people.

Francisco the discount was 3%. These authors argue that such discounts are in line with the actuarial probabilities of disasters taking place.

To further study the income elasticity of deaths while holding the quality of shocks constant, Table Six reports estimates of equation (2) for floods and wind storms. These shocks exhibit an even stronger income elasticity than earthquake deaths. A 10% increase in national GDP per-capita reduces deaths from a flood by 8.6% and wind storms by 8.6% (see specifications 2 and 4). While higher quality shocks cause more death, controlling for the quality of the shock has no impact on the estimated income elasticities.

The results in Tables Five and Six only focused on those shocks where the EM-DAT reports the quality of the shock (i.e a Richter scale reading). To study the effects of income in more detail, I now turn to the second data set based on the balanced panel from 1980 to 2002 for the 57 nations listed in Table Three. In Table Seven, I report estimates from five zero inflated negative binomial models reported in equation (3). In specification (1), I estimate the zero inflated negative binomial model while excluding variables that measure geography and institutional quality. I find that GDP per-capita has two statistically significant effects. Controlling for national geography, population size, and the count of shocks that a nation experiences, richer nations are less likely to experience a death when shocks occur and conditional that a positive number of deaths have taken place, richer nations suffer less death.[9]

The distribution of national income as well as its mean plays a role in determining deaths from natural disaster. Holding population and GDP per-capita constant, a higher Gini coefficients indicates that more people are living in poverty. Unlike the rich, the poor face greater exposure to natural disaster risk. Richer people can afford to live in a greater set of communities and are more likely to be educated and better able to process and to react to information warning them about an upcoming shock such as a hurricane (Bresnahan, Dickie and Gerking 1997). The poor are more likely to live in disaster prone areas and to live and work in structures that are unlikely to withstand the shock.[10] The poor living in informal settlements may not be able to benefit from government regulatory and zoning codes. All else equal, deaths from earthquakes are higher in nations with higher income inequality (see Table Five's column (6)). Based on the ZINB estimates reported in Table Seven, income Gini's positive effect on death counts is a robust finding across the four columns. Based on the results in specification (4) of Table Seven, a nation would have the same death count from natural disasters if its income Gini were one standard deviation higher or its GDP per-capita was $5,700 lower ((9.20*.0682/-.1087)). This is a very large effect.

To provide a sense of the size of these income coefficients, in Table Eight I predict death from natural disaster for a poor, middle income, and a rich nation. Holding population at 100 million, the year at 1990 and using the actual shock patterns for each nation, I use the results from column (1) and predict the probability that a nation experiences no deaths from natural disaster, and predict the count of deaths. The average nation with a GDP per-capita of $2,000 experiences 893 deaths from natural disaster per year. If this nation's GNP per-capita grew to $14,000 its death toll would fall to 189 per

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[9] A test of whether this GDP per-capita coefficient changes between the 1980s and 1990s indicates that I cannot reject the hypothesis of no change over time.

[10] Klinenberg (2002) documents that in the 1995 heat wave in Chicago, the elderly and blacks were over-represented among the 485 people killed in this disaster.

year.[11] In a nation of 100 million, this "savings" of 704 lives certainly is small as a percentage of total population but the percentage reduction in overall deaths due to economic development is large. In addition, recent value of life research has documented that the value of life increases faster than per-capita GNP (Costa and Kahn 2002, Hammitt and Liu 1998).[12]

This reduction in deaths counts in richer nations could have implications for global treaties to address climate change. Climate change is likely to increase the number of floods and their severity. Ex-ante mitigation steps, such as the Kyoto Protocols capping world carbon dioxide emissions, and ex-post adaptation strategies are substitutes. If richer nations believe that they can handle natural disaster shocks then this will reduce their desire to take costly ex-ante precautions. This implicit insurance may trigger a moral hazard problem unless the rising value of life and expected damage to physical assets such as coastal homes are large enough effects to spur richer countries to take ex-ante actions.

Hypothesis #2 Geography is a Key Determinant of Death From Disaster

The geography hypothesis states that ex-ante some locations are at risk to experience more shocks and more severe shocks than other locations. After a natural

[11] Based on estimates of equation (3) stratified by disaster type, I cannot reject the hypothesis that national per-capita income has no effect on deaths from extreme temperature events.

[12] These studies estimate hedonic wage regressions as a function of worker characteristics and the job fatality of the industry the worker works in. The OLS coefficient on job fatality is scaled up to calculate a value of life. Costa and Kahn (2002) report an income elasticity of 1.6 for this value of life estimate.

disaster has taken place, geography may play a role in determining a nation's ability to cope with the shock. I focus on four national geographical indicators; what continent it is located in, its elevation, distance from the equator, and the nation's average population density.

Table Four shows that the Americas, Asia and Europe are exposed to more shocks than nations in Africa and there are more land slides but fewer wind storms for nations at higher elevation levels. With the exception of land slides, nations further from the equator experience more disasters.

As shown in Table Five, I cannot reject the hypothesis that national geography plays no role in determining deaths from earthquakes. Column (2) shows that a nation's elevation and distance from the equator has no predictive power in explaining the severity of a shock that the nation experiences. While the death toll from floods is not affected by a nation's elevation or distance from the equator, the death toll from wind storms is lower in more elevated nations. An extra standard deviation of elevation, reduces the death count from a given wind storm by roughly 25%

The zero inflated negative binomial regression estimates reported in columns (2) through (5) in Table Seven also provide evidence on the importance of geography in explaining deaths from natural disasters. Relative to African nations, deaths are higher in the Americas, Asia and Europe with the Americas having a much higher death count than Europe. Based on the results in column (2), if a nation's elevation were 1,000 feet higher or if its GDP per-capita were $4,740 higher would have an equal impact on the death count. Nations further away from the equator suffer less death from natural disaster. While the latitude estimate is statistically significant in columns (2-4), including a nation's ethnic fragmentation index reduces the coefficient's value and it is no longer statistically significant.

The ZINB results reported in Table Seven aggregate across all the disaster categories. Such an empirical model cannot test for whether geography's impact on death counts differs by disaster type. In results available on request I have estimated ZINB models separately for the five disaster categories. With the exception of floods, all of the other individual disaster estimates are qualitatively similar to the aggregate results reported in Table Seven. Based on the floods ZINB estimates, all of the geography coefficients are not statistically significant except for the Americas dummy. All else equal, nations in the Americas have higher flood death counts than nations in Africa.

A nation's population density is another geographical determinant of death from natural disasters. While a uniformly distributed population would be less at risk from suffering enormous losses from a natural disaster, there are likely to be economies of scale in providing local infrastructure to protect the population from a disaster's consequences. As shown in Table Five, deaths from earthquakes are lower in nations with higher population density. Unlike earthquakes, deaths from floods and windstorms are higher in nations with higher population density (see Table Six). Aggregating across all disaster categories, the zero inflated negative binomial regressions in Table Seven show that nations with higher population densities have lower death counts from natural disasters.

Hypothesis #3 Institutional Quality Insulates Against Death

The recent comparative economics literature has highlighted the role of institutions in explaining cross-national differences in economic performance (Acemoglu and Johnson 2003, Acemoglu, Johnson and Robinson 2001, 2002, and Rodrik, Subramanian, and Trebbi 2002). To test the hypothesis that nations with better institutions suffer less death from natural disasters, I choose to focus on several empirical proxy measures for institutional quality. These include a nation's democracy level, its income inequality, ethnic fragmentation and World Bank indicators of good governance.

Democracies may be better suited to achieve political accountability so that the government takes proactive steps to adapt to such shocks and to mitigate their impact when they do occur. In a democracy, the free media flourishes and this contributes to greater political accountability and could reduce corruption. In such a setting, politicians who want to be re-elected and know that their constituents are informed about their activities have a greater incentive to take actions that protect their constituents (Besley and Burgess 2002).

To test the hypothesis that there is less death from disaster in democracies, in the zero inflated negative binomial estimates of equation (3) reported in Table Seven's columns (3)-(5), I add the Polity measure to the specification. All else equal, democracies do experience less death from disaster. The correlation between GDP per-capita and democracy index is 0.60. While democracy has a negative and statistically significant effect in Table Seven's results, when I included this variable in the earthquake, flood and wind storm regressions presented in Tables Five and Six, democracy's coefficient was statistically insignificant.[13]

A second set of indicators of national institutional quality is within nation income and ethnic heterogeneity. If social capital is harder to build in more heterogeneous societies, then institutional quality and heterogeneity measures could be negatively correlated. In more heterogeneous communities, the probability of public participation in civic life is less lower and productive public goods are less likely to be supplied (Alesina, Baqir and Easterly (1999), Alesina and Ferrara (2000), and Costa and Kahn (2003)). Based on World Value Survey micro data, Knack and Keefer (1997) conclude that trust and civic norms are stronger in nations with higher and more equal incomes, and in countries that are less polarized along lines of class or ethnicity. In more ethnically fragmented nations, middle class support for redistribution is lower (Alesina, Glaeser and Sacerdote 2001, Luttmer 2001). One form of redistribution that could reduce the death count from natural disasters is an active government attempt to enforce building codes and zoning laws.

To test the heterogeneity hypothesis, I include the income Gini measure and the ethnic fragmentation measure in Table Five's column (6) and Table Seven's column (5). As discussed above, a consistent finding across all of the regression estimates is that nations with higher income inequality have higher death rates from natural disasters. This result reflects the combination of two separate factors. First, a high Gini holding GDP per-capita constant indicates a larger share of a nation's population are poor.

[13] It is plausible that under-reporting of deaths in non-democracies leads to an under-estimate of the effect of democracy on reducing natural disaster deaths.

Second, social capital and trust in government institutions are harder to build in more unequal societies.

Unlike the income Gini estimates, the ethnic fragmentation results tell a more complicated story. In Table Five's earthquake results, ethnic fragmentation has a positive but statistically insignificant effect on deaths from earthquakes. Based on the ZINB estimate reported in Table Seven's column (5), nations with higher ethnic fragmentation have *lower* death counts.[14] This result is not driven by any outlier nations or by a particular continent.

The recent comparative economics literature has studied economic performance as a function of institutional quality in the present while instrumenting for institutional quality today using historical national variables. I follow this approach to study the robustness of OLS estimates. I use the nation/year total death count from disasters and estimates regressions of the form:

$$\text{Log}(1+\text{Death}_{jt}) = \text{controls}_{jt} + b*\text{explanatory variable}_{jt} + U_{jt} \qquad (4)$$

Controlling for a nation's population and geography, my sole focus is to compare OLS and instrumental variable estimates of "b" in equation (4). In Table Nine, the explanatory variable will either be a nation's GDP per-capita, its average protection against expropriation risk, its democracy index or governance quality measures from the

[14] Alesina, Devleeschauwer, Easterly, Kurlat, and Wacziarg (2003) study how these fragmentation measures correlate with economic indicators. They find that ethnic diversity is negatively correlated with schooling attainment and telephones per worker. In my data set the correlation between ethnic fragmentation and GDP per-capita is –0.45. Alesina, Baqir and Easterly (1999) used U.S city and county level data to document that

World Bank. Due to the high correlation of these variables, I only include one explanatory variable at a time.

In Table Nine, I report various estimates of "b" from equation (4) using two sets of instruments. The first instrument is from Acemoglu, Johnson and Robinson (AJR 2001). They document that one empirical proxy for national institutional quality is the logarithm of the settler mortality rate per thousand from over 100 years ago. AJR (2001) argue that settler mortality in the past affected the types of settlements created in these colonies and this in turn determined such nations' early institutional quality. If institutional quality persists over time, then settler mortality represents an exogenous measure of institutional quality.

A second set of instruments is the national legal origin dummies. LaPorta, Lopes-de-Silanes, Shleifer and Vishny (1997, 2000) have shown that most of the countries in the world have legal origins that ultimately stem from one of a small number of basic legal systems (i.e. French, British, German or Socialist). The legal origin of the country tends to be strongly correlated with a rich number of features of the government and the economy and in particular, civil law (i.e. French legal origin) countries tend to be more regulated than common law (i.e. English legal origin) countries.

Unfortunately, the two sets of instruments do not overlap for the same set of nations. To present the OLS results and the IV results for both sets of nations. I create two sub-samples and estimate equation (4) separately for each of the sub-samples. The AJR (2001) settler mortality data set includes 36 nations and the Legal Origins data set

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the production of productive public goods such as education, roads and sewers was lower in more fragmented areas.

includes 27 nations. To make this table's output manageable, I only report the estimate of "b" in equation (4) from each regression and suppress all other regression output.

Table Nine's top Panel A presents OLS and instrumental variable estimates of the coefficient "b" from equation (4). Based on the AJR (2001) settler mortality instrument, the OLS and IV estimates are quite comparable.[15] The right columns of Panel A show that instrumental variables estimates using the legal origins instruments yield much larger coefficient estimates than the OLS results. For example, instrumenting for the World Bank institutional quality variables (Regulatory Quality, Voice and Accountability, Rule of Law, and Control of Corruption) yields much larger estimates of "b" in equation (4).

Natural disasters are not the only type of shock that nations may experience each year. Another category of disasters are industrial disasters. A famous disasters of this type was the 1984 Bhopal, India disaster. Deaths from industrial disasters offer another test of the implicit insurance benefits of a nation having higher income and better institutions. An extreme pollution havens hypothesis would predict that poorer nations actively recruit disasters to take place. If the poorest nations compete for new industrial plant openings by promising not to enforce environmental or safety regulation, then ex-post the EM-DAT data will show that high poverty nations have higher industrial accident death counts. Rich countries would avoid such deaths by adopting regulation that pushes mobile dangerous plants abroad and then when industrial disasters do occur, just like with natural disasters, richer nations would have the resources to mitigate the disaster's death consequences. In this case, regression estimates of equation (4) for

[15] In results available on request, I have also estimated estimated IV regressions of equation (4) using the setteler motality variable and a nation's population density in 1500

deaths from industrial disasters would reveal a steeper negative income and institutions elasticity than similar estimates for "random" natural disasters. The results in presented in Panel B of Table Nine reject this hypothesis. Panel B is identical to Panel A except in this case I switch the dependent variable to be the log(1+nation j's industrial deaths in year t). Contrary to the pollution havens hypothesis, the results in Panel B are smaller in absolute value than the results in Panel A.

V. Conclusion

Between 1990 and 2002, 4,300 natural disasters took place killing 815,077 people.[16] This paper has used cross-national data for 57 nations to test hypotheses concerning the role of income, geography and institutions in mitigating death counts from natural disasters.

I reject the hypothesis that richer nations experience fewer shocks or are lucky enough to experience weaker disaster shocks than those experienced by poorer nations. In the face of an equal quantity and quality of shocks as poorer nations, richer nations suffer less death from natural disasters. As shown in Table Eight, if a nation with a population of 100 million experienced a GDP per-capita increase from $2,000 to $14,000, this nation would suffer 700 fewer natural disaster deaths a year.

Death counts differ sharply by continent. African nations experience fewer natural disasters and all else equal, suffer less death from natural disasters. Unlike other

(see Acemoglu, Johnson and Robinson 2002). The instrumental variable estimates change very little when I use both instruments.

[16] These facts are based on the entire EM-DAT data base covering 210 nations.

measures of economic performance, natural disaster deaths are lower for nations closer to the equator.

Institutions play a role in shielding the population from natural disaster death. Future research should pinpoint the mechanisms. This paper has shown using several empirical models, that controlling for national income, less democratic nations and nations with more income inequality suffer more death. Controlling for a nation's population size and geography, I showed using OLS and instrumental variable estimates that a host of institutional quality proxies lower national death counts from disasters.

One important hypothesis that merits future research is the role of government corruption in exacerbating death counts from natural disaster. Existing corruption indices are highly negatively correlated with national per-capita income. It is quite plausible that government corruption raises death counts through the lack of enforcement of building codes, infrastructure quality, and zoning enforcement.

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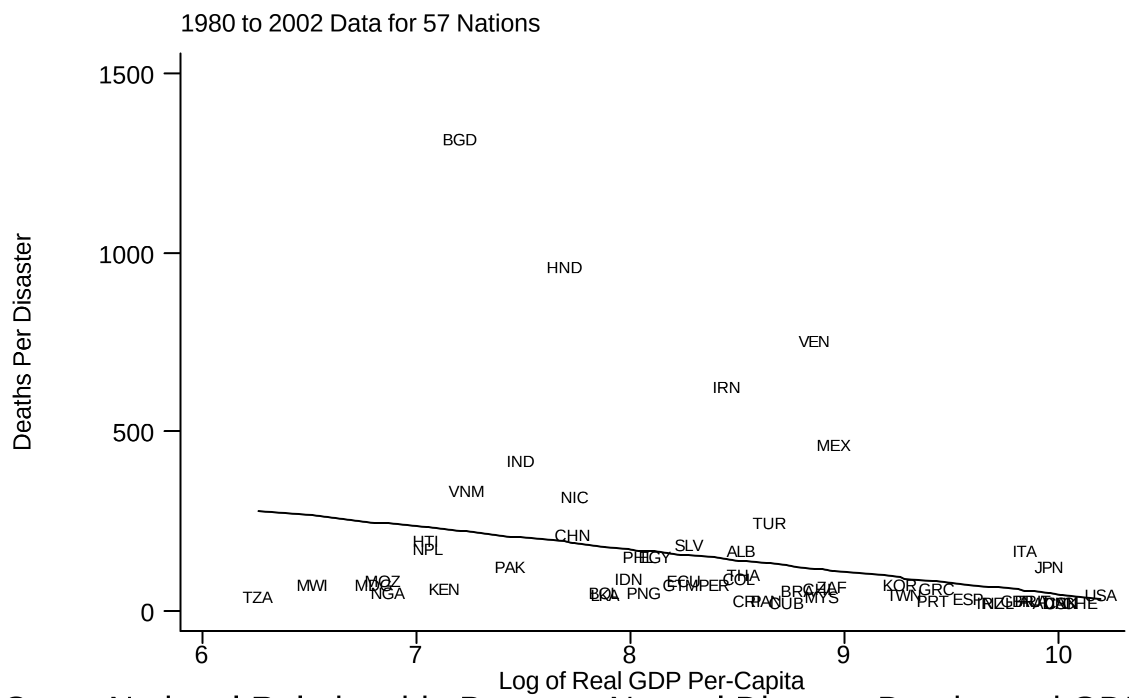
Figure One



Cross-National Relationship Between Natural Disaster Deaths and GDP

Table One: Major Disasters Death Count from 1980 to 2002

Disaster Type	Death Count		
Earthquake	40000 in Iran in 1990	20005 in India in 2001	17980 in Turkey in 1999
Extreme Temperature	2541 in India in 1998	1030 in India in 2002	1000 in Greece in 1987
Flood	30000 in Venezuela in 1999	6200 in China in 1980	3656 in China in 1998
Slide	640 in Colombia in 1987	472 in Nepal in 2002	400 in India in 1995
Wind Storm	138866 in Bangladesh in 1991	14600 in Honduras in 1998	10000 in Bangladesh in 1985
Industrial	2500 in India in 1984	1082 in Nigeria in 1998	508 in Brazil in 1984

The table reports the top three disasters by category for the set of nations listed in Table Three.

Table Two: National Summary Statistics

Variable	Observations	Mean	Std. Dev.
Population in Millions	1235	76833.4200	191293.0000
Elevation (1,000s of Meters Above Sea Level)	1235	0.6952	0.4954
Absolute Value of Latitude	1235	25.2681	16.3153
Average Population Density	1235	0.8273	1.2380
Democracy	1235	6.0494	3.9443
GDP Per-Capita ($1,000s dollars)	1235	8.1447	7.6433
Annual Total Count	1235	2.6162	3.8497
Annual Count of Earthquakes	1235	0.3215	0.7561
Annual Count of Extreme Temperature Events	1235	0.1150	0.3816
Annual Count of Floods	1235	0.9935	1.4928
Annual Count of Land Slides	1235	0.2105	0.5884
Annual Count of Wind Storms	1235	0.9757	2.3449
Annual Total Dead	1235	450.9393	4380.4070
Annual Total Dead From Earthquakes	1235	109.0470	1444.1250
Annual Total Dead From Extreme Temperature	1235	13.1263	109.5220
Annual Total Dead From Floods	1235	115.3498	928.7926
Annual Total Dead From Land Slides	1235	12.3741	52.3621
Annual Total Dead From Wind Storms	1235	201.0421	4006.9880

The unit of observation is a nation/year covering the years 1980 to 2002.
Democracy takes on the values 0 to 10 with 10 being the highest democracy level.
Latitude is determined by the country's centroid. Average population density is the typical population density experienced by an individual (1000s of persons/km^2).

Table Three: Natural Disaster Statistics for Sample Nations

Country	Annual Average Total Count of Disasters	Annual Average Total Deaths per Million People	Average Deaths Per Earthquake	Average Deaths Per Extreme Temperature Event	Average Deaths Per Flood	Average Deaths Per Land Slide	Average Deaths Per Wind Storm
Algeria	1.3478	8.5135	195.4375	.	91.4231	15.0000	2.0000
Argentina	2.0000	0.4299	3.0000	7.2500	9.7108	.	4.5625
Australia	4.0000	0.6825	7.6667	6.8333	5.4405	14.0000	1.7360
Austria	1.0435	0.7460	.	0.0000	3.7143	23.2500	1.0714
Bangladesh	6.2609	66.1410	6.0000	144.6364	257.5114	.	3574.0820
Bolivia	1.0000	4.6090	41.6667	7.5000	32.3846	37.2500	4.0000
Brazil	3.3913	0.8951	1.0000	28.0000	39.5842	39.0185	16.0000
Canada	1.1304	0.1795	.	0.0000	2.8636	.	8.6000
Chile	1.5217	3.6621	40.0000	0.6667	32.2879	86.5000	16.7000
China	13.9130	1.7824	43.5214	33.4667	453.2270	71.4105	77.1929
Colombia	2.9130	5.4838	194.5185	.	46.1324	76.6806	9.0000
Costa Rica	1.0000	2.6339	7.0000	.	4.0000	7.0000	21.0000
Cuba	1.3478	0.7798	0.0000	.	6.0385	.	4.4583
Denmark	0.3913	0.1587	.	0.0000	.	.	2.7143
Ecuador	1.1739	7.9537	32.0833	.	62.2778	106.4000	.
Egypt	0.6087	1.0363	190.3333	19.0000	154.2500	34.0000	24.0000
El Salvador	0.8696	27.1708	566.5000	.	62.4444	22.0000	98.4000
France	3.4348	0.3662	.	7.6000	5.9564	9.8000	8.8867
Greece	1.5217	6.0790	14.3214	216.8000	6.0000	.	16.6667
Guatemala	1.0870	7.0216	6.3571	0.0000	87.2222	47.3333	130.6667
Haiti	1.1739	15.3438	.	.	17.9000	0.0000	243.7143
Honduras	1.0000	111.2202	1.0000	.	32.4545	10.0000	2953.8000
Hong Kong	1.4783	1.5925	.	10.0000	3.2857	1.0000	5.4861
India	10.0870	4.4807	2898.4550	316.8235	371.9171	86.0487	294.7565
Indonesia	5.7826	1.9481	100.7625	.	52.0018	49.6346	0.6667
Iran	4.3043	41.9254	1222.5000	.	62.5648	26.5000	39.0000
Ireland	0.5217	0.4682	.	.	1.0000	.	7.0000
Italy	2.0870	4.0195	267.0370	5.0000	26.9630	15.2500	7.3333
Japan	4.0000	2.6937	246.3750	.	47.3846	26.1111	16.1642
Kenya	0.5217	0.6977	0.0000	.	45.1250	16.0000	50.0000
Korea, Rep	2.0435	2.9367	.	33.5000	68.6000	22.0000	55.8039
Madagascar	0.8696	3.8999	.	.	0.0000	.	61.5278
Malawi	0.6087	2.7681	9.0000	.	52.3000	.	.
Malaysia	0.8696	1.1162	.	.	9.4250	38.0000	90.6667
Mexico	4.2609	7.5301	806.2121	92.5000	49.1310	24.6667	47.4583
Mozambique	0.8261	3.9527	.	.	100.8333	87.0000	76.1667
Nepal	1.6522	14.1544	404.5000	30.0000	227.4063	116.2500	19.3000
New Zealand	1.3913	0.2177	1.0000	0.0000	0.1667	.	2.0000
Nicaragua	0.7826	36.0836	62.0000	.	8.8333	.	453.6250
Nigeria	1.0435	0.2543	.	39.0000	32.8125	8.0000	100.0000
Pakistan	3.2609	3.0155	53.7000	95.5625	175.8421	31.9286	81.8750
Panama	0.5652	1.6889	30.0000	.	2.7143	.	14.0000
Papua New Guinea	0.9130	6.2125	7.5000	.	7.5000	87.5000	23.5000
Peru	2.9130	7.8231	22.9028	21.0000	86.3529	69.5000	59.0000
Philippines	8.4348	17.0995	115.0833	.	30.4120	83.0000	142.8093
Portugal	0.3913	0.3551	.	0.0000	12.8333	.	2.0000
South Africa	1.5652	1.7483	11.3333	30.0000	83.4028	34.0000	10.5185
Spain	1.3043	0.4940	0.0000	18.3333	13.0625	84.0000	8.3000
Sri Lanka	1.4348	1.6981	.	.	26.6806	65.0000	2.5000
Switzerland	1.2174	0.2929	.	0.0000	0.8750	9.3333	1.5000
Taiwan	1.3913	1.2490	383.0000	.	20.5000	14.0000	30.9289
Tanzania	1.0000	0.7577	1.0000	.	21.8077	13.0000	4.0000
Thailand	2.4348	2.1161	.	.	80.9353	39.0000	50.0833
Turkey	2.4348	14.4174	447.9697	19.2500	26.0152	69.0000	9.5000
United Kingdom	1.8696	0.2013	0.0000	16.0000	1.2292	.	10.1786
United States	17.9565	1.3521	6.5909	105.9405	8.6364	.	20.7963
Venezuela	1.0435	56.2270	19.3000	.	1016.9670	96.0000	54.0000
Vietnam	3.6522	11.3328	.	.	122.8490	85.8333	212.9875

A "." indicates that the nation did not experience this natural disaster.

Table Four: Determinants of Whether a Nation Experienced A Natural Disaster

The dependent variable is a dummy variable that equals one if a nation experiences a disaster in that category in a given year.

	All	Earthquakes	Extreme Temperature	Floods	Land Slides	Wind Storms	All Except for Floods
Column	(1)	(2)	(3)	(4)	(5)	(6)	(7)
America Dummy	0.1929	0.1493	0.0962	0.2218	0.1527	0.1689	0.2633
	(0.0406)	(0.0870)	(0.0590)	(0.0807)	(0.0545)	(0.1046)	(0.0732)
Asia Dummy	0.3160	0.2414	0.1138	0.3905	0.2942	0.4024	0.4163
	(0.0383)	(0.1046)	(0.0709)	(0.0800)	(0.0664)	(0.1091)	(0.0674)
Europe Dummy	0.0907	0.2364	0.1575	0.0791	0.4144	-0.0144	0.2391
	(0.0809)	(0.2047)	(0.0906)	(0.1299)	(0.1334)	(0.1444)	(0.1245)
Elevation	0.0336	0.0962	-0.0242	-0.0062	0.0985	-0.1197	0.0343
	(0.0433)	(0.0622)	(0.0332)	(0.0501)	(0.0251)	(0.0666)	(0.0643)
Absolute Value of Latitude	0.0058	0.0004	0.0034	0.0044	-0.0041	0.0101	0.0059
	(0.0025)	(0.0030)	(0.0017)	(0.0032)	(0.0015)	(0.0041)	(0.0039)
Log of Land Area	0.0657	0.0567	0.0343	0.0833	0.0445	0.0460	0.0878
	(0.0133)	(0.0199)	(0.0096)	(0.0204)	(0.0099)	(0.0221)	(0.0201)
GDP Per-Capita ($1,000s)	-0.0060	-0.0066	-0.0052	-0.0147	-0.0018	-0.0006	-0.0058
	(0.0039)	(0.0051)	(0.0035)	(0.0055)	(0.0036)	(0.0073)	(0.0064)
Time Trend	0.0135	0.0000	0.0055	0.0195	0.0048	0.0075	0.0114
	(0.0023)	(0.0019)	(0.0017)	(0.0028)	(0.0013)	(0.0026)	(0.0025)
Mean Probability of Event	0.73	0.21	0.0900	0.5100	0.15	0.3500	0.5500
Observations	1235	1235	1235	1235	1235	1235	1235
pseudo R2	0.1573	0.1127	0.1775	0.145	0.1809	0.1523	0.13

Each column in this table reports a separate probit model. Column (1) aggregates all five disaster categories while columns (2-6) disagregate the disasters by category. Thus, in column (2) the dependent variable equals one if at least one earthquake took place within a nation in a given year. The table reports marginal probabilities and robust standard errors are reported in parentheses. The standard errors have been adjusted for clustering within nation. Africa is the omitted continent.

Table Five: Death and Destruction Caused by Earthquakes

Column	(1)	(2)	(3)	(4)	(5)	(6)
Dependent Variable	Log(1+Death)	Richter Scale	Log(1+Death)	Log(1+Injured)	Log(1+Homeless)	Log(1+Death)
Richter Scale			1.4849	1.7498	1.5016	1.5604
			(0.2252)	(0.1949)	(0.4193)	(0.2393)
Log(Population)	-0.0109	-0.0888	0.1316	0.1727	1.0390	0.2365
	(0.1546)	(0.0531)	(0.1542)	(0.1126)	(0.2992)	(0.1158)
Population Density	-0.0570	0.3128	-0.5416	-0.5708	-1.3390	-0.6510
	(0.1800)	(0.0613)	(0.2253)	(0.1145)	(0.3248)	(0.1321)
Log(GDP Per-Capita)	-0.5306	-0.0601	-0.4456	-0.2896	-0.5800	-0.4019
	(0.2593)	(0.1133)	(0.2371)	(0.2397)	(0.4016)	(0.2290)
TimeTrend	-0.0007	0.0067	-0.0118	0.0082	-0.0125	-0.0168
	(0.0174)	(0.0078)	(0.0148)	(0.0208)	(0.0400)	(0.0170)
Absolute Value of Latitude	0.0067	0.0006	0.0019	0.0107	-0.0429	0.0056
	(0.0129)	(0.0054)	(0.0127)	(0.0128)	(0.0243)	(0.0114)
Elevation	-0.4769	-0.0092	-0.4153	-0.2023	-0.2902	-0.4786
	(0.5106)	(0.1336)	(0.4599)	(0.3839)	(0.6967)	(0.3519)
Income Gini						0.0428
						(0.0168)
Ethnic Fragmentation						0.4697
						(0.7137)
Constant	7.2567	7.2819	-3.5715	-5.6430	-9.3024	-7.2669
	(2.7024)	(0.9880)	(2.3398)	(2.5205)	(5.1541)	(3.1124)
Observations	340	362	340	323	243	333
Continent Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R2	0.0251	0.1456	0.2561	0.259	0.1063	0.3022

Columns (1) and (3)-(6) report OLS estimates of equation (2) in the text. Robust standard errors are reported in parentheses. The standard errors are adjusted for within nation correlation. The unit of analysis is an earthquake.

Table Six: Death Caused by Floods and Windstorms

The dependent variable equals log(1+Death) where Death is the count of deaths from a specific disaster.

	Floods		Wind Storms	
Column	(1)	(2)	(3)	(4)
Disaster Quality Scale		0.0002		0.0057
		(0.0000)		(0.0018)
Log(Population)	0.3291	0.3133	0.1938	0.1934
	(0.1184)	(0.1237)	(0.1078)	(0.1084)
Population Density	0.1828	0.1843	0.1400	0.1412
	(0.0667)	(0.0675)	(0.1182)	(0.1176)
Log(GDP Per-Capita)	-0.8469	-0.8575	-0.8587	-0.8553
	(0.2369)	(0.2391)	(0.2036)	(0.2043)
Calendar Year	0.0236	0.0236	-0.0275	-0.0285
	(0.0259)	(0.0256)	(0.0312)	(0.0313)
Absolute Value of Latitude	0.0057	0.0057	-0.0122	-0.0125
	(0.0135)	(0.0135)	(0.0133)	(0.0133)
Elevation	-0.0173	-0.0491	-0.5126	-0.5365
	(0.2526)	(0.2651)	(0.2647)	(0.2685)
Constant	6.0951	6.3669	9.1744	9.1792
	(2.0400)	(2.0685)	(1.9316)	(1.9358)
Continent Fixed Effects	Yes	Yes	Yes	Yes
Observations	212	212	330	330
Adjusted R2	0.1929	0.2019	0.2994	0.2985

Each column reports an OLS estimates of equation (2) in the text. Robust standard errors are reported in parentheses. The standard errors are adjusted for within nation correlation.
The unit of analysis is a natural disaster.

Table Seven: Determinants of Annual National Total Death From Natural Disaster

Zero Inflated Negative Binomial Regressions

Column	(1)	(2)	(3)	(4)	(5)
Total Count of Disasters	0.1945	0.1347	0.1483	0.1483	0.1540
	(0.0492)	(0.0478)	(0.0484)	(0.0815)	(0.0665)
Total Count of Disaters Squared	-0.0056	-0.0052	-0.0056	-0.0056	-0.0053
	(0.0017)	(0.0017)	(0.0017)	(0.0027)	(0.0020)
Log of Population	0.6041	0.7527	0.7355	0.7355	0.7736
	(0.0766)	(0.0773)	(0.0776)	(0.1780)	(0.1685)
GDP Per-Capita	-0.1280	-0.1265	-0.1087	-0.1087	-0.0993
	(0.0089)	(0.0127)	(0.0152)	(0.0278)	(0.0262)
Income Gini		0.0637	0.0682	0.0682	0.0748
		(0.0094)	(0.0097)	(0.0168)	(0.0205)
Time Trend	0.0283	0.0172	0.0211	0.0211	0.0241
	(0.0097)	(0.0093)	(0.0095)	(0.0212)	(0.0215)
America Dummy		1.8588	1.9636	1.9636	1.4864
		(0.2436)	(0.2481)	(0.4855)	(0.5082)
Asia Dummy		1.2996	1.3738	1.3738	0.9156
		(0.2320)	(0.2353)	(0.4303)	(0.4973)
Europe Dummy		0.4222	0.6825	0.6825	0.3290
		(0.2496)	(0.2772)	(0.5191)	(0.4803)
Elevation		-0.6047	-0.6572	-0.6572	-0.2162
		(0.1573)	(0.1564)	(0.2515)	(0.3763)
Absolute Value of Latitude		0.0459	0.0431	0.0431	0.0216
		(0.0081)	(0.0084)	(0.0187)	(0.0185)
Average Population Density		-0.1807	-0.1838	-0.1838	-0.2386
		(0.0462)	(0.0462)	(0.0803)	(0.0774)
Democracy			-0.0536	-0.0536	-0.0723
			(0.0255)	(0.0428)	(0.0444)
Ethnic Fragmentation					-2.0329
					(0.7095)
Constant	-0.4870	-6.2747	-6.1856	-6.1856	-5.4296
	(0.7349)	(0.9286)	(0.9349)	(1.9624)	(1.8648)
Zero Inflated Logit Model					
Total Count of Disasters	-19.1499	-17.3079	-17.6555	-17.6555	-17.5977
	(5412.8110)	(1555.5490)	(1759.4610)	(2.4793)	(2.4149)
Total Count of Disasters*Log(population)	-0.6697	-0.5758	-0.5667	-0.5667	-0.5653
	(0.2784)	(0.2290)	(0.2307)	(0.2653)	(0.2698)
Total Count of Disasters*GDP per-capita	0.0960	0.0968	0.0972	0.0972	0.0823
	(0.0336)	(0.0288)	(0.0290)	(0.0380)	(0.0383)
Constant	22.7735	20.2571	20.5031	20.5031	20.5311
	(541.8110)	(1555.5470)	(1759.4590)	(0.5790)	
/lnalpha	1.1379	1.0067	1.0044	1.0044	0.9782
	(0.0459)	(0.0460)	(0.0461)	(0.0362)	(0.0387)
alpha	3.1203	2.7366	2.7302	2.7302	2.6597
.	(0.1433)	(0.1259)	(0.1258)	(0.0988)	(0.1028)
observations	1235	1235	1235	1235	1235

Each column of this table reports a separate estimate of a zero inflated negative binomial (ZINB) model.
As presented in equation (3) in the text, the ZINB model has two equations. The lower panel of the table reports the logit model estimates the probability that nobody in a given nation in a given year died from a natural disaster.
the probability that nobody in a given nation in a given year died from a natural disaster.
The upper panel reports the results from the negative binomial regression. Standard errors are presented in parentheses.
Specifications (4) and (5) reports standard errors adjusting for clustering within nations

Table Eight: Predicted Annual Death From Natural Disasters

GDP Per-Capita	Expected Deaths	Probability Death equals zero
$2,000	893	0.275
$8,000	412	0.279
$14,000	189	0.286

The table's predictions are based on the results in Table Seven's specification (1). In this table, population is set at 100 million and the year is set to 1990. The predictions are based on the actual count of natural disasters that a nation experiences.

Table Nine: Robustness Tests of Explanatory Variables in Death Regressions

Panel A

Dependent variable = log(1+Total Deaths from Natural Disaster)

	Sample #1			Sample #2	
Explanatory Variable	OLS	IV using Settler Mortality	Explanatory Variable's Standard Deviation	OLS	IV using Legal Origins
Real GDP Per-Capita	-0.0871	-0.0614	6.4605	-0.0553	-0.1048
	(0.0152)	(0.0312)		(0.0139)	(0.0244)
Average Protection Against Expropriation Risk	-0.3957	-0.2354	1.499		
	(0.0649)	(0.1191)			
Democracy	-0.0263	-0.1335	3.7829	-0.0034	-0.1794
	(0.0242)	(0.0703)		(0.0343)	(0.0626)
Regulatory Quality	-0.6705	-0.7248	0.6564	-0.2547	-1.2803
	(0.1589)	(0.3715)		(0.2779)	(0.6999)
Voice and Accountability	-0.3021	-0.5195	0.7997	-0.1402	-0.7866
	(0.1190)	(0.2757)		(0.1614)	(0.2511)
Rule of Law	-0.7474	-0.4737	0.8511	-0.4811	-1.0137
	(0.1263)	(0.2401)		(0.1711)	(0.2599)
Control of Corruption	-0.4298	-0.5895	0.8855	-0.3919	-1.5473
	(0.1238)	(0.3059)		(0.2190)	(0.6167)

Panel B

Dependent variable = log(1+Total Deaths from Industrial Disasters)

	Sample #1			Sample #2	
Explanatory Variable	OLS	IV using Settler Mortality	Explanatory Variable's Standard Deviation	OLS	IV using Legal Origins
Real GDP Per-Capita	-0.0254	-0.0232		-0.0211	-0.0188
	(0.0023)	(0.0037)		(0.0021)	(0.0037)
Average Protection Against Expropriation Risk	-0.0690	-0.1101			
	(0.0101)	(0.0175)			
Democracy	-0.0083	-0.0757		-0.0048	-0.0470
	(0.0046)	(0.0138)		(0.0080)	(0.0168)
Regulatory Quality	-0.1780	-0.3179		-0.2882	-0.4764
	(0.0226)	(0.0498)		(0.0041)	(0.1004)
Voice and Accountability	-0.1202	-0.2245		-0.1295	-0.2533
	(0.0191)	(0.0355)		(0.0275)	(0.0573)
Rule of Law	-0.1662	-0.1880		-0.1734	-0.1920
	(0.0165)	(0.0295)		(0.0223)	(0.0375)
Control of Corruption	-0.1475	-0.1882		-0.1955	-0.1906
	(0.0152)	(0.0297)		(0.0239)	(0.0357)

Each entry in the table reports a separate estimate of "b" from equation (4) in the text. Controlling for the log of a nation's population, continent fixed effects, a time trend, and a nation's absolute value of latitude and elevation, the table reports the coefficient on the explanatory variable. Robust standard errors are reported in parentheses. In addition to the controls, there is only one explanatory variable in each regression. Sample #1 represents the subset of 36 nations reported in Table Three that AJR (2001) report data on Settler Mortality Risk and Average Protection Against Expropriation Risk. Sample #2 represent the subset of 27 nations reported in Table Three whose Legal Origins could be coded.