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DEATH CAUSED BY NATURAL DISASTERS: THE ROLE OF ETHNIC HETEROGENEITY

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Abstract

Kahn (2005) found that ethnic heterogeneity reduces the number of deaths caused by natural disasters, a finding that is contrary to theoretical predictions. This paper casts doubt on this finding and uses cross-country data from 1965 to 2008 to conduct a re-estimation. To alleviate omitted variable bias, a legal origin dummy and additional economic variables are incorporated as independent variables. Further, to control for measurement problems, I have included an ethnic fractionalization index and an ethnic polarization index to capture ethnic heterogeneity. The key finding is that ethnic polarization is positively related to number of deaths, while ethnic fractionalization is not. This implies that ethnic polarization increases the level of damage caused by natural disasters, and is a more appropriate measure for ethnic heterogeneity than ethnic fractionalization.

Keywords: Deaths, Natural disaster, Ethnic fractionalization, Ethic polarization, Legal origin, Institution.

JEL classification: D81, O11; Q54; Z13

I. Introduction

With the recent devastating effects from natural disasters such as Hurricane Katrina, and the Sumatra and Kanto-Tohoku earthquakes, economists are increasingly interested in the outcomes of natural disasters. Existing works attempt to explore the relationship between economic condition and natural disasters.[1] The level of damage caused by natural disasters depends on economic factors such as economic openness, human capital, GDP per capita, and income inequality (Anbarci et al., 2005; Toya and Skidmore, 2007). In addition, quality of institution makes a significant contribution to the reduction of such damage (e.g., Kahn, 2005; Escaleras et al., 2007).

Easterly and Levine (1997) suggest that ethnic heterogeneity impedes economic growth. Further, ethnic heterogeneity slows development through the reduction of investment and the probability of conflict (Montalvo and Reynal-Querol, 2005a, 2005b). Therefore, in heterogeneous societies, it is difficult for people to take the collective action required to cope with unexpected events such as natural disasters. La Porta et al. (1999) state ethnic heterogeneity and legal origin as determining factors in institutional quality. Institution is considered to play an important role in reducing the impact of economic crisis (Johnson et al., 2000; Acemoglu et al., 2003).

Kahn (2005) stresses the relationship between social heterogeneity and institutional quality, which influence the death rates from natural disasters. He argues, “If social capital is harder to build in more heterogeneous societies, institutional quality and heterogeneity measures could be negatively correlated” (Kahn, 2005, 281). Thus, the hypothesis follows that heterogeneity increases the death rate in disasters. Kahn (2005) used an ethnic fractionalization index and income Gini coefficients to examine the hypothesis. The main estimation results

[1] Strobl (2011) provided evidence that hurricanes have a negative impact on coastal counties annual growth rate in the United States.

suggest that "nations with higher ethnic fragmentation have lower death counts" (Kahn 2005, 282), although nations with larger income inequality have higher death counts.[2] I question these results because Kahn (2005) did not control for various key factors. In addition to the ethnic fractionalization index, this paper uses an ethnic polarization index, which is an alternative index of ethnic heterogeneity. Additional variables used in Toya and Skidmore (2007) are also included as independent variables to conduct the re-estimation. Furthermore, Kahn (2005) used data from 73 countries, from 1980 to 2002. In this paper, to extend the dataset, the number of countries was increased to 90 and the estimated period spans 1965 to 2008.[3] While Kahn (2005) used 1,428–1,438 observations in the main estimations, this paper uses 2,573–3,354. The key finding from the present paper is that nations with higher ethnic polarization have higher death counts, whereas ethnic fractionalization does not influence death counts. This is consistent with the assertion by Montalvo and Reynal-Querol (2005a, 2005b) that the polarization index is better suited to capture the effect of social heterogeneity than the traditional index of fractionalization.

This paper is organized as follows: section II describes the data; section III presents the econometric specification; section IV exhibits the estimation results; and section V concludes.

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[2] With the exception of the main estimation, Kahn (2005) used a OLS model to estimate alternative specifications where the dependent variable is log (1+death). In those results, ethnic fractionalization takes positive and negative signs, and it is always statistically insignificant. This method, however, does not introduce a splitting process where zero-death count is estimated. Hence, the method is less accurate than the method (zero-inflated negative binominal model) mainly used for examination.

[3] Summary statistics and the list of countries are available from the author upon request.

II. Data

I used annual data on natural disasters from 90 countries from 1965 to 2008, for the estimations in this paper. The dependent variable is the number of deaths caused by natural disasters. I collected the number of deaths from EM-DAT (Emergency Events Database).[4]

Ethnic fractionalization indexes have previously been used in classic literature to capture ethnic heterogeneity (Easterly and Levine, 1997; La Porta et al., 1999). In more recent times, it has been asserted that ethnic polarization is the more appropriate index to capture ethnic heterogeneity, and has therefore been used as an alternative measure (Montalvo and Reynal-Querol, 2005a, 2005b). Hence, it is important to compare the effects of the ethnic fractionalization and ethnic polarization indexes, to scrutinize the effect of ethnic heterogeneity because estimation results vary according to the index used (e.g., Montalvo and Reynal-Querol 2005a, 2005b; Dincer, 2011). Kahn (2005) only used ethnic fractionalization as an independent variable. I used both ethnic fractionalization and ethnic polarization as proxy variables for ethnic heterogeneity to more precisely investigate the effect of ethnic heterogeneity. Due to a limitation in the data used in this study, ethnic fractionalization and polarization indexes take the same values for the 1965–2008 period.

Du (2010) provided evidence that French legal origin often increases the likelihood of global crises, such as the oil and currency crises. Further, Du (2010) asserted that persistent institutions are more closely related to the occurrence of crisis than time-varying institutions captured by a corruption or autocracy index. Further, the proxy for corruption is considered an endogenous variable, resulting in estimation bias (Kahn, 2005; Escaleras et al., 2007). In contrast, legal origin is considered an exogenous variable. Hence, I incorporate a French legal origin dummy

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

but do not proxy time-varying institutions.

Toya and Skidmore (2007) found that economic openness, government size, and schooling years affect the number of deaths caused by natural disasters. However, Kahn (2005) did not incorporate those variables as independent variables. The level of shock experienced in a natural disaster appears to differ between the agricultural sector and other sectors because farmers are involved more affected more directly by natural conditions. Thus, the ratio of the agricultural sector is taken into account. Schooling years are constructed based on data used in Easterly and Ross (1997). Schooling years are available for 1960, 1970, and 1980. Therefore, to construct panel data, additional data were generated by interpolation based on the assumption of constant changes in rates to make up for this deficiency for the period 1960–1980. From 1981 to 2008, schooling years for 1980 is used.[5] To alleviate omitted variables bias, these variables are incorporated as independent variables.

This paper also controlled for the variables used in Kahn (2005) such as income Gini coefficient, degree of democracy, GDP per capita, population, population density, absolute value of latitude, and time trend. Following Kahn (2005), for each nation this paper averages the income Gini coefficients of the World Bank (2010) within the year and then uses the average value of income Gini coefficients to capture income inequality. Ethnic polarization and fractionalization indexes are used in Montalvo and Reynal-Querol (2005a, 2005b).[6] Degree of democracy is measured using a polity III dataset as used in La Porta et al. (1999).[7]

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[5] Schooling years are used in Easterly and Ross (1997). The data are available from http://econ.worldbank.org/WBSITE/EXTERNAL/EXTDEC/EXTRESEARCH/0,,contentMDK:20700002~pagePK:64214825~piPK:64214943~theSitePK:469382,00.html (accessed June 2, 2011).

[6] Data on ethnic fractionalization and polarization are available at http://www.econ.upf.edu/~reynal/data_web.htm (accessed on June 1, 2011).

[7] French legal origin dummy and measure of democracy are available at

The democracy index ranges from 1 (low) to 10 (high). All other data used in this paper are gathered from the World Bank (2010).

III. Econometric Specification

The data on technological disasters used in this study can be considered to be typical count data. The Poisson regression model has been widely used to study such data (Greene, 2008). However, the Poisson model is not appropriate when the data is over-dispersed. In this case, Kahn (2005) used a zero-inflated negative binominal (ZINB) model, which allowed for the over-dispersion of death counts by introducing a splitting process. In a ZINB model, the negative binominal model and logit model are estimated simultaneously. In the logit model, the dependent variable takes 1 if nobody dies from natural disasters in nation j in year t. In the negative binominal model, the determinants of number of deaths are estimated. This paper also employs the ZINB model. Following Kahn (2005), for the logit estimation, independent variables are the count of natural disasters taken place in nation j in year t, the interaction of this count with a nation's population and GDP per capita. In the negative binominal model, as explained in the previous section, various economic and institutional variables are included as independent variables.

The key dependent variables are ethnic polarization and fractionalization indexes. If ethnic heterogeneity leads to increase of deaths caused by disasters, indexes of ethnic heterogeneity are expected to take the positive sign when the number of deaths from natural disasters is estimated.

IV. Results

The estimation results when both ethnic fractionalization and polarization are incorporated to capture ethnic heterogeneity are exhibited in Table 1. However, the

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http://www.economics.harvard.edu/faculty/shleifer/dataset (accessed on June 1, 2011).

results in Table 1 are difficult to interpret because the correlation between the fractionalization and polarization indexes may create a problem of multicollinearity (Montalvo and Reynal-Querol 2005a, 2005b). Hence, for a robustness check, I conducted the estimation using alternative specifications. Table 2 shows the results when only ethnic polarization is incorporated, while the results for ethnic fractionalization are shown in Table 3. I purposely focused on the results of the proxies for ethnic heterogeneity and as such only their results are exhibited in Tables 2 and 3. In each table, GDP per capita is included to capture the degree of economic development in columns (1)–(4), whereas the logarithms for GDP per capita are included in columns (5)–(8). Further, each table, to address the issue of heteroscedasticity, displays z-statistics in parentheses, calculated using robust standard errors adjusted for within-nation clustering. To examine the hypothesis regarding the effect of ethnic heterogeneity on the number of deaths from a disaster, this paper focuses on the results from the negative-binominal model, rather than those of the logit model.

I see in Table 1 that ethnic polarization takes the positive sign and is statistically significant in all estimations. Its absolute values range from 1.14 to 2.14. In contrast, contrary to the prediction, ethnic fractionalization takes the negative sign with the exception of column (1). Further, ethnic fractionalization is not statistically significant in columns (1)–(8). Hence, the effects of ethnic heterogeneity are obviously different between polarization and fractionalization indexes. Concerning income inequality, the Gini coefficient takes the negative sign in columns (1) and (5) and is statistically insignificant. This suggests that income inequality does not influence the number of deaths. Ethnic heterogeneity has a greater effect than economic heterogeneity, which is contrary to Kahn (2005). With regard to other proxies for institutional quality, the French legal origin dummy yields the positive sign with the exception of column (2). However, it is not statistically significant in all estimations.

GDP per capita takes the negative sign in column (1), while it takes the positive sign in columns (2)–(4). GDP per capita is not statistically significant in all estimations. In contrast, Log(GDP per capita) takes the negative sign and is statistically significant in columns (5)–(8), suggesting that the number of deaths from natural disasters is smaller in more developed countries, consistent with previous works (Kahn, 2005; Toya and Skidmore, 2007). Schooling years produces a negative sign in all estimations and is statistically significant in columns (1), (2), and (6). This indicates that human capital formation reduces the death count in disasters even after controlling for GDP per capita, which supports Toya and Skidmore (2007). The democracy index shows the positive sign in all estimations and is statistically significant in columns (1), (5), (6), and (7). This is contrary to the prediction that higher quality institutions lead to lower death counts. A probable reason for this result is that there is a "discrepancy between perceived institutions and actual institutions [which] weakens their powers in measuring institutional quality and predicting the likelihood and intensity of crisis" (Du, 2010; 179). In contrast, ethnic heterogeneity is considered to be an objective measure and is unlikely to suffer such bias.

Table 2 shows that ethnic polarization takes the positive sign and is statistically significant in all estimations. Its absolute values range between 1.12 and 1.67, which is similar to those in Table 1. I see in Table 3 that in all estimations ethnic fractionalization is not statistically significant, despite taking the positive sign. In summary, the results for ethnic heterogeneity are robust in the alternative specifications. Considering the results of ethnic polarization and fractionalization presented in Tables 1–3 as a whole, leads me to argue that ethnic polarization increases the number of deaths caused by natural disasters because ethnic polarization captures the ethnic heterogeneity effect.

V. Conclusions

Kahn (2005) found that ethnic heterogeneity reduces the number of deaths caused by natural disasters; a result that is contrary to the prediction proposed by Kahn (2005) and is therefore unconvincing. The present paper questions this finding and conducted a re-estimation. In this paper, to improve the estimation conducted by Kahn (2005), I extended the period of the cross-country panel data to 1965–2008 and controlled for key factors that were not captured in Kahn (2005). Further, to control for measurement issues, this paper not only used an ethnic fractionalization index, but also an ethnic polarization index to capture ethnic heterogeneity. Estimation results suggest that ethnic polarization is positively related to the number of deaths caused by natural disasters; in contrast, ethnic fractionalization does not influence the death count. This implies that ethnic polarization increases the level of damage caused by natural disasters, and is a more appropriate measure for ethnic heterogeneity than ethnic fractionalization, which is in line with Montalvo and Reynal-Querol (2005a, 2005b).

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Table 1. Determinants of annual national deaths from natural disasters (zero-inflated negative binominal regressions)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Ethnic polarization	1.29**	1.95***	2.10***	2.14***	1.14*	1.91**	1.91**	2.03***
	(2.04)	(2.57)	(2.69)	(3.08)	(1.71)	(2.56)	(2.49)	(3.16)
Ethnic fractionalization	0.12	–0.52	–1.23	–1.31*	–0.04	–0.90	-1.02	–0.90
	(0.14)	(–0.54)	(–1.24)	(–1.68)	(–0.06)	(–0.94)	(-1.08)	(–1.29)
French legal origin dummy	0.30	–0.06	0.43	0.35	0.40	0.05	0.49	0.43
	(0.82)	(–0.15)	(1.12)	(0.92)	(1.05)	(0.12)	(1.33)	(1.29)
Total number of disasters	0.15**	0.14*	0.10**	0.09**	0.14**	0.16**	0.12***	0.11**
	(2.41)	(1.86)	(2.06)	(2.23)	(2.63)	(2.32)	(2.63)	(2.48)
GDP per capita	–0.48	0.23	0.05	0.21				
	(–0.17)	(0.68)	(0.23)	(0.81)				
Log (GDP per capita)					–0.46**	–0.42*	-0.58***	–0.43**
					(–2.18)	(–1.68)	(-2.85)	(–2.47)
Log population	0.96***	1.09***	1.12***	1.04***	0.94***	1.09***	1.04***	0.90***
	(4.99)	(5.22)	(5.08)	(7.89)	(5.28)	(5.58)	(5.40)	(7.24)
Land area	–0.32***	–0.34***	–0.26***	–0.28***	–0.35***	–0.34***	-0.27***	–0.28***
	(–4.84)	(–4.04)	(–3.39)	(–3.90)	(–5.28)	(–4.15)	(-3.98)	(–5.06)
Population density	0.08	0.10	0.05	0.17	0.07	0.11	0.06	0.01*
	(0.77)	(0.70)	(0.50)	(0.12)	(0.70)	(0.62)	(0.54)	(1.73)
Absolute value of latitude	–0.02	–0.02	–0.01	–0.01	–0.01	–0.01	0.001	0.01
	(–1.37)	(–0.89)	(–0.77)	(–0.82)	(–1.10)	(–0.35)	(0.03)	(1.02)
Ratio of agricultural sector	0.03*	0.01	0.05***	0.05***	0.01	–0.002	0.004	0.007
	(1.88)	(0.76)	(2.78)	(2.68)	(0.53)	(–0.10)	(0.20)	(0.31)
Openness	0.01	0.01	0.007		0.005	0.01	0.01	
	(1.32)	(1.31)	(1.22)		(0.99)	(0.98)	(1.26)	
Government size	–0.02	–0.08*	–0.06**		–0.01	–0.06	-0.07**	
	(–0.70)	(–1.93)	(–2.27)		(–0.24)	(–1.32)	(-2.15)	
Democracy	0.13*	0.10	0.03		0.13**	0.14*	0.11**	
	(1.67)	(0.97)	(0.57)		(2.07)	(1.80)	(2.04)	
Schooling years	–0.19**	–0.30**			–0.11	–0.20*		
	(–1.99)	(–2.50)			(–1.14)	(–1.80)		
Income Gini coefficients	–0.05				–0.04			
	(–1.50)				(–1.39)			
Africa dummy	–0.95	–0.88	–0.40		–1.38*	–0.69	-0.35	
	(–1.07)	(–0.71)	(–0.53)		(–1.79)	(–0.64)	(-0.43)	
Asia dummy	–1.04	–1.46	–0.77		–1.32**	–1.61*	-1.06	
	(–1.47)	(–1.60)	(–0.89)		(–2.06)	(–1.84)	(-1.42)	
South America dummy	0.34	–0.71	–0.55		0.13	–0.58	-0.51	
	(0.34)	(–0.84)	(–0.79)		(0.15)	(–0.74)	(-0.72)	
Time trend	–0.04***	–0.06***	–0.04***	–0.04***	–0.04***	–0.06***	-0.05***	–0.04***
	(–3.01)	(–3.25)	(–2.66)	(–2.57)	(–3.08)	(–3.25)	(-3.08)	(–3.09)
Constant	–7.45**	–9.38***	–12.4***	–11.9***	–3.85	–6.83*	-6.35	–6.02*
	(–2.27)	(–2.64)	(–2.83)	(–5.93)	(–1.10)	(–1.68)	(-1.61)	(–1.87)
	Zero-inflated logit model							
Total number of disasters	9.56***	4.21	3.35	1.44	8.94***	4.31	3.76	2.37
	(3.37)	(1.21)	(1.10)	(0.52)	(3.14)	(1.28)	(1.28)	(0.86)
Total number of disasters* GDP per capita	0.29**	0.21	0.11	0.14				
	(2.26)	(1.39)	(0.61)	(0.06)				
Total number of disasters* log (GDP per capita)					0.05	–0.07	-0.07	–0.13
					(0.38)	(–0.47)	(-0.52)	(–0.93)
Total number of disasters* log (population)	–0.86***	–0.53***	–0.49***	–0.38**	–0.83***	–0.50**	-0.48***	–0.37**
	(–5.26)	(–2.68)	(–2.90)	(–2.48)	(–5.07)	(–2.45)	(-2.82)	(–2.46)
Constant	3.15***	3.21***	3.44***	3.52***	3.15***	3.20***	3.45***	3.53***
	(3.64)	(3.66)	(3.95)	(4.03)	(3.65)	(3.66)	(3.96)	(4.05)
Ln α	1.26***	1.32***	1.34***	1.36***	1.25***	1.32***	1.33***	1.35***
	(14.1)	(14.6)	(16.2)	(17.2)	(14.3)	(14.7)	(16.0)	(16.7)
Observations	2573	2691	3183	3354	2573	2691	3183	3354
Non-zero observations	1323	1367	1524	1570	1323	1367	1524	1570

Log likelihood function	–9073	–9402	–10585	–10876	–9065	–9416	–10568	–10865

Note: Each column in this table reports a separate estimate of a zero-inflated negative binominal model. As discussed in the text, this model has two equations. The lower panel of the table reports the logit model estimates of the probability that nobody becomes a victim of a natural disaster. The upper panel reports the results from the negative binominal regression. 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. The sample size may vary across different regression specifications due to the constraints of data availability.

Table 2. Determinants of annual national deaths from natural disasters

(zero-inflated negative binominal regressions)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Ethnic polarization	1.36**	1.67**	1.48**	1.42**	1.12*	1.43**	1.38**	1.51**
	(2.24)	(2.43)	(2.09)	(2.37)	(1.77)	(2.11)	(1.97)	(2.56)
Ln α	1.26***	1.32***	1.35***	1.36***	1.25***	1.32***	1.33***	1.32***
	(14.1)	(14.5)	(15.9)	(16.8)	(14.3)	(14.6)	(15.9)	(16.7)
Observations	2573	2691	3183	3354	2573	2691	3183	3354
Non-zero observations	1323	1367	1524	1570	1323	1367	1524	1570
Log likelihood function	–9073	–9402	–10585	–10876	–9065	–9418	–10571	–10869

Notes: Estimation results of a zero-inflated negative binominal model are exhibited in this table. The dependent and independent variables included in this table are the same (with the exception of ethnic fractionalization, which is excluded from the function) as included in the corresponding columns of Table 1. However, the results of the variables are not reported because of space limitations. 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. The sample size may vary across different regression specifications due to the constraints of data availability.

Table 3. Determinants of annual national deaths from natural disasters

(zero-inflated negative binominal regressions)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Ethnic fractionalization	1.10	1.11	0.35	0.13	0.80	0.68	0.40	0.44
	(1.37)	(1.25)	(0.38)	(0.17)	(1.01)	(0.79)	(0.46)	(0.62)
Ln α	1.27***	1.33***	1.36***	1.38***	1.25***	1.33***	1.34***	1.36***
	(14.3)	(14.6)	(16.2)	(17.5)	(14.8)	(14.6)	(15.9)	(17.2)
Observations	2573	2691	3183	3354	2573	2691	3183	3354
Non-zero observations	1323	1367	1524	1570	1323	1367	1524	1570
Log likelihood function	–9079	–9402	–10585	–10876	–9071	–9429	–10585	–10888

Notes: Estimation results of a zero-inflated negative binominal model are exhibited in this table. The dependent and independent variables included in this table are the same (with the exception of ethnic polarization, which is excluded from the function) as included in the corresponding columns of Table 1. However, the results of the other variables are not reported because of space limitations. Values in parentheses are z-statistics calculated using robust standard errors adjusted for within-nation clustering. *** denotes significance at the 1% level. The sample size may vary across different regression specifications due to the constraints of data availability.