Welfare effects of natural disasters in developing countries: an examination using multi-dimensional socioeconomic indicators

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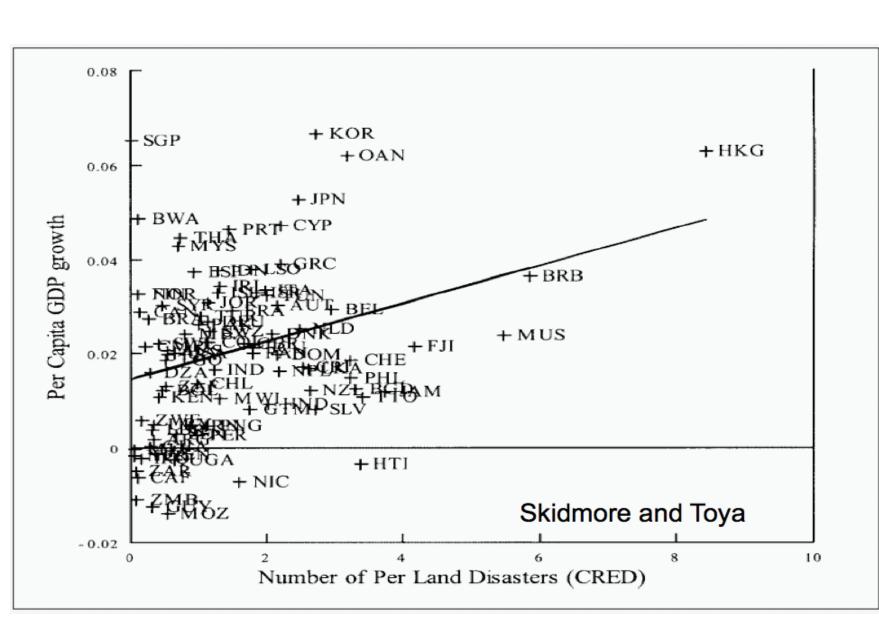
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Statement of the problem

How do natural disasters affect welfare and human development in poor countries?

Although intuition might suggest that poor countries would be the most deeply affected by natural disaster shocks, there is surprisingly little support for this claim. Research on the economics of natural disasters impacts is still at an early stage but a growing empirical literature is now making rigorous examinations of the effects of natural disasters on economic growth(see presentations Friday in U53C. Social Impacts of Climate Change and Climate Variability). An early study by Alberta-Bertrand (1993) suggested that natural disasters may have a positive effect of GDP growth in the short run, largely due new investment in physical capital that would promote growth. Using cross country regressions Skidmore and Toya (2002) show a more complex relationship in which disasters like earthquakes have a negative impact while climaterelated disasters have a positive correlation to both economic growth and the growth of total factor productivity. Climatic disasters lead to an updating of capital stock and new technologies that boosts growth. Though geophysical disasters might be expected to have a similar effect on investment, the empirical analysis did not support this hypothesis.



A positive relationship between per land disaster occurrence and GDP growth (Skydmore and Toya, 2002)

The standard measure of welfare, GDP, is only a partial indicator of development especially in middle and low-income countries where subsistence level activities are common and the informal economy is large. These activities may not register disaster setbacks in national GDP accounts. The alterations to their lives that disasters bring can include loss of livelihood, loss of key assets, disruption of health causing increases in child and maternal mortality and loss of savings. Although unseen in GDP, such losses can impact on a variety of other welfare indicators.

Our study examines the impact of natural disasters using more comprehensive indicator of welfare – human development. We test whether countries impacted by natural disasters experience changes in levels of human development as measured by the UNDP's Human Development Index (HDI), a composite index that captures life expectancy, education and Gross National Income (GNI) per capita.

HDI may pick up losses in systems important to the growth of human capital such as the destruction of schools and health care facilities that would not show in GDP. It is also possible that some countries experience an improvement in human development levels following natural disaster, after a time lag. New investment in education and health infrastructure that replaces destroyed facilities could lead to improved performance in education and health, although this would be contingent on national capacity and human capital availability as well as donor support.

References:

Albala-Bertrand, J.M. (1993) Natural disaster situations and growth: a macroeconomic model for sudden disaster impacts, World Development, 21(9):1417-1434

Skidmore, Mark, and Hideki Toya. 2002. Do Natural Disasters Promote Long-run Growth? Economic Inquiry, 40(3): 644–686.

Methodology

We use cross-country regressions to estimate versions of:

HDIit = $\alpha + \beta Xit + \gamma DISit + \epsilon$,

where:

i: country

t: year (1970-2010)

HDI: average annual growth rate of Human Development Index for the period 1970-2010

DIS: disaster's immediate impact

X: vector of factors that affect HDI for

Given our focus on poorer countries, the estimation is done for Middle (both Upper Middle and Lower Middle) and Low-income countries as defined by the World BanK, a total of 111 countries with available HDI data.

Variable	Model 1	Model 2	Model 3
Constant	1.898662	1.928823	1.83294
	(27.76)	(20.97)	(23.74)
Initial HDI	-1.377836	-1.519715 (-	-1.459044
	(-14.85)	14.71)	(-15.92)
Investment	.0097507	.0097355	.0115491
	(4.08)	(4.24)	(4.75)
Aid (sqrt)	0505139	036179	0392885
	(-4.03)	(-2.67)	(-2.95)
Cyclone_EMDAT		.0075826	
		(0.80)	
Flood_EMDAT		.0183299	
		(1.07)	
Drought_EMDAT		0501271	
		(-3.06)	
Geologic_EMDAT		.0166237	
		(1.46)	
Per land			.0010597
cyclone_EMDAT			(0.20)
Per land			.0107294
flood_EMDAT			(1.10)
Per land			0145548
drought_EMDAT			(-1.74)
Per land	•		.0162097
geologic_EMDAT			(2.54)
No. of observations	107	107	107
Adjusted R ²	0.6732	0.7075	0.7018

Dependent variable: HDI growth (1970-2010, sqrt)

In Model 2, we are adding the natural disaster events, and in Model 3 we are testing the natural disaster events normalized by land area. The results differ significantly between the adjusted and unadjusted events.

In Model 4 and 5 we go beyond the natural disaster events data to include hazard intensity measures. The significance differ by type of disaster, showing that the relative effects of the type of disaster on HDI growth are not similar. The results are largely the same between the adjusted and unadjusted intensity measures: flood intensity is positively correlated with HDI growth, whereas drought intensity has a negative impact on HDI growth.

Analysis

We are focusing on the number of natural events, separated by the type of event (variables Cyclone_EMDAT, Flood_EMDAT, Drought_EMDAT and Geologic_EMDAT). In addition, we normalize the number of natural events by land area separately for each type of disaster, as larger countries are likely to experience a larger number of natural disasters.

The regressions are estimated using ordinary least squares. The numbers in parenthesis represent t-statistics, and the significance at 1% level is t>2.58, 5% level is 1.96, and 10% level is 1.64.

In Model 1 we first estimate the growth in HDI using three control variables considered likely predictors of HDI: the initial level of HDI (HDI for year 1970), foreign direct investments, net inflows, as percent of GDP and net official development assistance (ODA) as percent of GNI. The quadratic regression equation explains about 67% of the variation of HDI growth.

Dependent variable: HDI growth (1970-2010, sqrt)

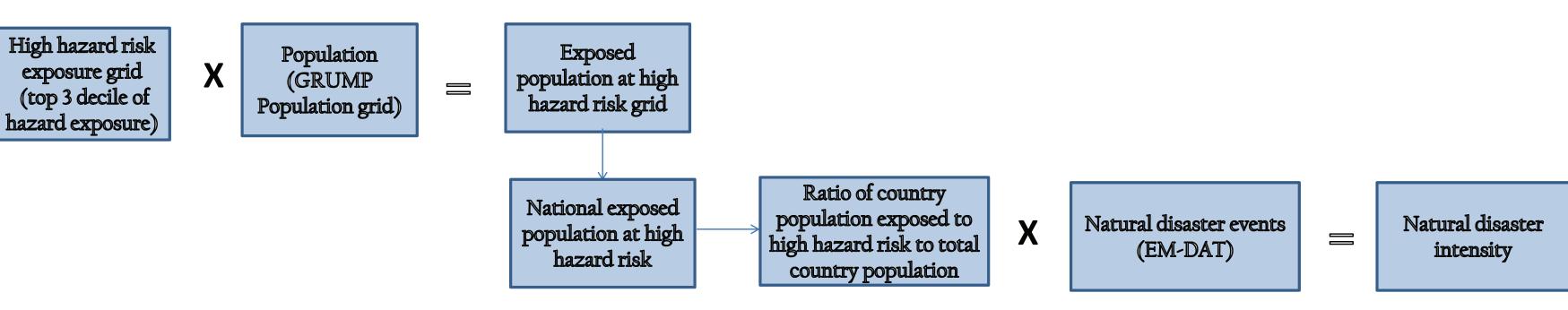
Variable	Model 4	Model 5
Constant	1.851464	1.848449
	(23.96)	(25.10)
Initial HDI	-1.376326	-1.415843
	(-14.41)	(-15.03)
Investment	.0099261	.0112183
	(4.28)	(4.71)
Aid (sqrt)	0396001	0452005
	(-2.86)	(-3.51)
Cyclone_intensity	0161675	
	(-0.48)	
Flood_intensity	.0622592	
	(2.52)	_
Drought_intensity	1456264	
	(-2.12)	
Geologic_intensity	.0152223	
	(1.05)	
Per land		.0012372
cyclone_intensity		(0.14)
Per land		.0254446
flood_intensity		(2.56)
Per land		0377877
drought_intensity		(-2.18)
Per land		.0111917
geologic_intensity		(1.29)
No. of	107	107
observations		
Adjusted R ²	0.6979	0.6988

Sourcing Data

l. Natural disaster events: the source is the EM-DAT database available from the Center for Research in the Epidemiology of Disasters (CRED) http://www.emdat.be/. This database is used in virtually all studies of natural disasters. In our analysis, natural hazards refer exclusively to earthquake, tropical, cyclone, flood and drought.

2. Risk hotspots maps: hotspots were generated based on disaster intensity measures generated by UNEP/GRID-Europe for floods(Peak-flow magnitude) and tropical cyclones(wind speed and storm surge), IRI for droughts (Standard Precipitation Index), and Lamont Doherty Earth Observatory for earthquakes (PGA, or peak ground acceleration). Our study is focusing on high at risk areas exposed to a hazards, and includes the top 3 deciles of risk gridded risk surface.

3. Hazard intensity: these measures were calculated by the authors as follows:



The population grid used in calculatingphysical exposure is a product generated by Center for International Earth Science Information Network (CIESIN), named Global Rural-Urban Mapping Project(GRUMP). 4. HDI: the source is UNDP. The values based on the updated methodology include data for every 5 years for period 1980-2000, however, algorithms were applied for computation of yearly values on the study period (1970-2010). Amelia package in R uses the time series and cross country association as well as the explanatory power of the covariates. The covariates used for imputation included the HDI components: education (mean years of schooling and expected years of schooling), health (female and male life expectancy) and income (per capita GNI). 5. HDI predictors: the data source for investments and ODA is the World Development Indicators (WDI)

Findings

Firstly, we examine whether four types of natural disasters have an impact on country level HDI, when controlling for other possible determinants of HDI. The natural disaster types are floods, drought, cyclones and geologic disasters. Model 2 is a cross country regression that estimates the impact of four types of disasters. In addition, a number of control variables are included in this model of HDI determinants, which are theoretically indicated determinants of HDI. The estimation shows that droughts are negatively and significantly correlated to HDI. Countries with a greater frequency of drought suffer in terms of human development. The other types of disasters do not have a significant impact on changes in HDI.

Secondly, we probe disaster effects on HDI further by using an alternative measures of disaster. In Model 3 the determinants of HDI are estimated using variables that capture the frequency of disasters relative to land area. These variables are also used by Skidmore and Toya (2002) in their cross-country regressions on the impact of disasters on economic growth. Model 3 geologic disasters to have a significant effect on human development. Droughts have a negative effect, as in Model 2, though insignificant.

Thirdly, we examine disaster effects on HDI using intensity measures of natural disasters. This is an advance most previous studies on the socioeconomic effects of disasters that only use 'the number of disaster events' as a measure of natural disasters. In Model 4 and Model 5, the four types of natural disasters are measured using intensity variables. In both estimations drought continues to have a negative and significant effect on human development. Floods, in contrast, have a positive significant impact. In these estimations, geological disasters do not emerge as having a significant effect on human development in this estimation.

Robustness

In order to check for the robustness of our estimations all the above models were reestimated using additional potential determinants of HDI. These include variables that capture political regime, geographical location and latitude. When we incorporate any of these controls, the significance of natural disasters are maintained.

The robustness of our estimations are also indicated by other expected determinants of HDI such as the initial level of HDI (i.e. HDI for year 1970), investments (which includes a country's investments in human welfare improvement) and official development assistance, measured as a percent of GNI.

Interpretation of the results

Our estimations are at a preliminary stage but differ from earlier results using GDP as an indicator and some explanations can be posited as follows:

Firstly, our analysis indicates the importance of going beyond economic growth when studying the effect of disasters on a country's development. Broader human welfare is impacted upon by disasters.

Secondly, while this impact varies according to the type of disaster, the effects are not uniform. This concurs with the finding by Skidmore and Toya (2002) that economic growth effects vary by disaster type.

Thirdly, our finding in Model 3 show that geologic disaster have a positive effect on HDI, contrasts with Skidmore and Toya's finding that this type of disaster are negatively correlated with economic growth. Geologic disasters could have a positive impact on changes in HDI in poor countries due to new investment in health and education infrastructure that follows disaster events. The immediate negative effects on HDI (through disruptions in schooling and health services and through high mortality and injuries) after geologic disasters can be offset by higher investment in welfare-improving social sectors in the medium and long-run.

Finally, our analysis indicates that different types of climatic disasters affect human development differently: floods positively and droughts negatively. The positive effect of floods could again be explained by increased investment in welfare infrastructure. Welfare services (i.e. medical services) can improve in poor countries with the entry of foreign aid after a disaster. In addition, floods may at times the next season crop. For instance, in countries such as Pakistan there have been good harvests after floods due to the re-charging of groundwater aquifers which meant there was abundant, but not too much water (there had been a drought season before the floods). Together these effects could outweigh the negative effects on education, health and incomes that arise following floods.