Do Natural Disasters Affect Growth? A Macro Model-Based Perspective on the Empirical Debate

Laura Bakkensen & Lint Barrage
U. of Arizona
Brown U. & NBER

IMF Workshop on Macroeconomic Policy and Income Inequality

February 10, 2017

Motivation

- How do natural disasters affect macroeconomic outcomes?
- Rich, growing body of empirical work featuring:
  1. Wide range of results:
     - positive impacts (e.g., Skidmore & Toya, 2002, "ST")
     - negligible impacts (e.g., Strobl, 2011; Hochrainer, 2009)
     - large negative impacts (Hsiang & Jina, 2015, "HJ"): Tropical cyclones reduce annual GDP growth by 1.27% (world), 7.3% (Philippines)
  2. Limited connections to macroeconomic models
     - Unclear how to compare different empirical results (HJ, 2015)

$\Rightarrow$ We develop a stochastic endogenous growth model with regional cyclone shocks to review empirical evidence through structural lens

Natural Disasters and Growth: Theory

- Limited theory explicitly focused on natural disasters and growth
  - Ikefuji & Horii (2012): Lit "still in its infancy"; Akao & Sakamoto (2015)

- However, large macroeconomic literature on idiosyncratic income risk:
  - Ayiagari (1994), Krusell & Smith (1998): Uninsurable *labor income risk*
  - Krebs (2003a,b; 2006): Uninsurable *human capital risk*
  - Angeletos (2007): Uninsurable *investment risk*

$\Rightarrow$ We build on this literature to model cyclone impacts on growth:

- Storms as potentially uninsurable risk to individual locations
- Storms destroy human, physical, entrepreneurial capital

$\rightarrow$ Change growth by altering level, composition, returns to investments

Preview of Main Results

1. **Model can reconcile empirical methods as identifying different effects**
   - *Cyclone risk may increase growth, while cyclone strikes reduce it*
     - $(+)$ in cross-section (ST) vs. $(-)$ in panel (HJ)
     - Intuition: Precautionary savings vs. rate of return effects
   - *Different risk measures can affect growth in opposite ways*
     - $(-)$ for avg. capital damage (HJb) vs. $(+)$ for avg. # disasters (ST)
2. **Explore combined estimator of overall disaster growth impacts**
   - Avg. effects: Strikes: -0.72%, Risk: $+0.63\%$, Overall: -0.09%
3. **Risk can have opposite effects on growth and welfare**

Outline

Part I: Theory

1. Model Setup
2. Disaster Risk and Long-Run Growth
3. Disaster Strikes and Growth

Part II: Empirical Analysis

2. Empirical Implications & Analysis

Model Overview

- Unit masses of households (HHs) $i \in [0, 1]$ and "corporate" firms $j \in [0, 1]$ spread across continuum of locations
- HHs can invest in: (1) human capital h_{it}, (2) financial savings s_{it}, (3) local / entrepreneurial capital k_{2it}
  - Growth rate depends on level and composition of investments
- Each period, each location faces log-Normal risk of cyclone strike

$\longrightarrow$ Depreciation shocks to human η_{it}^{h}, local $\eta_{it}^{k_2}$, corporate $\eta_{jt}^{k_1}$ capital

"Corporate" Firms

- Each firm j rents human capital n_{jt} and physical capital k_{1jt} in competitive *national* market
  - Pays gross return R_{ht} on human capital
  - Pays R_{k1t} plus depreciation as net return on financial capital

- Firms face *iid* cyclone capital damage risk $\eta_{jt}^{k_1} \sim \ln N(\mu_{k1}, \sigma_{k1}^2)$

- Risk-neutral firm maximizes expected profits:

$$\max_{k_{1jt}, n_{jt}} \left(A_1 k_{1jt}^{\alpha} n_{jt}^{1-\alpha}\right) - R_{ht} n_{jt} - \left(R_{k1t} + \delta_{k1} + \mu_{k1}\right) k_{1jt}$$

Factor Returns

- Corporate firm $j's$ profit-maximization problem yields:

$$R_{ht} = (1-\alpha)A_1\left(\frac{n_{jt}}{k_{1jt}}\right)^{-\alpha}$$

$$R_{k1t} = (\alpha)A_1\left(\frac{n_{jt}}{k_{1jt}}\right)^{1-\alpha} - \delta_k - \mu_{k1}$$

- National capital market $\rightarrow$ HH financial savings diversified

  $\rightarrow$ Return on corporate capital R_{k1t} is risk-free

- Entrepreneurial sector uses local capital: $y_{2it} = A_2 k_{2it}$

  $\rightarrow$ Return $A_2 - \delta_{k2} - \eta_{it}^{k_2}$ vulnerable to uninsurable cyclone shocks

Households

- Representative HH in region i chooses state-contingent plans for consumption c_{it} and investments in financial (x_{sit}), human (x_{hit}), and entrepreneurial (x_{k2it}) capital to maximize expected lifetime utility:

$$\max E_0 \sum_{t=0}^{\infty} \beta^t U(c_{it})$$

- subject to sequence of constraints:

$$\begin{aligned} c_{it} + x_{st} + x_{ht} + x_{k2t} &= s_{it} R_{k1t} + h_{it} R_{ht} + (A_2 k_{2it}) \\ k_{2it+1} &= (1 - \delta_{k2} - \eta_{it}^{k_2}) k_{2it} + x_{k2it} \\ h_{it+1} &= (1 - \delta_h - \eta_{it}^{h}) h_{it} + x_{hit} \\ s_{it+1} &= s_{it} + x_{sit} \\ & \quad h_{i0}, s_{i0}, k_{20} \text{ given} \end{aligned}$$

Households

- Overall return on HH's assets r_{it}: Share-weighted sum of returns on financial, human, entrep. capital net of disaster damages Details

Let:

- $\widetilde{h_{it}} \equiv \frac{h_{it}}{s_{it}}$ ∼ human-financial capital ratio
- $\Theta_{k2it} \equiv \frac{k_{2it}}{(s_{it}+h_{it}+k_{2it})}$ ∼ entrepreneurial capital-wealth ratio
- $\widetilde{c}_{it} \equiv \frac{c_{it}}{(1+r_{it})(s_{it}+h_{it}+k_{2it})}$ ∼ consumption-wealth ratio

And assume:

$$U(c_{it}) = \frac{c_{it}^{1-\gamma}}{1-\gamma}$$

⇒ Construct stationary equilibrium following Krebs (2003a,b)

Part 1.2: Disaster Risk and Long-Run Growth

Consumption Growth Impacts: Mechanisms

Result 1

In stationary equilibrium, aggregate growth = expected local growth:

$$\frac{C_{t+1}}{C_t} = E\left[\frac{c_{it+1}}{c_{it}}\right] = (1-\widetilde{c})(1+E[r(\widetilde{h}_i{}', \Theta'_{k2i}, \eta_i^{h\prime}, \eta_i^{k2\prime})])$$

$\Rightarrow$ Disaster risk affects long-run growth through two channels:

1. **(Precautionary) Savings Effect:** If uninsurable storm risk increases savings $(1-\widetilde{c}) \rightarrow$ higher consumption growth, ceteris paribus.
2. **Rate of Return Effect:** If uninsurable storm risk decreases expected returns $E[r(.)] \rightarrow$ lower consumption growth, ceteris paribus.

Consumption Growth Impacts: Full Characterization

- HH investment $\longrightarrow$ Portfolio choice problem (Campbell and Viceira, 2001)

$\Rightarrow$ Equations defining optimal investment shares in corporate, human, and entrepreneurial capital

- Example: Optimal entrepreneurial capital share in risky investments =

$$\frac{((R_{k2}-\mu_{k2})-(R_{k1}-\mu_{k1}))\sigma_h^2-((R_h-\mu_h)-(R_{k1}-\mu_{k1}))\rho_{h,k2}\sigma_h\sigma_{k2}}{((R_{k2}-\mu_{k2})-(R_{k1}-\mu_{k1}))[\sigma_h^2-\rho_{h,k2}\sigma_h\sigma_{k2}]+((R_h-\mu_h)-(R_{k1}-\mu_{k1}))[\sigma_{k2}^2-\rho_{h,k2}\sigma_h\sigma_{k2}]}$$

$\Rightarrow$ Differential effects of avg. storm damage measures $(\mu_{k2}, \mu_{k2}, \mu_h)$

Consumption Growth Impacts: Full Characterization

- To assess impacts of storm variables on growth:

1. Implicitly differentiate optimal investment share equations
    - How does change in storm risk affect HH investments?
2. Given effect of storm risk on investment shares Θ_{k2i}, $\widetilde{h}_i$, aggregate growth impact predictions follow from Result 1:

$$\frac{C_{t+1}}{C_t} = (1 - \widetilde{c}(\Theta_{k2i}, \widetilde{h}_i))(1 + E[r(\widetilde{h}_i{}', \Theta'_{k2i}, \eta_i^{h\prime}, \eta_i^{k2\prime})])$$

Consumption Growth Impacts: Full Characterization

- Cannot sign comparative statics in fully general benchmark case

- *Assumption: Disaster damages to human and local capital are each proportional to a fundamental cyclone strength measure* $\varepsilon_{it} \sim \ln N(\mu_\varepsilon, \sigma^2_\varepsilon)$ *(iid over time and space), with:*

$$\begin{aligned} \eta^h_{it} &= \xi^h \varepsilon_{it} \\ \eta^{k2}_{it} &= \xi^{k2} \varepsilon_{it} \end{aligned}$$

- Further need to partition parameter space into different cases:
- *Case 1*: (i) $\xi^{k_2} > \xi^h$, (ii) $0 < \widetilde{r}_h - r_{k1} < \sigma^2_\varepsilon \gamma [\xi^h]^2$, (iii) $(1-\alpha) < \frac{\widetilde{h}}{1+\widetilde{h}}$

Proposition (1)

A mean-preserving increase in cyclone variance $\sigma_{\varepsilon}^{2\prime} > \sigma_{\varepsilon}^{2}$ *leads to the following:*

1. *A decreased human-financial capital ratio:* $\frac{d\widetilde{h}}{d\sigma_{\varepsilon}^{2}} < 0$
2. *A lower equilibrium return on corporate capital* $R_{k1}(\widetilde{h}') < R_{k1}(\widetilde{h})$ *and a higher equilibrium (gross) return on human capital* $R_h(\widetilde{h}') > R_h(\widetilde{h})$
3. *A lower expected return on the HH's overall portfolio:* $E[r(\widetilde{h}_i', \Theta_{k2i}', ...)] < E[r(\widetilde{h}_i, \Theta_{k2i}, ...)] \Rightarrow$ *Rate of Return Effect*
4. *A lower, equal, or higher consumption-out-of-wealth ratio:*
   - $\widetilde{c} < \widetilde{c}'$ *if* $\gamma < 1$
   - $\widetilde{c} = \widetilde{c}'$ *if* $\gamma = 1$
   - $\widetilde{c} > \widetilde{c}'$ *if* $\gamma > 1$

$\Rightarrow$ *Savings rate* $(1 - \widetilde{c}')$ *higher if* $\gamma > 1 \Rightarrow$ *Precautionary Savings Effect ...*

Proposition (1, ctd.)

A mean-preserving increase in cyclone risk $\sigma_{\varepsilon}^{2\prime} > \sigma_{\varepsilon}^{2}$ *leads to the following:*

6. *Larger cyclone risk can increase, leave unaffected, or decrease consumption growth (and thus output growth), depending on whether Precautionary Savings Effect outweighs the Rate of Return Effect.*
7. *However, larger cyclone risk unambiguously decreases welfare:*

$$E_0 \sum_{t=0}^{\infty} \beta^t \frac{c_{it}^{1-\gamma}}{1-\gamma} \leq E_0 \sum_{t=0}^{\infty} \beta^t \frac{c_{it}^{\prime 1-\gamma}}{1-\gamma}$$

$\Rightarrow$ *Hazard risk increases can affect growth and welfare in opposite ways*

Consumption Growth Impacts: Average Risks

- Proposition 1: Effect of cyclone *variance* σ_ε^2 on long-run growth
- Next: Effect of cyclone damage *averages* μ_{k2}, μ_h

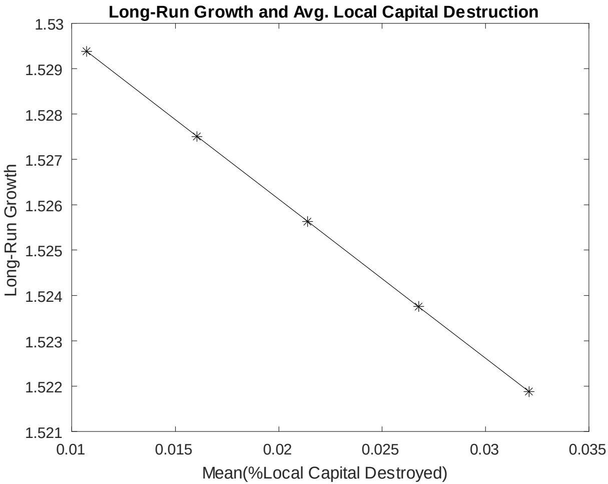
- **Numerical example** (Data Sources: EM-DAT, World Bank)
-

$\mu_{k2} = 2.14\%$	$\sigma_{k2} = 9.67\%$	$(\widetilde{r_2} - \widetilde{r_{k1}}) = 3.5\%$
$\mu_h = 0.0047\%$	$\sigma_h = 0.03\%$	$(\widetilde{r_h} - \widetilde{r_{k1}}) = 0.0004\%$
$\gamma = 1$ (log)	$\beta = 0.96$	$\rho_{h,k2} = 0.34$

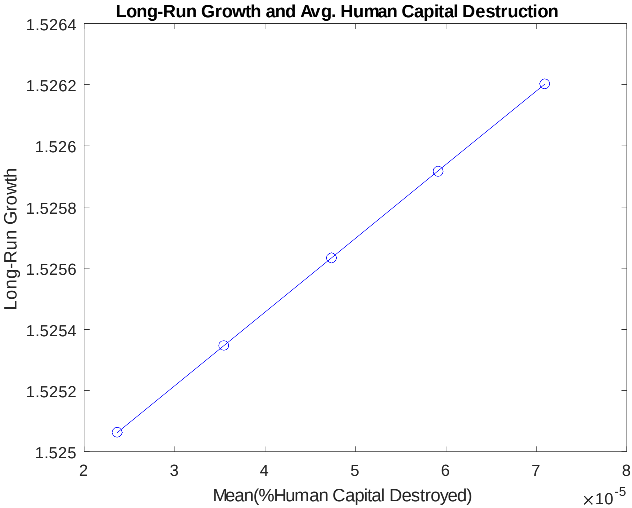
- Benchmark: HH invests 36% of wealth in entrep. capital
  - Could increase avg. growth by investing more, but too risky

- Long-run growth impacts of changing μ_{k2}, μ_h each by $\pm 50\%$, $\pm 25\%$?

Avg. Entrep. Capital Destruction and Long-Run Growth



Avg. Human Capital Destruction and Long-Run Growth



Empirical Implications: Disaster Measures

$\Rightarrow$ Different damage measures can affect growth in opposite ways

$$g \sim f(\text{Portfolios}) \sim g(R_{k2}(\mu_{k2}(\mu_\varepsilon)), R_h(\mu_h(\mu_\varepsilon)), R_{k1}(\mu_{k1}(\mu_\varepsilon)), \sigma_{k2}, \sigma_h, \rho_{h,k2})$$

- Connect to empirical studies: $g = \beta_0 + \beta_1 \mu_j + \beta_2 X + \varepsilon$
  - $\widehat{\beta_1} < 0$ for μ_j ~avg. capital depreciation (Hsiang & Jina, 2015b)
  - $\widehat{\beta_1} > 0$ for μ_j ~avg. #disasters (Skidmore & Toya, 2002)
  - $\widehat{\beta_1} < 0$ for μ_j ~avg. capital loss, $\widehat{\beta_1} \geq 0$ for #fatalities (Noy, 2009)*

- Model can reconcile empirical results as identifying different effects

Part 1.3: Disaster Strikes and Growth

Disaster Strikes and Growth

Result 3

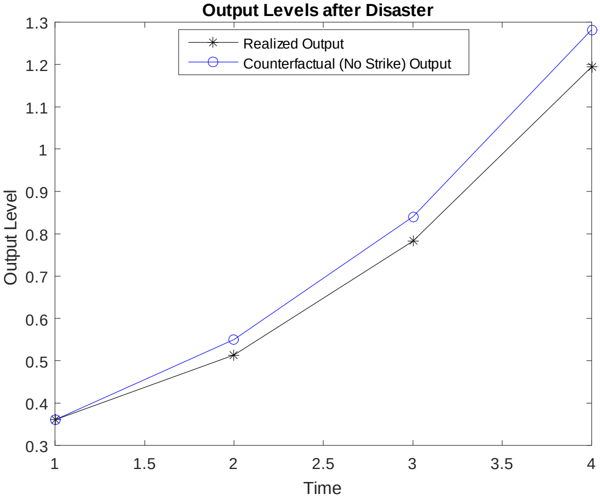
A cyclone *shock (strike $\bar{\varepsilon}_{it} > \mu_\varepsilon$)* decreases contemporaneous local growth relative to the average:

$$\frac{c_{it}}{c_{it-1}} = (1 - \tilde{c})(1 + r(\tilde{h}_i, \Theta'_{k2i}, \xi^h \bar{\varepsilon}_{it}, \xi^{k2} \bar{\varepsilon}_{it})) < E_{t-1}[\frac{c_{it}}{c_{it-1}}]$$

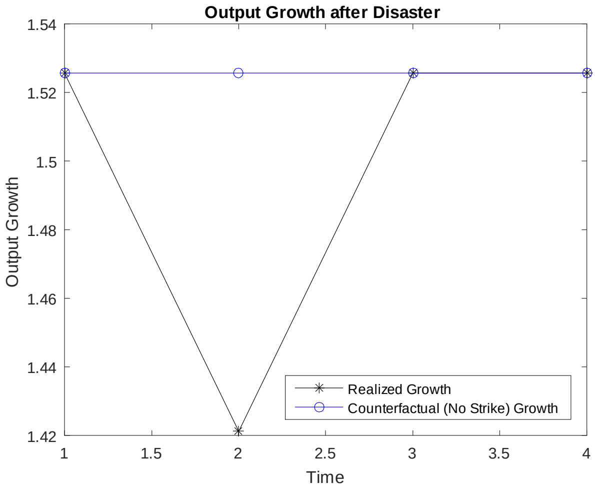
- Note: Only above-average disasters lead to below-average growth
  - $\longrightarrow$ In line with empirical evidence (e.g., Hochrainer, 2009; Cavallo et al., 2013)

- Transitional/Medium Term Impacts:
  - Contemporaneous growth returns to long-run levels
  - However, output gap never recovered $\longrightarrow$ As in HJ (2015)

Disaster Strikes and Growth



Disaster Strikes and Growth



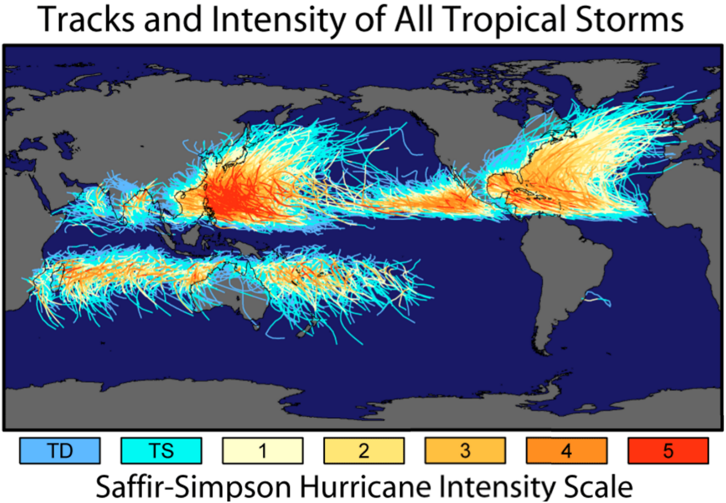
Comparison: Solow Growth Model

Part 2: Empirical Analysis

Combined 2-Step Growth Impacts Estimation

- Estimate the impact of disaster strikes and risk on growth
- **Step 1**: Estimate effect of cyclone *strikes* on growth in FE panel
- **Step 2**: Estimate effect of cyclone *risk* on avg. no-strikes growth
  - → Remove cyclone-risk effect from avg. no-strikes growth (panel fixed effects) to compute no-cyclones growth

⇒ (i) Observed growth, (ii) no-strikes growth, (iii) no-cyclones growth



Source: NASA Earth Observatory

Data

Step 1: Panel FE

- Country-level per capita GDP growth: World Bank's WDI
- Cyclones: IBTrACS (1950-2015)
  - Generate (i) max. landfall windspeed, (ii) sum of max. landfall windspeeds, (iii) energy $\sim$ sum of (max. windspeed)^3

Step 2: Cross-Sectional

- Average no-strikes growth: estimated from Step 1
- Identification concern in cross-section: cyclone activity not randomly distributed; correlated with geography/institutions
  - Controls: country latitude (PSU Geography Data), domestic credit by financial sector as %GDP (World Bank WDI), corruption perceptions index (Transparency International), additional controls (World Bank)

Estimation: Step 1

- Panel fixed effect specification in spirit of Hsiang and Jina (2015):

$$G_{i,t} = \sum_{L=0}^{20} [\beta_L \times S_{i,t-L}] + \gamma_i + \delta_t + \theta_i \times t + \epsilon_{i,t}$$

$G_{i,t} \sim$ real p.c. GDP growth for country i in year t, $S_{i,t}$ $\sim$cyclone exposure, $\gamma_i \sim$ country FE, $\delta_t \sim$ time FE, $(\theta_i \times t) \sim$ country trend

$\Rightarrow$ Counterfactual no-strikes growth rates $\widehat{G_{i,t}}^{NS}$:

$$\begin{aligned} \widehat{G_{i,t}}^{NS} &= \sum_{L=0}^{20} [\hat{\beta}_L \times 0] + \hat{\gamma}_i + \hat{\delta}_t + \hat{\theta}_i \times t \\ \overline{\widehat{G_{i,t}}^{NS}} &= \widehat{\gamma}_i + (\widehat{\theta}_i \times \overline{t}) \end{aligned}$$

Results Strike Impact

Estimation: Step 2

- Cross-sectional

$$\overline{\widehat{G_{i,t}}^{NS}} = \widetilde{\alpha} + \widetilde{\lambda_1} L_i + X_i \times \beta + \widetilde{\delta_{Ri}} + \epsilon_i$$

where $L_i \sim$ long-run cyclone *risk*, $X_i \sim$ controls, $\delta_{Ri} \sim$ regional FE.

  - Bootstrapped standard errors

$\Rightarrow$ Counterfactual no-cyclone growth rates $\widehat{G_{i,t}}^*$

$$\widehat{G_{i,t}}^* = \widehat{G_{i,t}}^{NS} - \widehat{\widetilde{\lambda_1}} L_i$$

Long Run Growth Decomposition

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependent Variable	$\widehat{\overline{G_{i,t}}}$	$\widehat{\overline{G_{i,t}}}$	$\widehat{\overline{G_{i,t}}}$	$\widehat{\overline{G_{i,t}}}$	$\widehat{\overline{G_{i,t}}}$	$\widehat{\overline{G_{i,t}}}$	$\widehat{\overline{G_{i,t}}}$
Average Max Wind	0.0203***	0.0230***	0.0184**	0.0202***	0.0197***	0.0149*	0.0140
	(0.00686)	(0.00711)	(0.00719)	(0.00492)	(0.00741)	(0.00878)	(0.0104)
Variance Max Wind						0.000932	0.00114
						(0.00141)	(0.00156)
Absolute Latitude		-0.00362	-0.00168	-0.0612*	-0.0470	-0.0747*	-0.0671
		(0.0464)	(0.0308)	(0.0363)	(0.0480)	(0.0409)	(0.0553)
Corruption Perception Index		0.0582*	0.0248	0.0294	0.0209	0.0333	0.0260
		(0.0335)	(0.0250)	(0.0213)	(0.0224)	(0.0227)	(0.0226)
Constant	3.082***	0.183	3.234***	-1.695	2.905	-1.322	4.014
	(0.450)	(0.811)	(0.827)	(6.397)	(7.010)	(6.507)	(7.356)
Region FE	N	N	Y	N	Y	N	Y
Additional Controls	N	N	N	Y	Y	Y	Y
Observations	203	149	149	74	74	74	74
R-squared	0.017	0.064	0.106	0.464	0.539	0.464	0.540

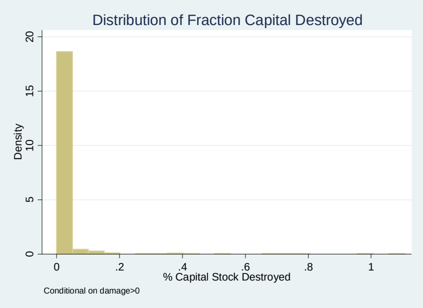
Bootstrapped standard errors in parentheses. Additional controls: Ln Initial GDP pc, Avg Tertiary Eduction of Labor Force, Avg Birth Rate, Avg Capital Formation, Avg Gov Consumption, Avg Trade, Ln Land Area, Ln Population, Ln Urbanization, Pct Tropical. *** p<0.01, ** p<0.05, * p<0.1

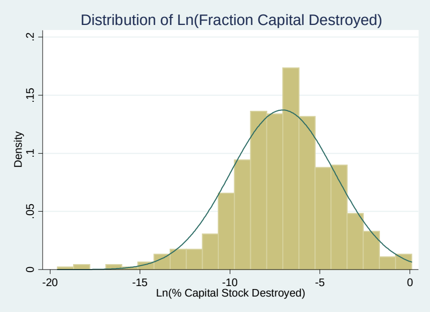
Overall Growth Impact: Results

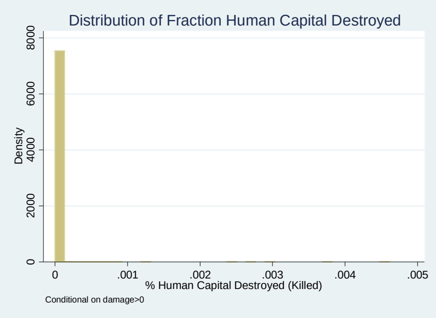
- Unweighted average (conditional on having cyclones)
  - Strikes: -0.72%, Risk: $+0.63\%$, Overall: -0.09% Figure
- In line with literature and theoretical model, overall impact estimate between strike and risk effects
- Caveats:
  - *Welfare* effects remain open question
  - As always, econometric concerns in cross-country regression

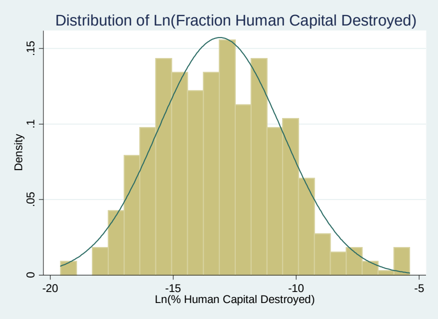
Conclusions

- We review the empirical evidence on natural disasters and growth through the lens of a macroeconomic model
  - Use incomplete markets literature to build stochastic endogenous growth model with (partly) uninsurable cyclone risk
- Model can match, reconcile several key empirical results
  - Predicts different growth impacts for e.g., cyclone risks vs. strikes
- Highlight estimation of overall cyclone impacts
- Future steps
  - Welfare mapping
  - Empirically test underlying model mechanisms Credit
  - Aggregate shocks (small vs. large country impacts)


Distribution of Fraction Capital Destroyed
Density
0
5
10
15
20
0
.2
.4
.6
.8
1
% Capital Stock Destroyed
Conditional on damage>0


Distribution of Ln(Fraction Capital Destroyed)
Density
0
.05
.1
.15
.2
-20
-15
-10
-5
0
Ln(% Capital Stock Destroyed)


Distribution of Fraction Human Capital Destroyed
Density
0
2000
4000
6000
8000
0
.001
.002
.003
.004
.005
% Human Capital Destroyed (Killed)
Conditional on damage>0


Distribution of Ln(Fraction Human Capital Destroyed)
Density
0
.05
.1
.15
-20
-15
-10
-5
Ln(% Human Capital Destroyed)

Back

Cyclone Strikes in Panel Regressions

	(1)	(2)
Dependent Variable	GDP PC Growth	GDP PC Growth
Cyclone Variable	Max Wind	Energy
Years	1970-2015	1970-2015
Cyclone t	-0.00220	-9.22e-08*
	(0.00455)	(5.41e-08)
Cyclone t-1	-0.00134	1.95e-08
	(0.00382)	(5.03e-08)
Cyclone t-2	-0.00420	-4.22e-08
	(0.00382)	(4.90e-08)
Cyclone t-3	-0.00163	-5.53e-08
	(0.00409)	(4.93e-08)
Cyclone t-4	-0.00379	4.29e-09
	(0.00376)	(4.55e-08)
Cyclone t-5	-0.00188	-8.44e-08
	(0.00392)	(5.21e-08)
...	...	...
Cyclone t-19	-0.000989	8.15e-08
	(0.00506)	(7.41e-08)
Cyclone t-20	0.00120	5.73e-08
	(0.00415)	(6.04e-08)
Country FE	Y	Y
Year FE	Y	Y
Country-Year Trend	Y	Y
Observations	7,348	7,348
R-squared	0.268	0.268

Robust standard errors in parentheses.
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Back

Cyclone Strike Cumulative Impacts

- Following HJ, compute cumulative impact as:

$$\Omega_j = \sum_{L=0}^{20} \widehat{\beta}_L$$

- Results:

Lags	Max Wind Coefficient Sum	Max Wind P-Values	Energy Coefficient Sum	Energy P-Values
5	-0.015	0.1902	-1.58E-07	0.0862
10	-0.022	0.0831	-3.56E-07	0.0284
15	-0.037	0.0348	-4.61E-07	0.0151
20	-0.039	0.0851	-2.14E-07	0.1369

Back

Stationary Equilibrium

- Aggregate capital stocks: $K_{1t} \equiv \int k_{1jt} dj = \int s_{it} dj$ and $H_t \equiv \int h_{it} di$
- Stationary equilibrium $\longrightarrow$ constant *aggregate* $\widetilde{h} \equiv \frac{H}{K_1}$

  $\longrightarrow$ Constant factor returns $R_h(\widetilde{h})$, $R_{k1}(\widetilde{h})$

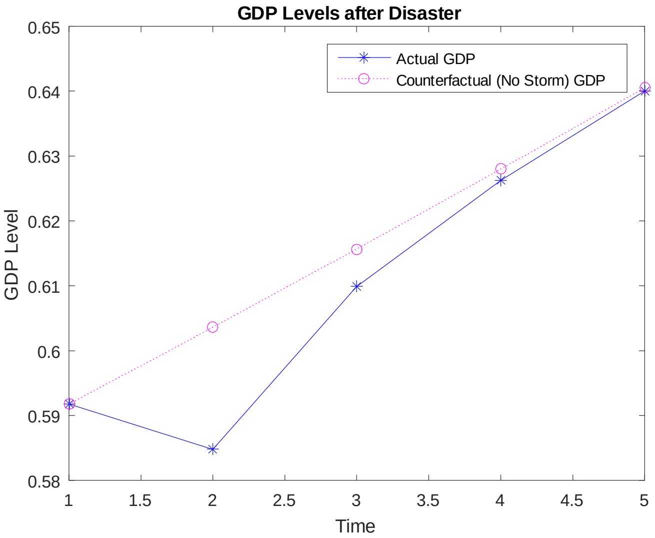
- Recursive formulation of HH's problem: Back

$$V(w_i, \widetilde{h}_i, \Theta_{k2i}, \eta_i^h, \eta_i^{k2}) = \max u(c_i) + \beta E[V(w_i', \widetilde{h}_i', \Theta_{k2i}', \eta_i^{h\prime}, \eta_i^{k2\prime})]$$

s.t. law of motion for wealth: $w_i' = [1 + r(\widetilde{h}_i, \Theta_{k2i}, \eta_i^h, \eta_i^{k2})]w_i - c_i$

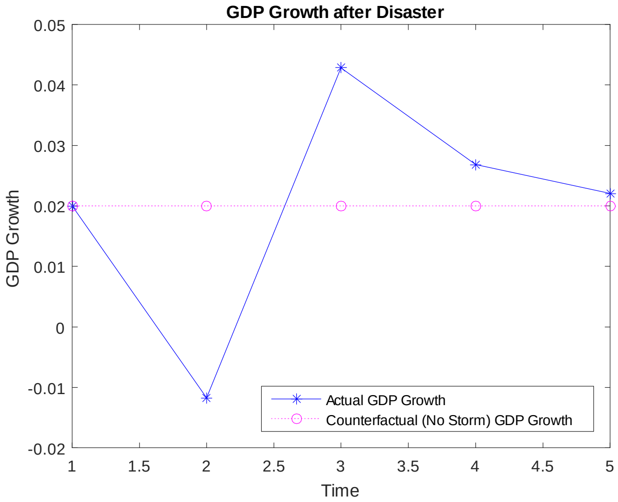
$$\begin{aligned} r(.) \quad = \quad & (1 - \Theta_{k2it})\{(1 - \theta_h(\widetilde{h}_{it}))R_{k1t} + \theta_h(\widetilde{h}_{it})(R_{ht} + 1 - \delta_h - \eta_{it}^h)\} \\ & + \Theta_{k2it}(A_2 + 1 - \delta_{k2} - \eta_{it}^{k_2}) \end{aligned}$$

Illustration: Solow Growth Model

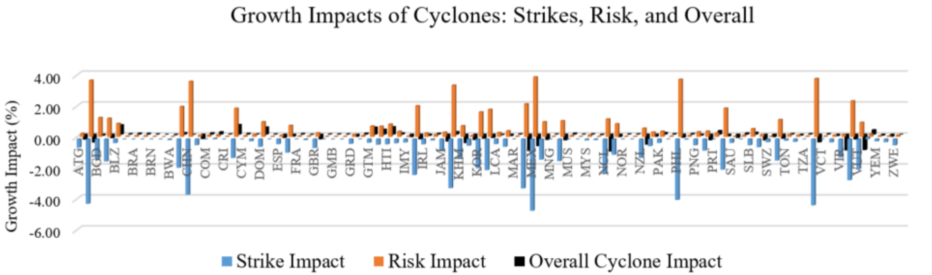


Back

Illustration: Solow Growth Model



Overall Growth Impacts



Back

Growth Impact Reduction: Credit

	(1)	(2)	(3)	(4)
Dependent Variable	Avg Growth	Avg Growth	Avg Growth	Avg Growth
Avg Max Wind	0.0374***	0.0477***	0.0365***	0.0339***
	(0.0137)	(0.0136)	(0.0102)	(0.0100)
Avg Credit	-0.000261	-0.00276	0.00446	-0.00300
	(0.00581)	(0.00526)	(0.00488)	(0.00468)
Avg Max Wind X Avg Credit	-6.80e-06	-3.71e-05	-0.000133*	-9.49e-05
	(9.82e-05)	(7.90e-05)	(7.88e-05)	(7.44e-05)
Abs Latitude		0.0182		0.0148
		(0.0231)		(0.0163)
Corruption Perception Index		0.00646		0.0174
		(0.0166)		(0.0147)
Constant	1.341***	0.593	0.604	2.152***
	(0.502)	(0.493)	(0.598)	(0.602)
Region FE	N	N	Y	Y
Observations	112	87	92	87
R-squared	0.055	0.107	0.164	0.188

Robust standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

Back