Discussion of "Do Disasters Affect Growth? A Macro Model-Based Perspective on the Empirical Debate" by L. Bakkensen and L. Barrage

Rody Manuelli
Washington University in St. Louis and Federal Reserve Bank of St. Louis

IMF Workshop on Macroeconomic Policy and Income Inequality
Washington D.C., February, 2017

Introduction: Paper

- The paper:

Introduction: Paper

- The paper:
  - There is conflicting evidence on the growth effects of natural disasters:

Introduction: Paper

- The paper:
  - There is conflicting evidence on the growth effects of natural disasters:
    - Cyclone risks.

Introduction: Paper

- The paper:
  - There is conflicting evidence on the growth effects of natural disasters:
    - Cyclone risks.
    - Cyclone strikes.

Introduction: Paper

- The paper:
  - There is conflicting evidence on the growth effects of natural disasters:
    - Cyclone risks.
    - Cyclone strikes.
  - Develops a theoretical model to "organize" the evidence.

Introduction: Paper

- The paper:
  - There is conflicting evidence on the growth effects of natural disasters:
    - Cyclone risks.
    - Cyclone strikes.
  - Develops a theoretical model to "organize" the evidence.
  - Describes empirical results inspired by the implications of the theoretical model.

Introduction: Paper

- The paper:
  - There is conflicting evidence on the growth effects of natural disasters:
    - Cyclone risks.
    - Cyclone strikes.
  - Develops a theoretical model to "organize" the evidence.
  - Describes empirical results inspired by the implications of the theoretical model.
- Findings:

Introduction: Paper

- The paper:
  - There is conflicting evidence on the growth effects of natural disasters:
    - Cyclone risks.
    - Cyclone strikes.
  - Develops a theoretical model to "organize" the evidence.
  - Describes empirical results inspired by the implications of the theoretical model.
- Findings:
  - Cyclone risks and cyclone strikes can have different effects on growth: strikes -0.72 and risk +0.63

Introduction: Paper

- The paper:
  - There is conflicting evidence on the growth effects of natural disasters:
    - Cyclone risks.
    - Cyclone strikes.
  - Develops a theoretical model to "organize" the evidence.
  - Describes empirical results inspired by the implications of the theoretical model.
- Findings:
  - Cyclone risks and cyclone strikes can have different effects on growth: strikes -0.72 and risk +0.63
  - Measurement: different measures of risk have different effects.

Introduction: Paper

- The paper:
  - There is conflicting evidence on the growth effects of natural disasters:
    - Cyclone risks.
    - Cyclone strikes.
  - Develops a theoretical model to "organize" the evidence.
  - Describes empirical results inspired by the implications of the theoretical model.
- Findings:
  - Cyclone risks and cyclone strikes can have different effects on growth: strikes -0.72 and risk +0.63
  - Measurement: different measures of risk have different effects.
  - Growth and welfare do not necessarily move together.

Introduction: Discussion

- Empirical evidence about the growth effects of natural disasters: Present a set of "alternative facts."

Introduction: Discussion

- Empirical evidence about the growth effects of natural disasters: Present a set of "alternative facts."
- Theory:

Introduction: Discussion

- Empirical evidence about the growth effects of natural disasters: Present a set of "alternative facts."
- Theory:
  - What do standard (off-the shelf) models say about the growth effects of risk (potential for a loss) and actual losses.

Introduction: Discussion

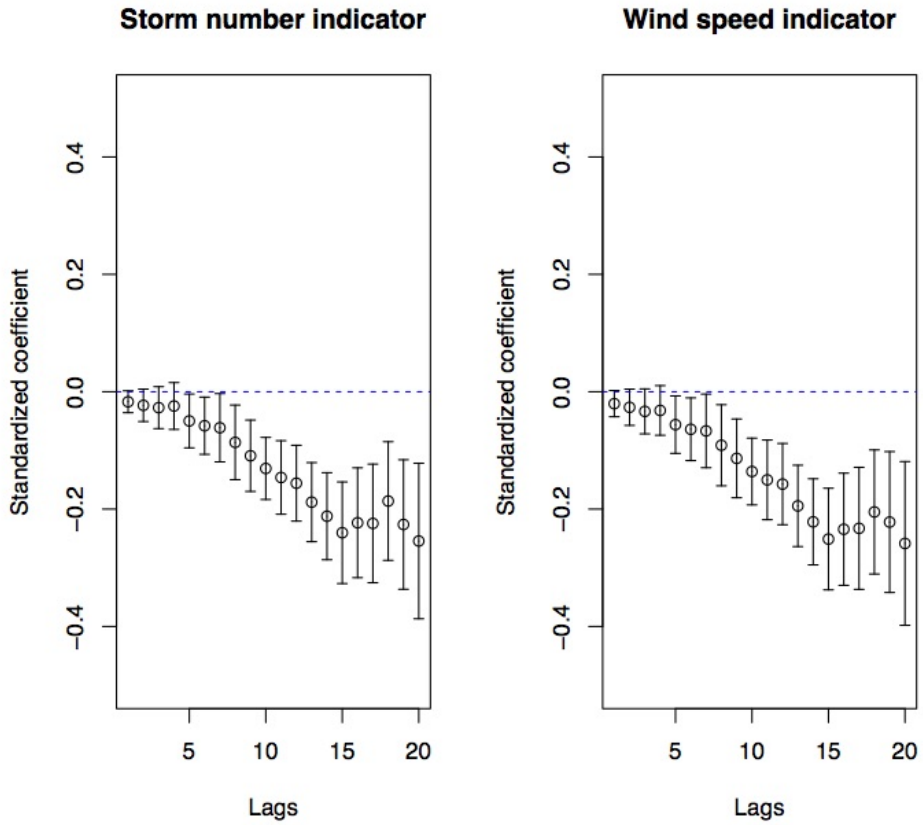
- Empirical evidence about the growth effects of natural disasters: Present a set of "alternative facts."
- Theory:
  - What do standard (off-the shelf) models say about the growth effects of risk (potential for a loss) and actual losses.
  - What do standard (off-the shelf) models say about the relationship between growth and welfare.

Introduction: Discussion

- Empirical evidence about the growth effects of natural disasters: Present a set of "alternative facts."
- Theory:
  - What do standard (off-the shelf) models say about the growth effects of risk (potential for a loss) and actual losses.
  - What do standard (off-the shelf) models say about the relationship between growth and welfare.
- What is the role of theoretical models?

Hurricanes : Do they have an impact on growth?

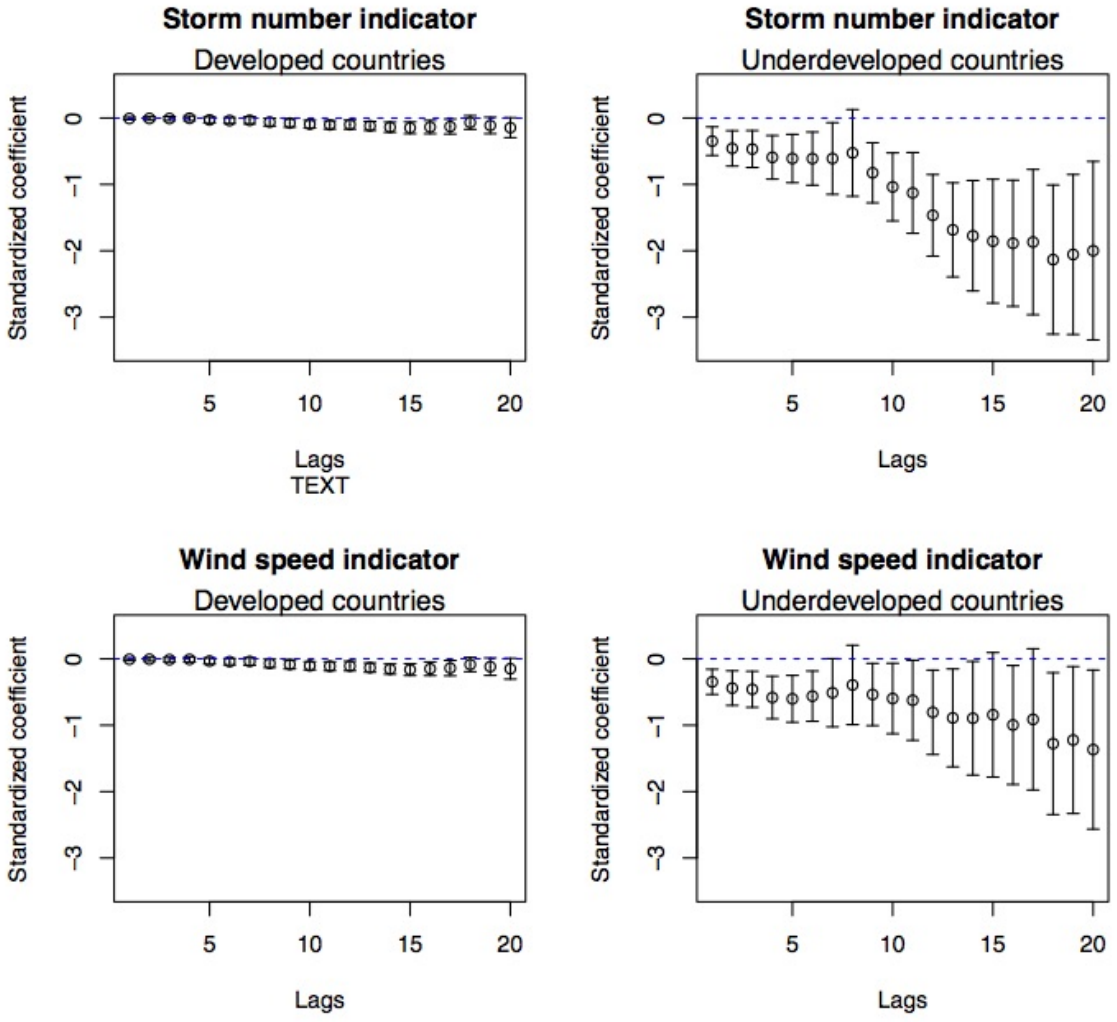
- From "Hurricanes, Economic Growth and Transmission Channels" by Berleman and Wenzel (2016).



Cumulative Impact on Growth Rates (Years)

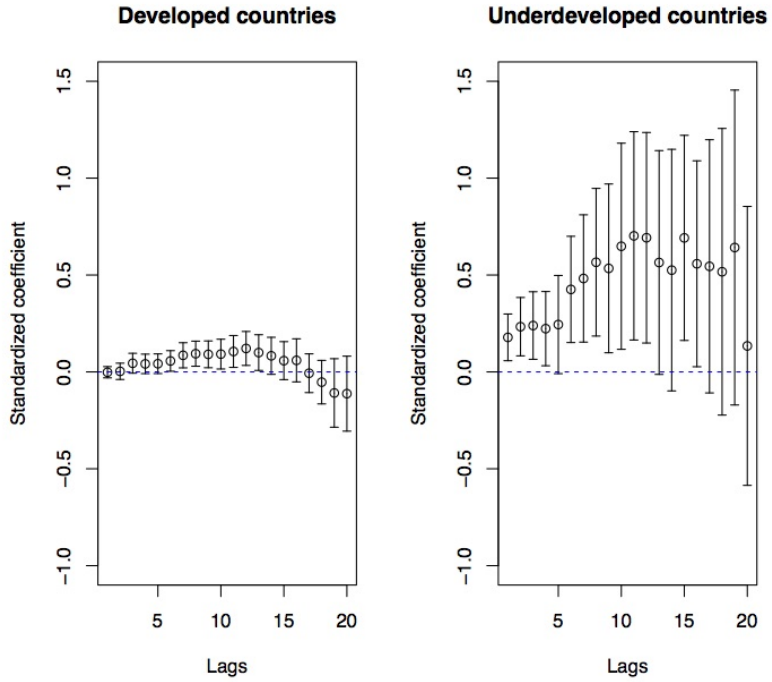
Hurricanes : Develop vs. underdeveloped countries

- From Berleman and Wenzel (2016)

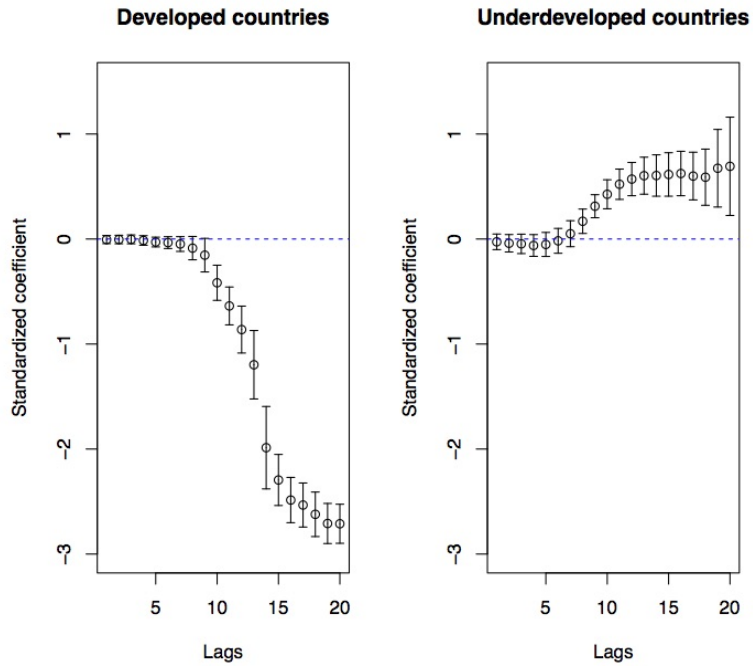


Hurricanes : What else responds?

- From Berleman and Wenzel (2016)



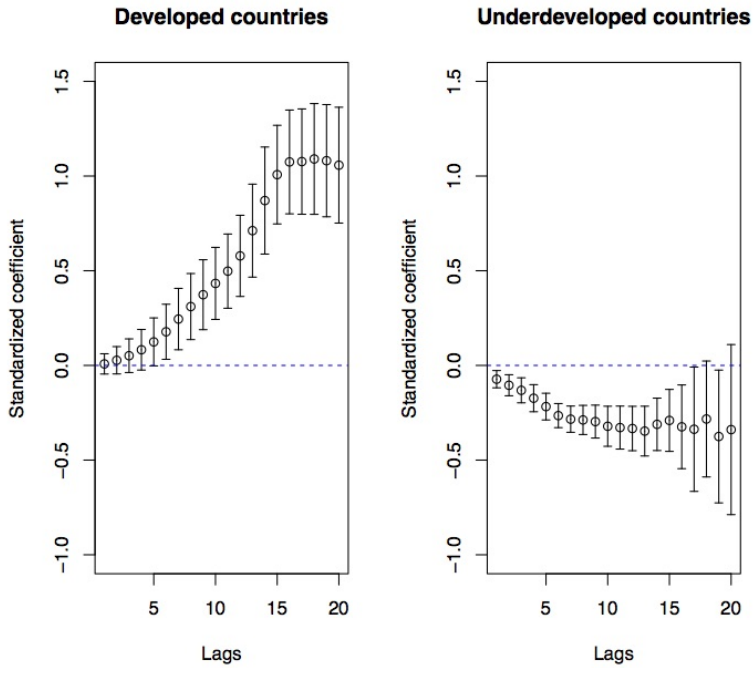
Impact on Investment



Impact on Fertility

Hurricanes : What else responds?

- From Berleman and Wenzel (2016)

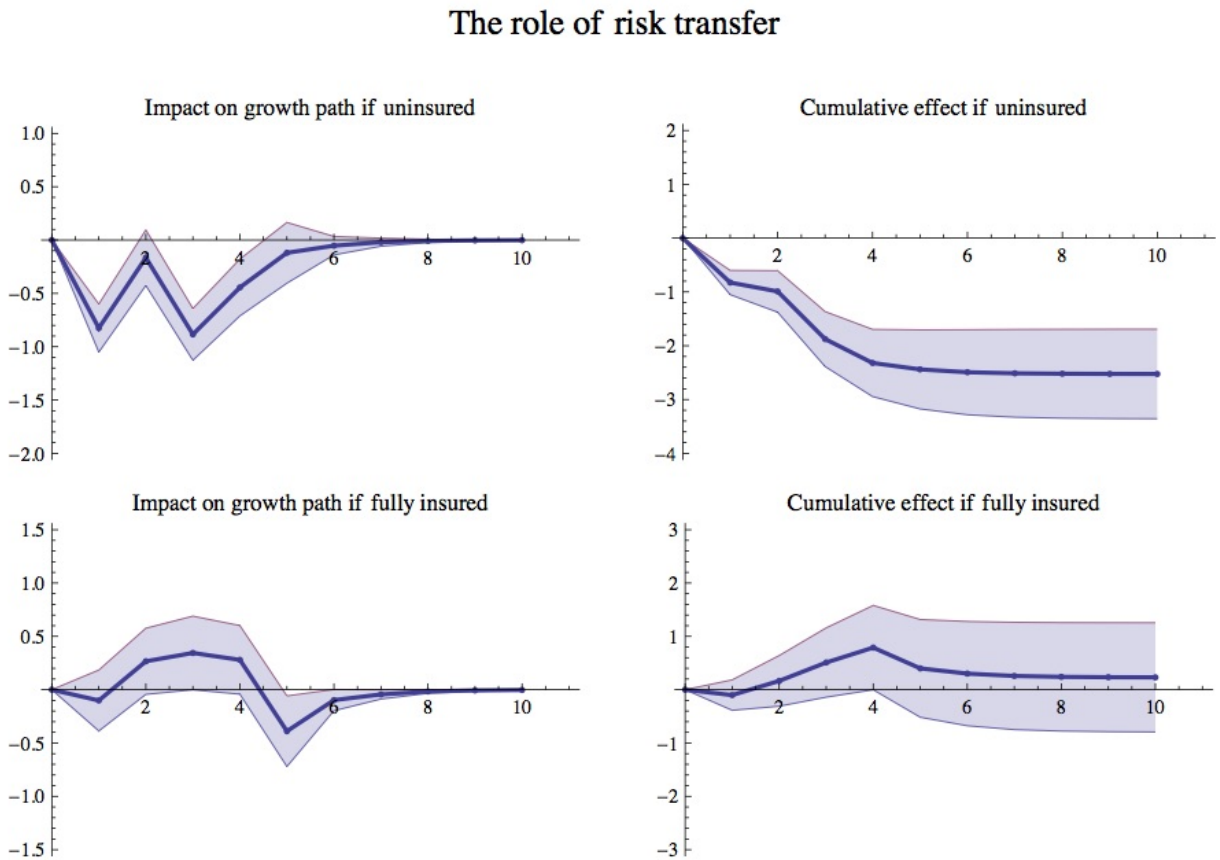


Years Secondary Schooling (avg.)

- Should we use this information to "educate" the models?

Natural Disasters : What role for insurance?

- From "Unmitigated Disasters? New Evidence on the Macroeconomic Cost of Natural Catastrophes," by von Peter et. al. (2012)



A Simple Model

- Standard CRRA preferences (γ).

A Simple Model

- Standard CRRA preferences (γ).
- Two stocks

$$dk = Akdt + \underbrace{\sigma k dZ}_{\text{TFP shocks}} - \underbrace{(1-\mu_\delta \delta)}_{\text{Loss}} \underbrace{k dN_t}_{\text{Risk (Poisson } \eta)},$$

$$\begin{aligned} dh &= Hhdt + (1-\mu_\delta \delta)\, h dN_t, \\ k &= \alpha w, \text{ and } h = (1-\alpha) w. \end{aligned}$$

A Simple Model

- Standard CRRA preferences (γ).
- Two stocks

$$dk = Akdt + \underbrace{\sigma k dZ}_{\text{TFP shocks}} - \underbrace{(1-\mu_\delta \delta)}_{\text{Loss}} \underbrace{k dN_t}_{\text{Risk (Poisson } \eta)},$$

$$\begin{aligned} dh &= Hhdt + (1-\mu_\delta \delta)\, h dN_t, \\ k &= \alpha w, \text{ and } h = (1-\alpha) w. \end{aligned}$$

- Law of motion

$$\begin{aligned} dw &= [(\alpha A + (1-\alpha)\, H) - c]\, w dt \\ &\quad + \sigma A^{1/2} \alpha w dZ + (\mu_\delta \delta - 1)\, w dN_t. \end{aligned}$$

A Simple Model

- Standard CRRA preferences (γ).
- Two stocks

$$dk = Akdt + \underbrace{\sigma k dZ}_{\text{TFP shocks}} - \underbrace{(1-\mu_\delta\delta)}_{\text{Loss}} \underbrace{kdN_t}_{\text{Risk (Poisson } \eta)}, \quad ,$$

$$\begin{aligned} dh &= Hhdt + (1-\mu_\delta\delta)\, hdN_t, \\ k &= \alpha w, \text{ and } h = (1-\alpha)w. \end{aligned}$$

- Law of motion

$$\begin{aligned} dw &= [(\alpha A + (1-\alpha)\, H) - c]\, wdt \\ &\quad + \sigma A^{1/2} \alpha w dZ + (\mu_\delta\delta - 1)\, wdN_t. \end{aligned}$$

- When the disaster (Poisson) hits

$$w' = w(\mu_\delta\delta), \text{ and } \delta \text{ has mean 1 and variance } \sigma_\delta^2$$

A Simple Model

- It is easy to solve with pencil and paper

A Simple Model

- It is easy to solve with pencil and paper
  - share of risky asset (Merton and eqn. (13))

$$\alpha = \frac{A - H}{\gamma \sigma^2}$$

A Simple Model

- It is easy to solve with pencil and paper
  - share of risky asset (Merton and eqn. (13))

$$\alpha = \frac{A - H}{\gamma \sigma^2}$$

  - growth rate of wealth (eqn (17))

$$\frac{dw_t}{w_t} = \mu_w dt + \sigma A^{1/2} \frac{(A - H)}{\gamma \sigma^2} dZ_t - (1 - \mu_\delta \delta_t)\, dN_t.$$

A Simple Model

- It is easy to solve with pencil and paper
  - share of risky asset (Merton and eqn. (13))

$$\alpha = \frac{A - H}{\gamma \sigma^2}$$

  - growth rate of wealth (eqn (17))

$$\frac{dw_t}{w_t} = \mu_w dt + \sigma A^{1/2} \frac{(A - H)}{\gamma \sigma^2} dZ_t - (1 - \mu_\delta \delta_t)\, dN_t.$$

  - expected growth is

$$\mu_w - (1 - \mu_\delta)\, \eta,$$

A Simple Model

- It is easy to solve with pencil and paper
  - share of risky asset (Merton and eqn. (13))

$$\alpha = \frac{A - H}{\gamma \sigma^2}$$

  - growth rate of wealth (eqn (17))

$$\frac{dw_t}{w_t} = \mu_w dt + \sigma A^{1/2} \frac{(A - H)}{\gamma \sigma^2} dZ_t - (1 - \mu_\delta \delta_t)\, dN_t.$$

  - expected growth is

$$\mu_w - (1 - \mu_\delta)\, \eta,$$

  - expected growth conditioning on $dN_t = 0$ is (eqn (20))

$$\mu_w = \frac{1}{\gamma}\left[H + \frac{(A - H)^2}{\gamma \sigma^2} - \rho + \eta\left(\mu_\delta^{1-\gamma} E(\delta^{1-\gamma}) - 1\right)\right],$$

where $(\eta, \mu_\delta, \sigma_\delta^2)$ are the indicators of "cyclone risk characteristics."

A Simple Model: Properties

.

- What are the effects of natural disasters $(\eta, \mu_\delta, \sigma_\delta^2)$ on the expected growth rate (savings channel)? Theory says that it depends on γ.

A Simple Model: Properties

.

- What are the effects of natural disasters $(\eta, \mu_\delta, \sigma_\delta^2)$ on the expected growth rate (savings channel)? Theory says that it depends on γ.
  - If $\gamma \in (0,1)$ then

$$\Delta\mu_\delta < 0 \text{ and } \Delta\sigma_\delta^2 > 0 \Longrightarrow \Delta\mu_w > 0,$$
$$\Delta\eta > 0 \Longrightarrow \Delta\mu_w < 0.$$

A Simple Model: Properties

.

- What are the effects of natural disasters $(\eta, \mu_\delta, \sigma_\delta^2)$ on the expected growth rate (savings channel)? Theory says that it depends on γ.
  - If $\gamma \in (0,1)$ then

$$\Delta\mu_\delta < 0 \text{ and } \Delta\sigma_\delta^2 > 0 \Longrightarrow \Delta\mu_w > 0,$$
$$\Delta\eta > 0 \Longrightarrow \Delta\mu_w < 0.$$

  - If $\gamma > 1$

$$\Delta\mu_\delta < 0 \text{ and } \Delta\sigma_\delta^2 > 0 \Longrightarrow \Delta\mu_w < 0,$$
$$\Delta\eta > 0 \Longrightarrow \Delta\mu_w > 0.$$

A Simple Model: Properties

.

- What are the effects of natural disasters $(\eta, \mu_\delta, \sigma_\delta^2)$ on the expected growth rate (savings channel)? Theory says that it depends on γ.
  - If $\gamma \in (0,1)$ then

$$\Delta\mu_\delta < 0 \text{ and } \Delta\sigma_\delta^2 > 0 \Longrightarrow \Delta\mu_w > 0,$$
$$\Delta\eta > 0 \Longrightarrow \Delta\mu_w < 0.$$

  - If $\gamma > 1$

$$\Delta\mu_\delta < 0 \text{ and } \Delta\sigma_\delta^2 > 0 \Longrightarrow \Delta\mu_w < 0,$$
$$\Delta\eta > 0 \Longrightarrow \Delta\mu_w > 0.$$

- Portfolio effects. Differential loss rates

$$\hat{\alpha} = \frac{A-H}{\gamma\sigma^2} - \frac{1}{\gamma\sigma^2} E\left[\frac{\mu_\delta^k \delta^k - \mu_\delta^h \delta^h}{\left(\hat{\alpha}\mu_\delta^k \delta^k + (1-\hat{\alpha})\mu_\delta^h \delta^h\right)^\gamma}\right]$$

A Simple Model: Properties

.

- What are the effects of natural disasters $(\eta, \mu_\delta, \sigma_\delta^2)$ on the expected growth rate (savings channel)? Theory says that it depends on γ.
  - If $\gamma \in (0,1)$ then

$$\Delta\mu_\delta < 0 \text{ and } \Delta\sigma_\delta^2 > 0 \Longrightarrow \Delta\mu_w > 0,$$
$$\Delta\eta > 0 \Longrightarrow \Delta\mu_w < 0.$$

  - If $\gamma > 1$

$$\Delta\mu_\delta < 0 \text{ and } \Delta\sigma_\delta^2 > 0 \Longrightarrow \Delta\mu_w < 0,$$
$$\Delta\eta > 0 \Longrightarrow \Delta\mu_w > 0.$$

- Portfolio effects. Differential loss rates

$$\hat{\alpha} = \frac{A-H}{\gamma\sigma^2} - \frac{1}{\gamma\sigma^2} E\left[\frac{\mu_\delta^k \delta^k - \mu_\delta^h \delta^h}{\left(\hat{\alpha}\mu_\delta^k \delta^k + (1-\hat{\alpha})\mu_\delta^h \delta^h\right)^\gamma}\right]$$

Some Thoughts on Models

- These linear Ak type of models are such that there are no income effects. Thus, in the absence of "enhancements" they will have a hard time explaining the difference in response between developed and less developed countries.

Some Thoughts on Models

- These linear *Ak* type of models are such that there are no income effects. Thus, in the absence of "enhancements" they will have a hard time explaining the difference in response between developed and less developed countries.
  - Strict concavity to generate "convergence" effects. Evidence?

Some Thoughts on Models

- These linear *Ak* type of models are such that there are no income effects. Thus, in the absence of "enhancements" they will have a hard time explaining the difference in response between developed and less developed countries.
  - Strict concavity to generate "convergence" effects. Evidence?
- Are there "other" dimensions that account for the differences in the growth effects of cyclones?

Some Thoughts on Models

- These linear *Ak* type of models are such that there are no income effects. Thus, in the absence of "enhancements" they will have a hard time explaining the difference in response between developed and less developed countries.
  - Strict concavity to generate "convergence" effects. Evidence?
- Are there "other" dimensions that account for the differences in the growth effects of cyclones?
  - Differential "destruction" rates of the different types of capital and slow adjustment.

Some Thoughts on Models

- These linear *Ak* type of models are such that there are no income effects. Thus, in the absence of "enhancements" they will have a hard time explaining the difference in response between developed and less developed countries.
  - Strict concavity to generate "convergence" effects. Evidence?
- Are there "other" dimensions that account for the differences in the growth effects of cyclones?
  - Differential "destruction" rates of the different types of capital and slow adjustment.
  - Lower productivity (not just lower stocks) associated with natural disaster and the response of investment.

Some Thoughts on Models: Laundry List

- What is missing?:

Some Thoughts on Models: Laundry List

- What is missing?:
  - Resources that can be allocated to "prevention" and "mitigation." These features can endogeneize the loss of productivity and the duration of the "disaster phase."

Some Thoughts on Models: Laundry List

- What is missing?:
  - Resources that can be allocated to "prevention" and "mitigation." These features can endogeneize the loss of productivity and the duration of the "disaster phase."
  - Insurance (pricing?) and the crowding out associated with foreign aid.

Some Thoughts on Models: Laundry List

- What is missing?:
  - Resources that can be allocated to "prevention" and "mitigation." These features can endogeneize the loss of productivity and the duration of the "disaster phase."
  - Insurance (pricing?) and the crowding out associated with foreign aid.
  - Do the details of how aid (or insurance) is provided matter?

Some Thoughts on Models: Laundry List

- What is missing?:
  - Resources that can be allocated to "prevention" and "mitigation." These features can endogeneize the loss of productivity and the duration of the "disaster phase."
  - Insurance (pricing?) and the crowding out associated with foreign aid.
  - Do the details of how aid (or insurance) is provided matter?
    - Specific type of capital.

Some Thoughts on Models: Laundry List

- What is missing?:
  - Resources that can be allocated to "prevention" and "mitigation." These features can endogeneize the loss of productivity and the duration of the "disaster phase."
  - Insurance (pricing?) and the crowding out associated with foreign aid.
  - Do the details of how aid (or insurance) is provided matter?
    - Specific type of capital.
    - Contingent on productivity/growth.

Some Thoughts on Models: Laundry List

- What is missing?:
  - Resources that can be allocated to "prevention" and "mitigation." These features can endogeneize the loss of productivity and the duration of the "disaster phase."
  - Insurance (pricing?) and the crowding out associated with foreign aid.
  - Do the details of how aid (or insurance) is provided matter?
    - Specific type of capital.
    - Contingent on productivity/growth.
- Do rich and poor countries have the same prevention and mitigation technologies? (agency)

What is a Model Good For?

- Should we try to build models that are useful tools for:

What is a Model Good For?

- Should we try to build models that are useful tools for:
  - Evaluating the impact of aid (before and after a natural disaster).

What is a Model Good For?

- Should we try to build models that are useful tools for:
  - Evaluating the impact of aid (before and after a natural disaster).
    - General vs. specific? Timing?

What is a Model Good For?

- Should we try to build models that are useful tools for:
  - Evaluating the impact of aid (before and after a natural disaster).
    - General vs. specific? Timing?
  - Assessing costs and benefits of insurance schemes (e.g. catastrophe bonds).

What is a Model Good For?

- Should we try to build models that are useful tools for:
  - Evaluating the impact of aid (before and after a natural disaster).
    - General vs. specific? Timing?
  - Assessing costs and benefits of insurance schemes (e.g. catastrophe bonds).
    - Incentive effects.

What is a Model Good For?

- Should we try to build models that are useful tools for:
  - Evaluating the impact of aid (before and after a natural disaster).
    - General vs. specific? Timing?
  - Assessing costs and benefits of insurance schemes (e.g. catastrophe bonds).
    - Incentive effects.
    - Institutional: design of instruments.

What is a Model Good For?

- Should we try to build models that are useful tools for:
  - Evaluating the impact of aid (before and after a natural disaster).
    - General vs. specific? Timing?
  - Assessing costs and benefits of insurance schemes (e.g. catastrophe bonds).
    - Incentive effects.
    - Institutional: design of instruments.
- The theoretical possibilities are well understood. I believe that progress will involve:

What is a Model Good For?

- Should we try to build models that are useful tools for:
  - Evaluating the impact of aid (before and after a natural disaster).
    - General vs. specific? Timing?
  - Assessing costs and benefits of insurance schemes (e.g. catastrophe bonds).
    - Incentive effects.
    - Institutional: design of instruments.
- The theoretical possibilities are well understood. I believe that progress will involve:
  - developing better models to capture the interplay between prevention, mitigation, aid and the demand for insurance.

What is a Model Good For?

- Should we try to build models that are useful tools for:
  - Evaluating the impact of aid (before and after a natural disaster).
    - General vs. specific? Timing?
  - Assessing costs and benefits of insurance schemes (e.g. catastrophe bonds).
    - Incentive effects.
    - Institutional: design of instruments.
- The theoretical possibilities are well understood. I believe that progress will involve:
  - developing better models to capture the interplay between prevention, mitigation, aid and the demand for insurance.
  - developing models that can be taken to data to be used to "think" about policies.