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An Economic Framework for Adaptation

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Overview

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- Adaptation and the cost of climate change
- The costs and benefits of adaptation
- The timing of adaptation
- The role of policy

Adaptation and total costs

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- Adaptation costs are an integral part of the economic costs of climate change. Climate change costs (CCC) are defined as:

  adaptation cost (A) + residual damage costs (D)

- Formally:

  Min CCC = A (a, T) + D (a, T)

  $\Rightarrow$ optimal condition: $A_a = - D_a$

  $\Rightarrow$ optimal adaptation: $a^* = a^*(T)$

  $\Rightarrow$ min.cost: $CCC^*(T) = A (a^*(T),T) + D (a^*(T),T)$

a = adaptation effort (decision variable); T = temperature

Costs and benefits

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- The net benefit (NB) of adaptation (a) is:

$$NB(a) = [D(a^*, T) - D(a, T)] - A(a^*, T)$$

- Where $D(a^*, T) - D(a, T)$ is the reduction in climate change damage - the direct adaptation benefit
- In addition, there may be ancillary benefits
  - Lower impact of natural climate variations
  - Other side benefits (e.g., cyclone shelters as schools)

A hypothetical example

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	Current Climate		Changed climate	
Current adaptation	Adaptation cost	70	Adaptation cost	70
	Avoided climate damage	90	Avoided climate damage	100
	Residual damage	30	Residual damage	200
	Net adap. benefit	*90-70*	*Net adap. benefit*	*100-70*
	Climate cost	*70+30*	*Climate cost*	*70+200*
Higher adaptation	Adaptation cost	150	Adaptation cost	150
	Avoided climate damage	110	Avoided climate damage	250
	Residual damage	10	Residual damage	50
	Net adap benefit	*110-150*	*Net adap benefit*	*250-150*
	Climate cost	*150+10*	*Climate cost*	*150+50*

Note: numbers are illustrative

Climate change costs

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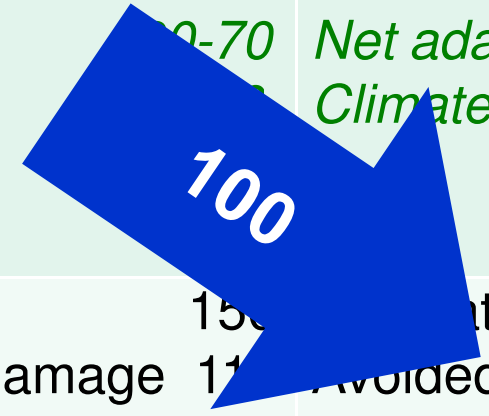
	Current Climate		Changed climate	
Current adaptation	Adaptation cost	70	Adaptation cost	70
	Avoided climate damage	90	Avoided climate damage	100
	Residual damage	30	Residual damage	200
	Net adap. benefit	*-70*	*Net adap. benefit*	*100-70*
	Climate cost		*Climate cost*	*70+200*
Higher adaptation	Adaptation cost	15	tion cost	150
	Avoided climate damage	11	oided climate damage	250
	Residual damage	10	Residual damage	50
	Net adap benefit	*110-150*	*Net adap benefit*	*250-150*
	Climate cost	*150+10*	*Climate cost*	*150+50*



Note: numbers are illustrative

Cost without adaptation

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	Current Climate		Changed climate	
Current adaptation	Adaptation cost	70	Adaptation cost	70
	Avoided climate damage	90	Avoided climate damage	100
	Residual damage		Residual damage	200
	Net adap. benefit		*Net adap. benefit*	*100-70*
	Climate cost		*Climate cost*	*70+200*
Higher adaptation	Adaptation cost	150	Adaptation cost	150
	Avoided climate damage	110	Avoided climate damage	250
	Residual damage	10	Residual damage	50
	Net adap benefit	*110-150*	*Net adap benefit*	*250-150*
	Climate cost	*150+10*	*Climate cost*	*150+50*

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Note: numbers are illustrative

The benefit of adaptation

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	Current Climate		Changed climate	
Current adaptation	Adaptation cost	70	Adaptation cost	70
	Avoided climate damage	90	Avoided climate damage	100
	Residual damage	30	Residual damage	200
	Net adap. benefit	*90-70*	*Net adap. b*	*100-70*
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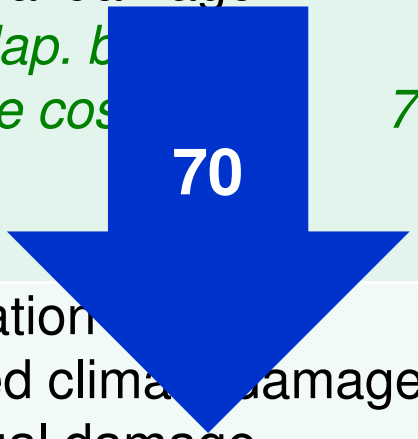

Note: numbers are illustrative

The timing of adaptation

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- Net present value of adaptation now (N)

$$NPV^N = A^N + D^N_0 + \Sigma D^N_t \delta^t$$

- Net present value of action later (L)

$$NPV^L = D^L_0 + A^L \delta + \Sigma D^L_t \delta^t$$

- The net cost of delay

$$(A^L \delta - A^N) + (D^L_0 - D^N_0) + \Sigma (D^L_t - D^N_t) \delta^t$$

time benefit of delayed investment	unmitigated damage today	difference in future damage (e.g., irreversible loss)

Things to do now

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- Prevent costly retrofits ($A^N << A^L$)
  - Design of long-lived investments like harbours, bridges
  - Adjust long-term development plans (e.g., building on flood plains)
- Avoid near-term losses ($D^N_0 << D^L_0$)
  - Dealing with current climate variability
  - Environmental protection to increase ecosystem resilience
  - Investment in people (health, education)
- Avoid irreversible damage ($\Sigma\ (D^N_t - D^L_t)\ \delta^t << 0$)
  - E.g. loss of unique systems like coral reefs

The role of policy

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- Provide “public good” adaptation
  - Research and development (e.g, crops, drugs)
  - Climate-proof infrastructure
  - Dedicated adaptation infrastructure (e.g. flood control)
- Remove barriers
  - Climate information
  - Market imperfections (e.g. on insurance)
  - Capacity constraints
- Create adaptation incentives
  - Regulation (eg. Building codes, zone planning)
  - Market incentives (eg water pricing, environmental markets)

Insurance

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- Higher payouts and spikes in payouts
  - Need to increase capital base or share loss with wider financial sector (e.g. Cat bonds)
- Cover offered by the market is not “optimal”
  - Uncertainty due to changing hazard statistics
  - Inertia and budget constraints prevent optimal adaptation
- A role for public policy
  - Finance adaptation to bring losses down to acceptable level
  - Share (peak) losses with the private sector
  - Address gaps in coverage (e.g. in poor regions)

Environmental markets and pricing

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- Markets and pricing correct market failure
  - Internalise external benefits (e.g. value genetic biodiversity)
  - Send a scarcity signal (e.g., water pricing)
  - Ensure allocative efficiency (e.g. irrigation vs municipal water)
- Adaptation benefit: Reduce baseline stress to make ecosystems more resilient
- Adaptation benefit: Monetize adaptation services of ecosystems
  - Watershed protection (forests), coastal protection (magroves)

Public private partnerships

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- Need to climate-proof infrastructure will stretch government capacity
  - Work with private sector to overcome financial, administrative constraints
- Adjust existing PPPs
  - Many PPPs are vulnerable: ports, water, roads, power
  - Implicit coverage of climate risks
  - Need to make climate an explicit risk
- Dedicated adaptation infrastructure?
  - E.g. Build, own, operate a flood barrier
  - No existing examples, but relevant experience is there

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