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Disasters and International Risk Sharing:
Effectiveness of Market and Non-Market Insurance in Asia

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Outline

1. Disasters in Asia

2. Overall effectiveness of market and non-market insurance
   – Global and intra-Asia consumption insurance
   – Within country insurance: A case of Vietnam

3. Remarks

Note: So-called "natural disasters" refer to "disasters triggered by natural hazards." Since disasters involving physical and human losses are not caused by nature, World Bank and United National (2010) call them "natural hazards and unnatural disasters."

Four Types of **Disasters**

- A disaster is defined as "an unforeseen large negative event which overwhelms local capacity (CRED)." There are four types:

1) Disasters triggered by *Natural* hazards
   - Hydro-meteorological: Floods, storms (typhoons), and droughts
   - Geophysical: Earthquakes, tsunamis and volcanic eruptions
   - Biological: Epidemics and insect infestations.

2) *Technological* disasters (human-made)
   - Industrial accidents: radiation leak, collapses of industrial infrastructures
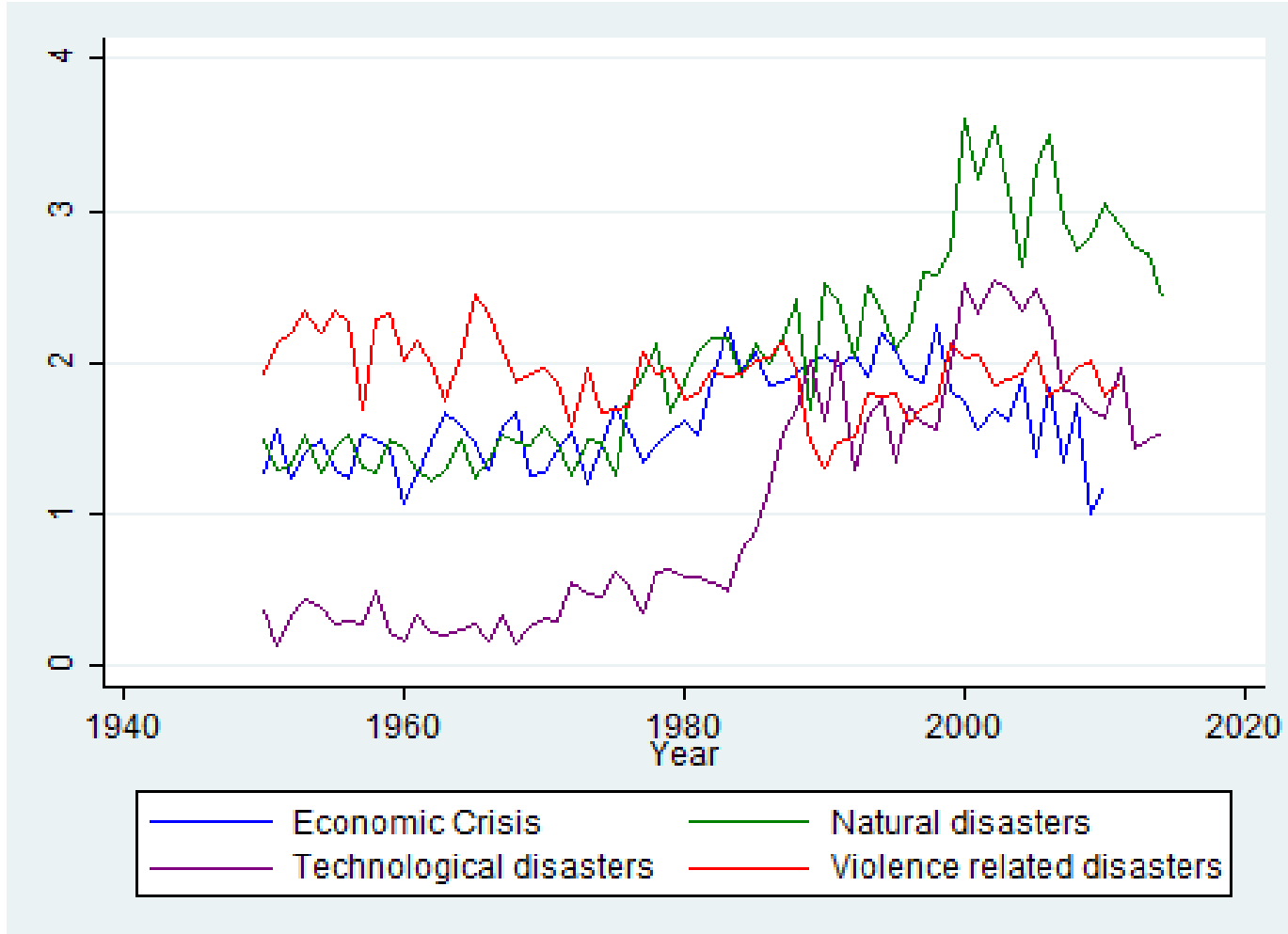   - Transport accidents: By air, rail, road or water means of transport.

3) *Economic* crises (human-made)
   - Growth collapse, food crisis, and financial & currency crises

4) *Violence* related disasters (human-made)
   - Terrorism, civil strife, riots, and wars.
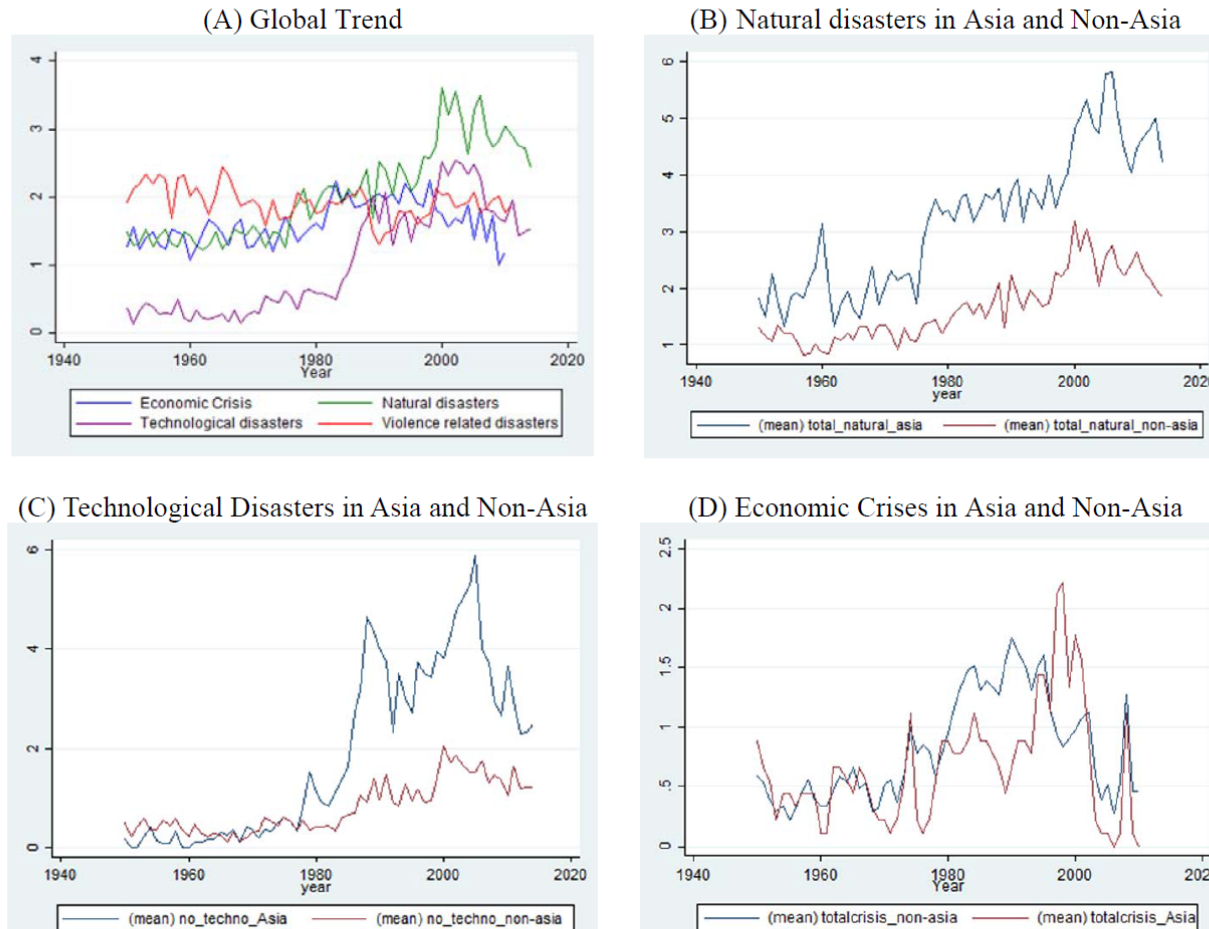
Disaster *Frequency* is increasing

Note: These figures indicate the average occurrence of the four types of disasters in each country per year.

Data sources: Natural and technological disasters are from Emergency Events Database (EM-DAT of CRED (2015), economic crisis is from Reinhart and Rogoff (2009, 2010) and IMF (2015), and violence related disasters relating to wars and conflicts are from the Global Terrorism Database (GTD) (National Consortium for the Study of Terrorism and Responses to Terrorism, 2015) and the Correlates of War (COW) database (Sarkees, Meredith Reid and Frank Wayman, 2010).

Asia Exposed to Disasters Disproportionately

Figure 3
**Frequency of Four Types of Major Disasters**

Note: These figures indicate the average occurrence of the four types of disasters in each country per year.

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Substantial and Increasing Disaster Losses in Asia

Figure 1: Disaster Losses Are Growing at the Same Rate as
Gross Domestic Product in ADB's Developing Member Countries
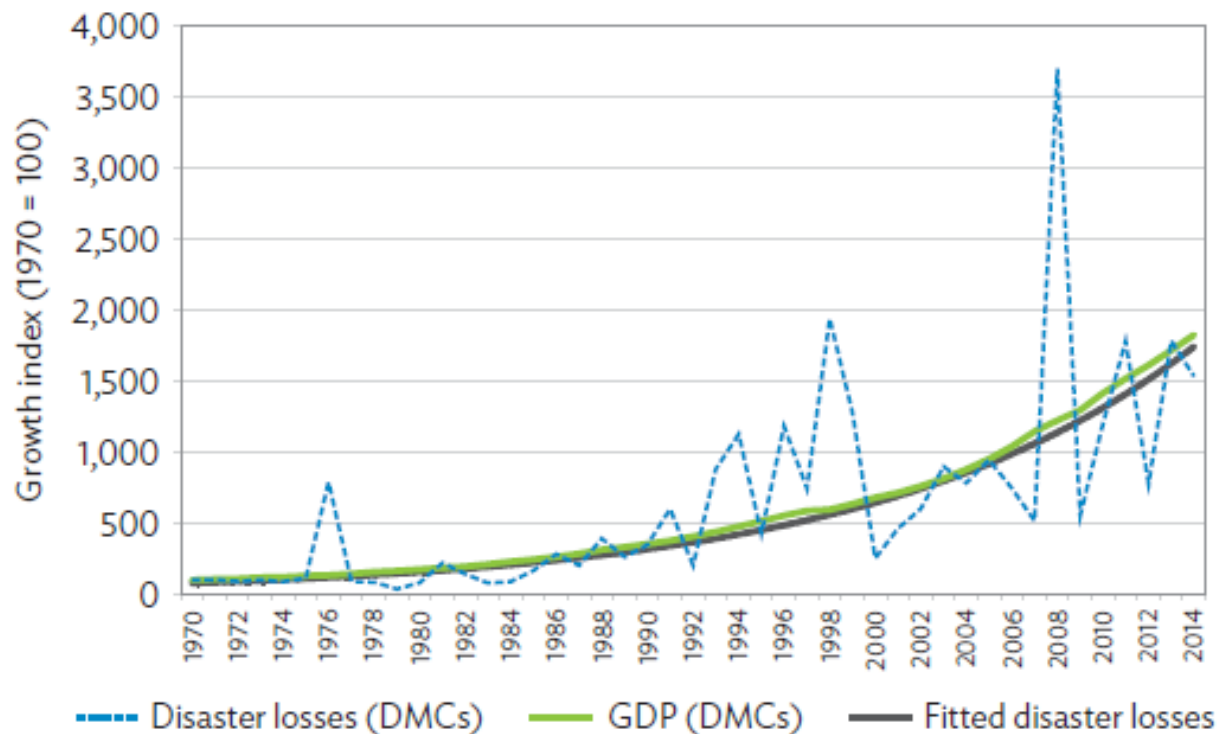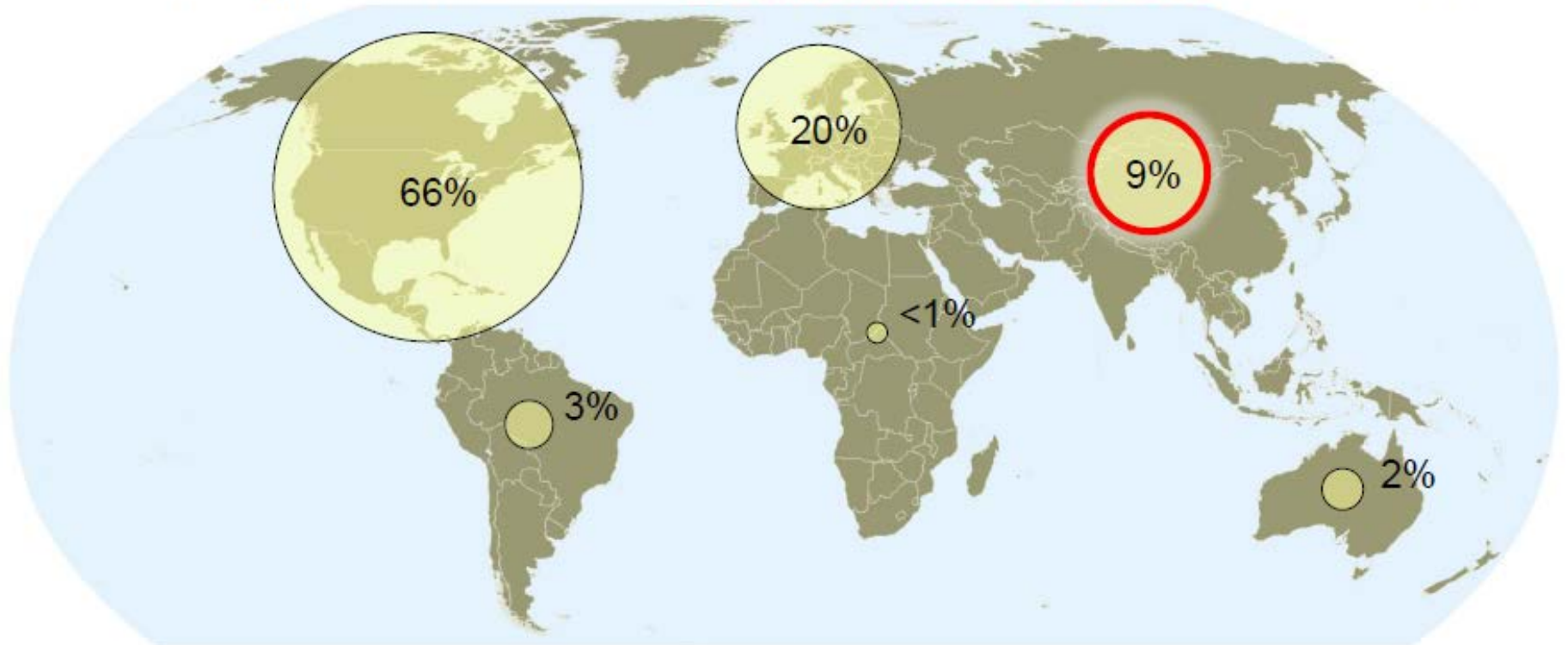

ADB = Asian Development Bank.
Note: Covers ADB DMCs up to 2014.
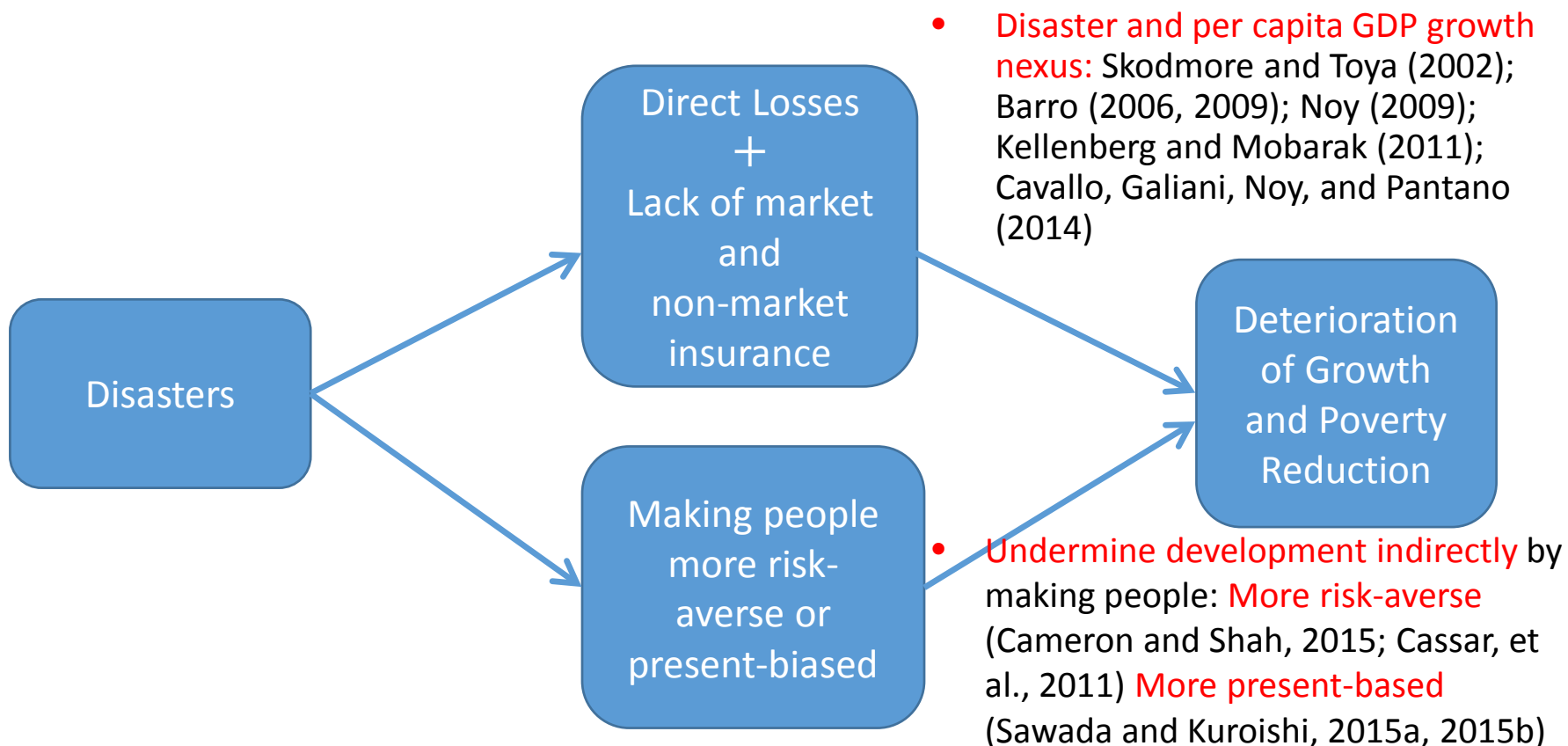Source. Asian Development Bank.

But....   Asia is uninsured

Percentage distribution of insured disaster losses 1980-2009

(Source) Munich RE

Disasters as a Development Challenge in Asia

Figure 1
Direct and Indirect Impacts of Disasters

- Disaster and per capita GDP growth nexus: Skodmore and Toya (2002); Barro (2006, 2009); Noy (2009); Kellenberg and Mobarak (2011); Cavallo, Galiani, Noy, and Pantano (2014)

Disasters → **Direct Losses + Lack of market and non-market insurance** → **Deterioration of Growth and Poverty Reduction**

Disasters → **Making people more risk-averse or present-biased** → **Deterioration of Growth and Poverty Reduction**

- Undermine development indirectly by making people: More risk-averse (Cameron and Shah, 2015; Cassar, et al., 2011) More present-based (Sawada and Kuroishi, 2015a, 2015b)

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Market and Non-Market Insurance Mechanisms

1. Market (direct insurance market; indirect credit and labor markets):
   - Indemnity-based insurance
     - Crop Insurance
     - Health Insurance
     - Disaster (floods, earthquake, cyclone, and etc.) insurance
   - Micro-insurance, index-based risk transfer products, & weather insurance
     - Rainfall, temperature, and flood insurance
     - NDVI based crop and livestock insurance
   - Macro Insurance
     - Nation-wide insurance schemes (usually, indemnity-based)
     - Regional insurance fund (CCRIF and PCRAFI)
     - Conflict prevention insurance
     - Chiang Mai Initiative Multilateralization (CMIM)

2. State: Public insurance, SRM, and other social protection programs

3. Community: Informal (consumption) insurance to achieve consumption risk sharing (Townsend, 1994; Udry, 1994)

The Market, State, and Community Trinity
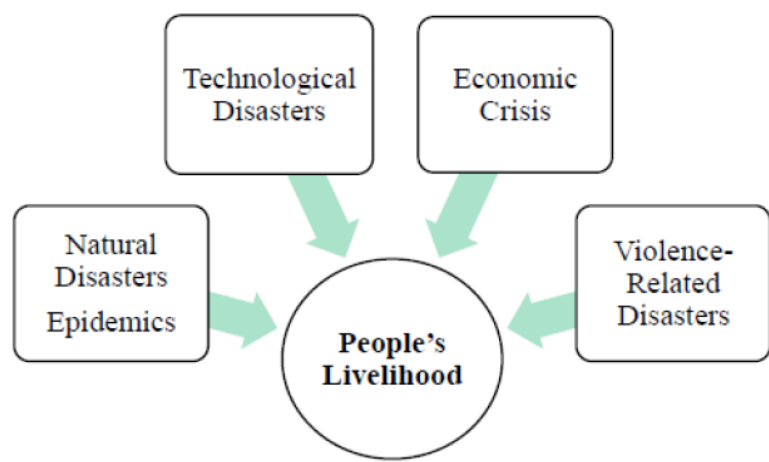
Source: Aldrich, Sawada, and Oum (2014) based on Hayami (2009)

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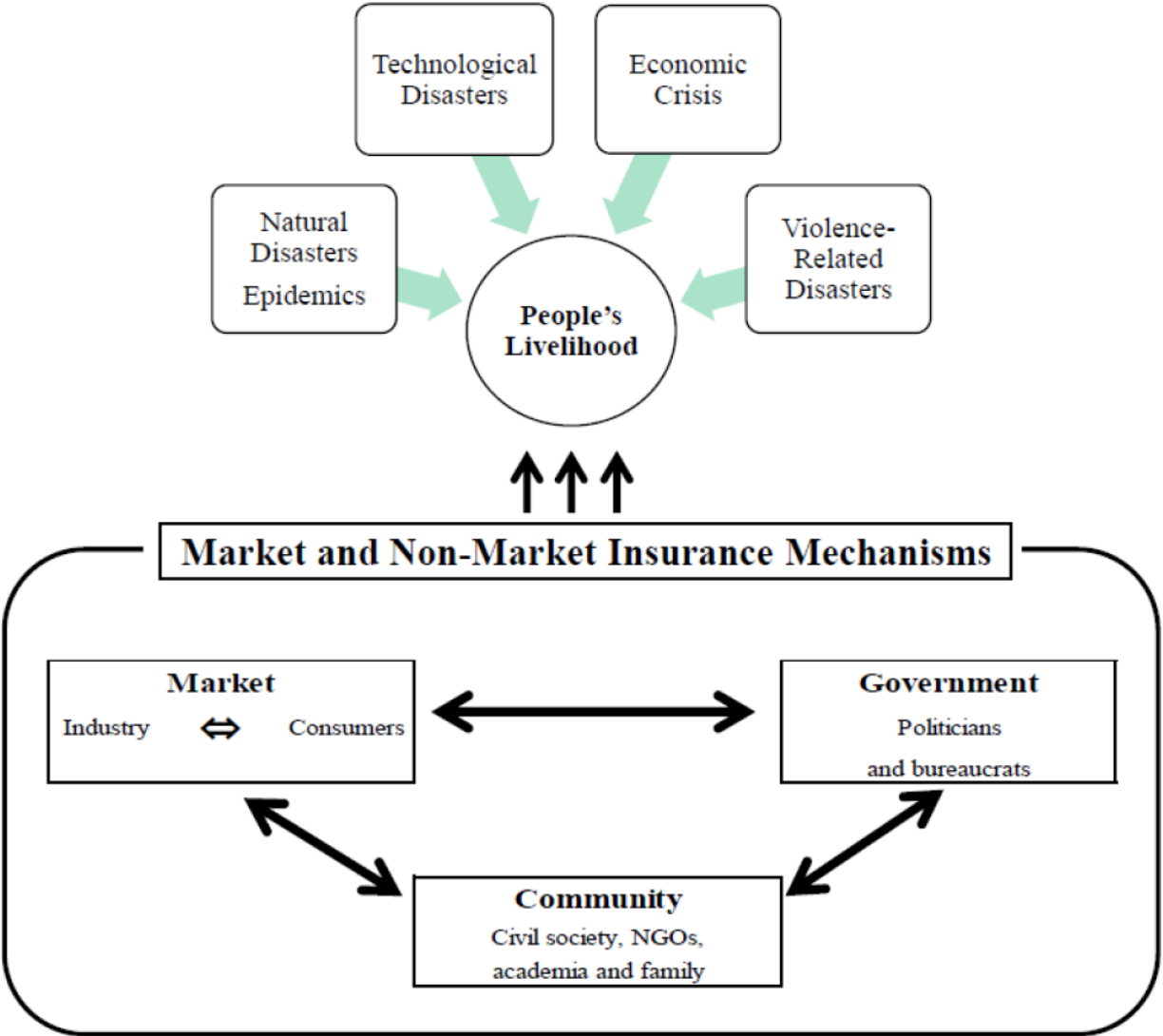
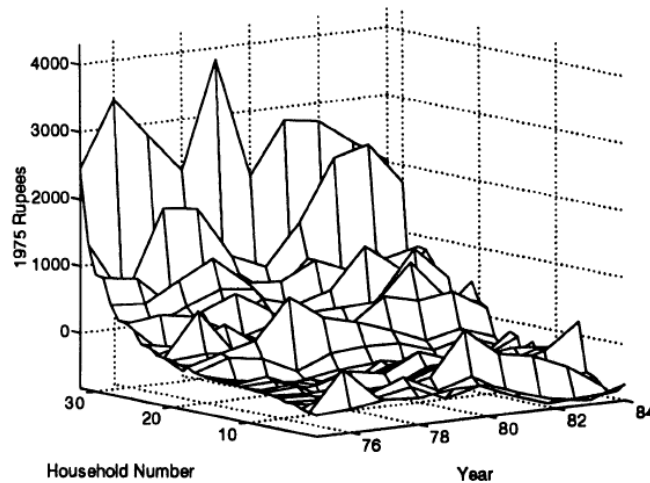Source: Aldrich, Sawada, and Oum (2014) based on Hayami (2009)

Consumption Risk Sharing

- Consumption risk sharing = mutual insurance:
  - Community-level informal insurance arrangements to cope with idiosyncratic shocks. But ineffective against aggregate (covariate) shocks
- A simple example of two persons & two state banana economy.
  - If there is no saving nor credit possible, i.e., there is no self-insurance available. Then, two households always face 50% of famine.
  - A strong incentive to form a consumption risk-sharing arrangements by these two households because under 50%-50% risk-sharing arrangement, both household can avoid risks of famines.
  - Carefully investigated by Townsend (1994), and Udry (1994)
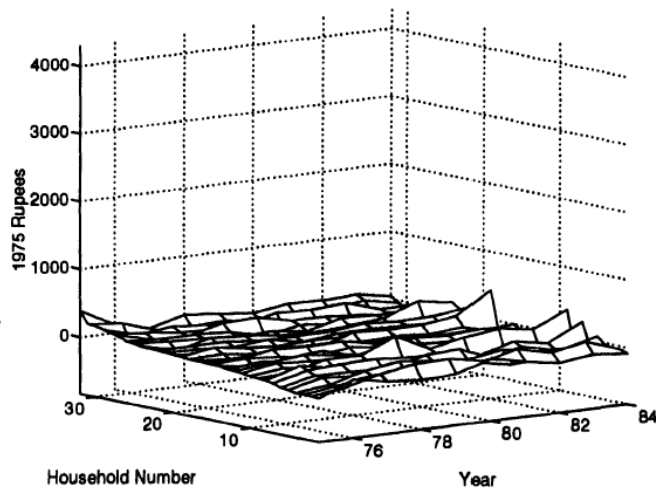
Banana Economy (poverty line=1.4)

State	Household A	Household B	50-50 Perfect risk sharing (yet, aggregate shock remains)
S1	1	3	2
S2	2	1	1.5

Consumption Risk Sharing

(a) Comovement of household incomes (deviation from village average) Aurepalle.

(a) Comovement of household consumptions (grain only) (deviation from village average) Aurepalle.

Townsend, Robert M. (1994), "Risk and Insurance in Village India," *Econometrica*, May 1994, v. 62, iss. 3, pp. 539-91:

- A village in India

- Income and consumption of each HH from 1975-1984

- Income deviate from the village average

- Consumption surprisingly comove

- Risk sharing must be functioning

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Consumption Risk Sharing

- Under full risk sharing arrangements, *idiosyncratic* income changes should be absorbed by all other members in the same insurance network
    - Individual: Townsend (1994); Mace (1991); Cochrane (1991); Udry (1994); Mazzocco and Saini (2012); and Ambrus et al., (2014)
    - International: Obstfeld (1994); Lewis (1996); Kose, Prasad, and Terrones (2009); and Flood, Marion, and Matsumoto (2012)

Global

East, Southeast, and South Asia

East and Southeast Asia

Vietnam

District

Commune
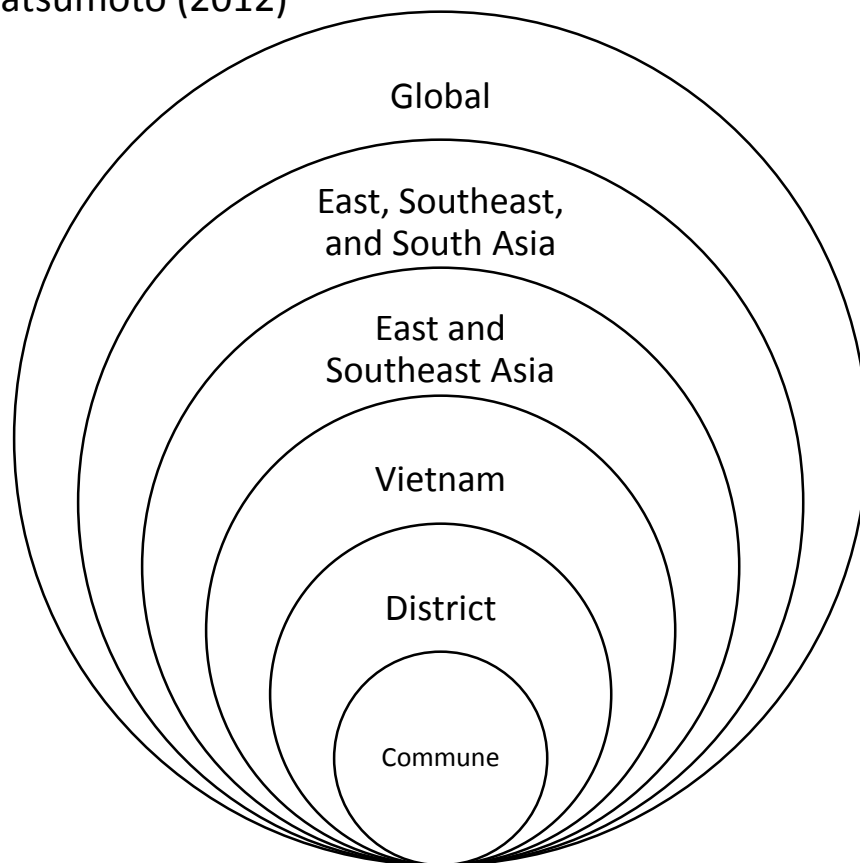
Consumption Risk Sharing

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(1)

$$\max_{\{c^T,c^N\}} \sum_{j=1}^{N} \lambda^j \left\{ \sum_{t=1}^{\infty} \sum_{s^t} \left(\frac{1}{1+\delta^j} \right)^t \pi\left(s^t\right) u\left[c_{jt}^T\left(s^t\right), c_{jt}^N\left(s^t\right)\right] \right\}$$

$$s.t. \sum_{j=1}^{N} c_{jt}^T\left(s^t\right) \leq \sum_{j=1}^{N} y_{jt}^T\left(s^t\right), \forall s^t,$$

$$c_{jt}^N\left(s^t\right) \leq y_{jt}^N\left(s^t\right), \forall s^t,$$

F.O.C.

$$\left(\frac{1}{1+\delta} \right)^t \lambda_j \, \pi(s_t) \frac{\partial u\left[c_j^T(s_t), c_j^N(s_t)\right]}{\partial c_j^T(s_t)} = \Lambda^J(s_t), \forall s_t,$$

Consumption Risk Sharing

- Under full risk sharing arrangements, idiosyncratic income changes should be absorbed by all other members in the same insurance network

- Under CRRA utility,

$$\gamma \Delta \log (c_{it}/c_{jt}) = \Delta \log (e_{ijt}),$$

$$\Delta \log c_{it} = a_1 \frac{1}{N} \sum_{j=1}^{N} \Delta \log c_{jt} + a_2 \frac{1}{N} \sum_{j=1}^{N} \Delta \log e_{ijt} + \zeta \Delta \log y_{it},$$

$$\Delta \log c_{it} = a_0 + \alpha_t + \alpha_i + \alpha_R \Delta \log REER_{it} + g \Delta \log y_{it} + u_{it},$$

$\zeta = 0$ and $g=0$ corresponds to the full consumption risk sharing hypothesis

Consumption Risk Sharing

- Data:

  ✓ 167 nations from 1972 to 2011

  ✓ Natural hazard triggered disasters and technological disasters: Emergency Events Database (EM-DAT of CRED (2015)

  ✓ Economic crisis: Reinhart and Rogoff (2009, 2010) and IMF (2015), and

  ✓ Violence related disasters:
    ✓ Global Terrorism Database (GTD) (National Consortium for the Study of Terrorism and Responses to Terrorism, 2015)
    ✓ Correlates of War (COW) database (Sarkees, Meredith Reid and Frank Wayman, 2010).

  ✓ Macro data from PTW, WDI, and IFS

Table 3
A Test of International Consumption Risk Sharing
Independent Variable: A first difference of log per capita consumption, $\Delta \log c_{it}$

|	(I)	(II)	(III)	(IV)	(V)	(VI)
Estimation method	FE	FE	FE	IV-FE	IV-FE	IV-FE
Country coverage	Global	East, Southeast, and South Asia	East and Southeast Asia	Global	East, Southeast, and South Asia	East and Southeast Asia
Independent variable						
$\Delta \log y_{it}$				0.774***	0.614***	0.523***
				(12.94)	(5.48)	(4.43)
# of natural disasters	-0.000226	0.000106	-0.000912			
# of technological disasters	0.00110	0.000815	0.000880			
# of economics crisis	-0.00595**	-0.000928	0.00534			
# of violence-related disasters	-0.00499**	-0.00143	-0.000314			
# of lag natural disasters	-0.000493	-0.00140**	-0.00111			
# of lag technological disasters	0.000778	0.00000651	-0.000369			
# of lag economics crisis	0.00165	-0.00890	-0.0145*			
# of lag violence-related disasters	0.00104	-0.00308***	-0.00235			
$\Delta \log REER_{it}$	0.00432	-0.0548***	-0.0429	0.0157	-0.0149	-0.0544
	(0.11)	(-3.03)	(-0.72)	(1.06)	(-0.43)	(-0.68)
Constant term	0.0463***	0.0184	0.0459	0.00534	0.00493	0.0148
N	6,075	819	507	6,075	819	507
adj. R-sq	0.033	0.029	0.014			

Note) t statistics in parentheses. Statistical significance is shown by: * $p<0.10$, ** $p<0.05$, and *** $p<0.01$. Other control variables whose estimated coefficients are not shown is: data missing dummies for disaster variables and REER, year dummies, and country fixed effects.

For the specifications (III), (IV), and (V), the following variables are used as identifying instrumental variables: number of natural disasters, technological disasters, economics crisis, and violence-related disasters as well as one year lagged variables of these variables.

Risk Sharing in Vietnam

- Sawada, Nakata, and Kotera (2017) *World Development*

- We combine two data sets:
  - ✓ 2006 VHLSS data
  - ✓ 2008 RIETI-CAP data
    (A resurvey of subsample 2,000 HHs of VHLSS 2006 households in 4 provinces)
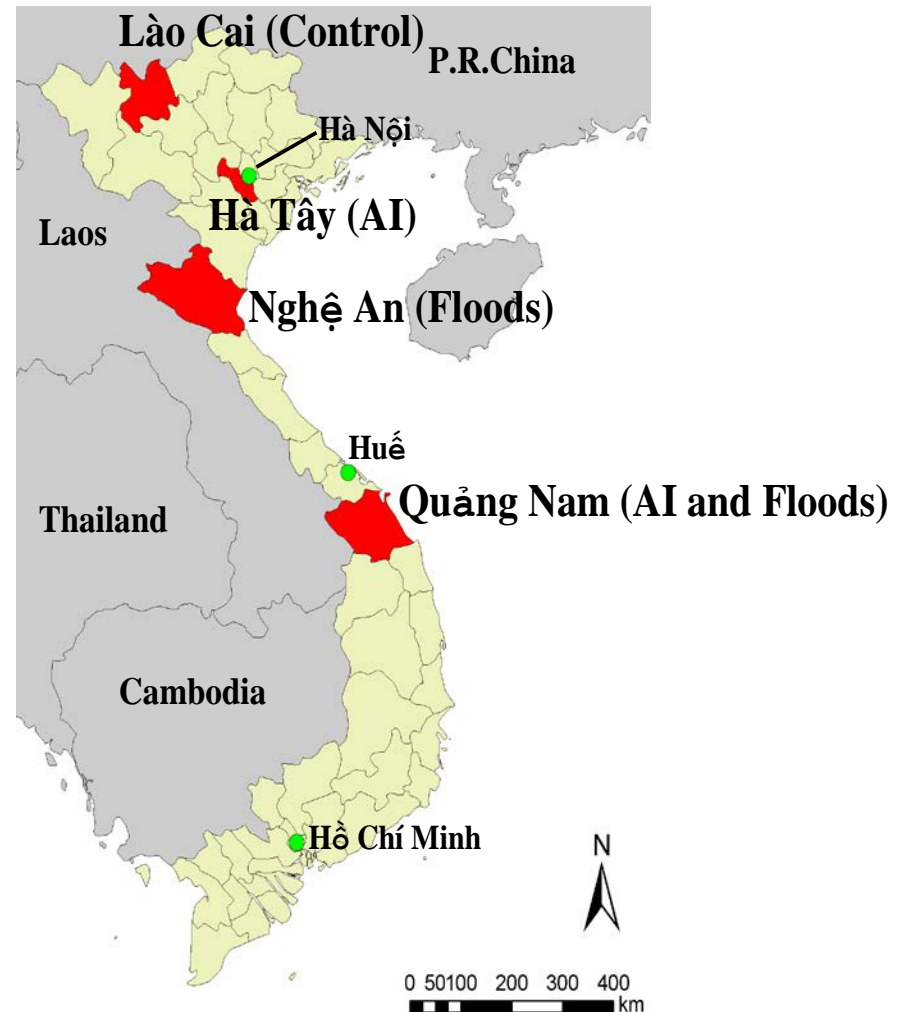
Risk Sharing in Vietnam

Table 4
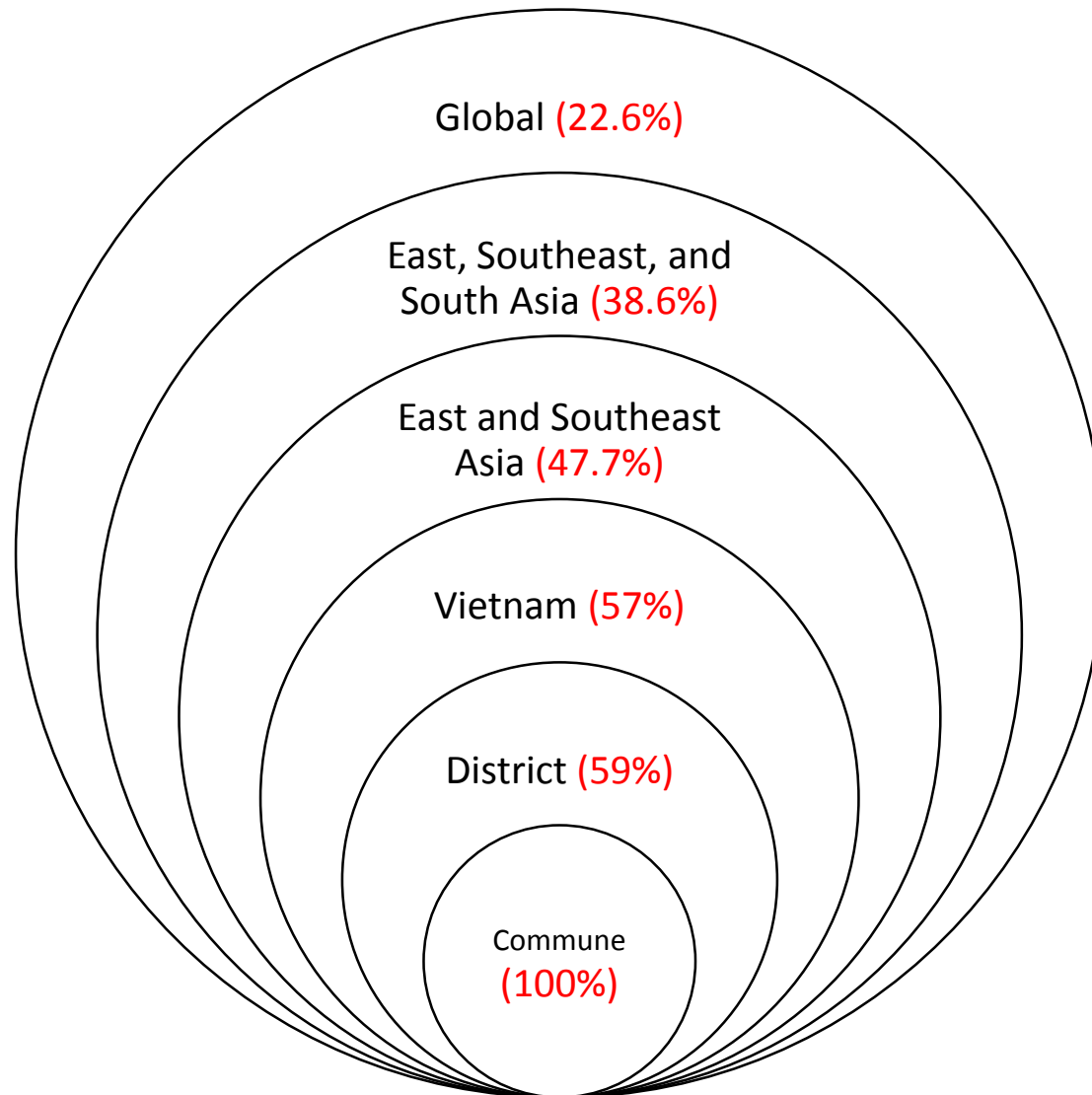**A Test of Within Country Consumption Risk Sharing**
Independent Variable: A first difference of log per capita consumption, $\Delta \log c_{it}$

Specification	(I)	(II)	(III)
Method	IV	IV	IV
District fixed effect	No	Yes	No
Commune fixed effect	No	No	Yes
Independent variable			
$\Delta \log y_{it}$	0.430***	0.409**	0.181
	(4.300)	(2.509)	(1.240)
Number of observations	1,813	1,813	1,812
Number of districts	-	34	-
Number of communes	-	-	132

Note) There results are extracted from Sawada, Nakata, and Kotera (2011). Number of observations is 1,813, number of districts is 34, and number of communes is 132. t statistics are shown in in parentheses. Statistical significance is shown by: * $p<0.10$, ** $p<0.05$, and *** $p<0.01$. We use the following variables as instrumental variables: total number of landslides, typhoons, floods, droughts, epidemics and other disasters in 2006 and 2007, value of real estate in 2006, value of capital assets in 2006, and household size in 2006.
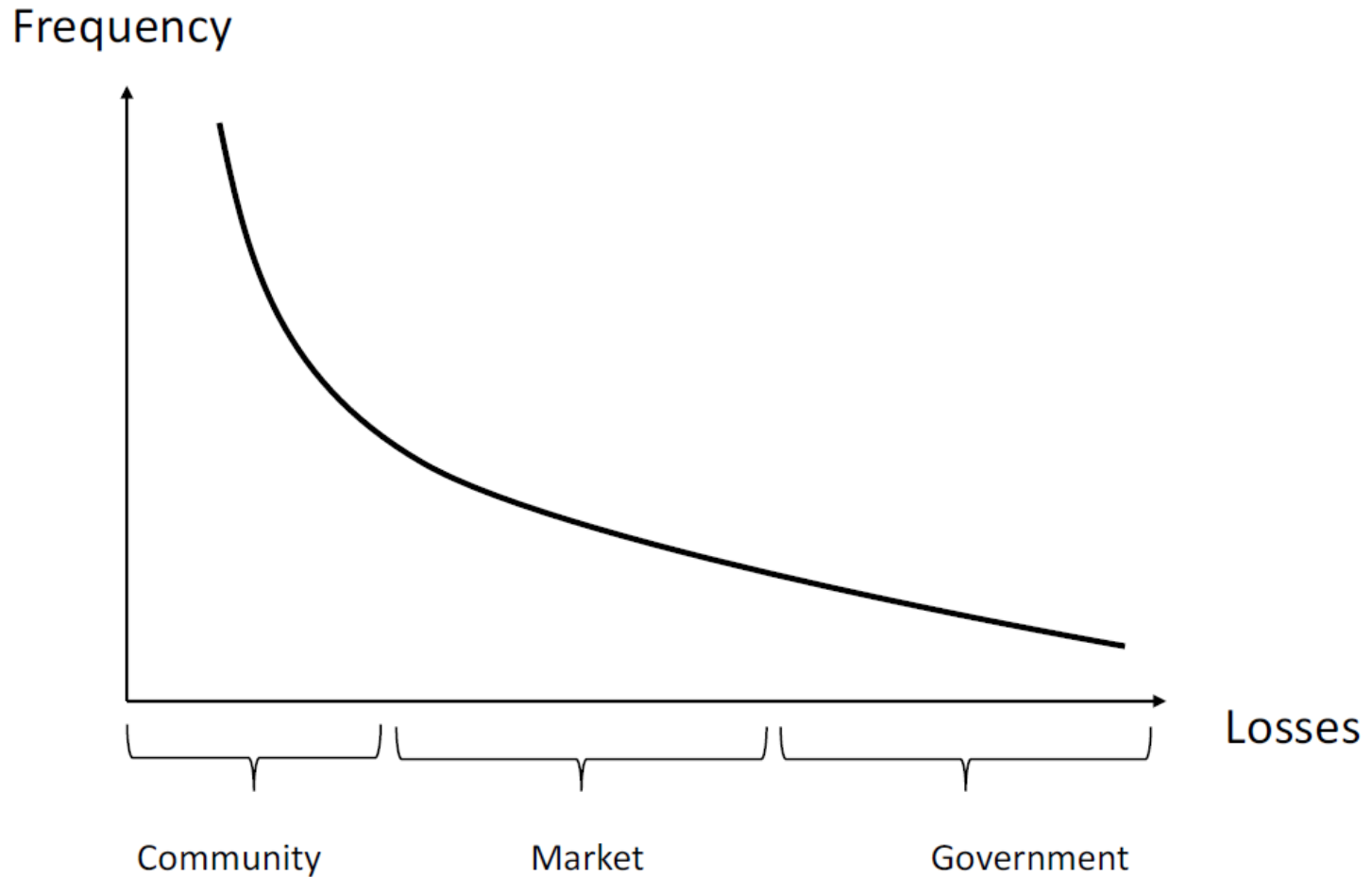
Consumption Risk Sharing

- Overall Insurability of *Idiosyncratic* shocks

Global (22.6%)

East, Southeast, and South Asia (38.6%)

East and Southeast Asia (47.7%)

Vietnam (57%)

District (59%)

Commune (100%)

Layers of Insurance Mechanisms

Figure 5
Layers of Community, Market, and Government Insurance

Insurance Channels

- Separable CARA utility function (Fafchamps and Lund, 2003):

(5) $$c_{it} + c_{it}^d = y_{it} + p_{it}^r + b_{it} + p_{it}^b + \Delta w_{it} - \Delta d_{it} + F_{it},$$

(6) $$-c_{it}^d + b_{it} + \Delta w_{it} + F_{it} + p_{it}^r + p_t^b = -y_{it} + \Delta d_{it} + \frac{1}{N}\sum_{j=1}^{N} c_{jt} + (1/\sigma)\left(\ln \lambda^i - \frac{1}{N}\sum_{j=1}^{N}\ln \lambda^j\right).$$

Risk-coping channels to diversify the idiosyncratic disaster risk
and to maintain smooth consumption profile:
- consumption cut on durable (or luxury) goods $(-c^d)$
- borrowing (b)
- dis-saving(Δw)
- additional labor income (F)
- private transfers (p^r) & public transfers (p^b)

- damages caused by a disaster, Δd.

Insurance Channels

Summary of empirical results on individual or household ex-post risk coping strategies against natural disasters

Study	Disaster type	Damages	Risk coping strategies					
			Reallocation of consumption	Borrowing	Dissaving	Labor adjustments	Income transfers	Other
Horioka et al. (2002)	Overall unexpected events in Japan	Sickness, accidents, disasters, unemployment, bankruptcy	—	Limited	Effective	—	Private transfers effective	Insurance
Sawada and Shimizutani (2008, 2011)	Hanshin Awaji Earthquake in Japan	Houses	Effective	Effective	Ineffective	—	Limited	—
		Assets	Effective	Ineffective	Effective	—	Ineffective	—
Yang (2008)	Hurricanes (global level)	Hurricane damages	—	Ineffective	—	—	Effective (private, ODA)	—
Shoji (2010)	Floods in Bangladesh	Assets	Effective	Effective	—	—	—	—
Gray and Mueller (2012)	Floods and crop failures in Bangladesh	Floods and crop failures	—	—	—	—	—	Migration
Cameron and Shah (2015)	Earthquakes and floods in Indonesia	Risk tolerance	—	Effective (ROSCA)	Effective (ROSCA)	Effective	Effective	Less new business or technology
Heltberg et al. (2015)	Natural and manmade disasters in Afghanistan, China, Lao PDR, Tajikistan, Uzbekistan, and Vietnam	Disasters, employment & health shock, asset & crop loss, household breakup, crime	Effective	Effective	Effective	Effective	Effective	
Gignoux and Menendez (2016)	Earthquakes in Indonesia	Assets and income	Effective	—	Effective	—	Effective	—
Park and Wang (2016)	Sichuan earthquake in China	Assets and income	—	Effective	—	Ineffective	Public transfers effective	—
Takasaki (2017, 2018)	Cyclone Ami in January 2003 (43 villages in Cakaudrove province)	Assets, income, and health	—	—	—	Effective	Ineffective	Risky investments

Note: — indicates that there is no explicit analysis in the study.

Role of ADB

- In 1987, ADB became the 1st regional MDG to adopt disaster and emergency assistance policy

- ADB's Strategy 2020 mainstreamed DRM

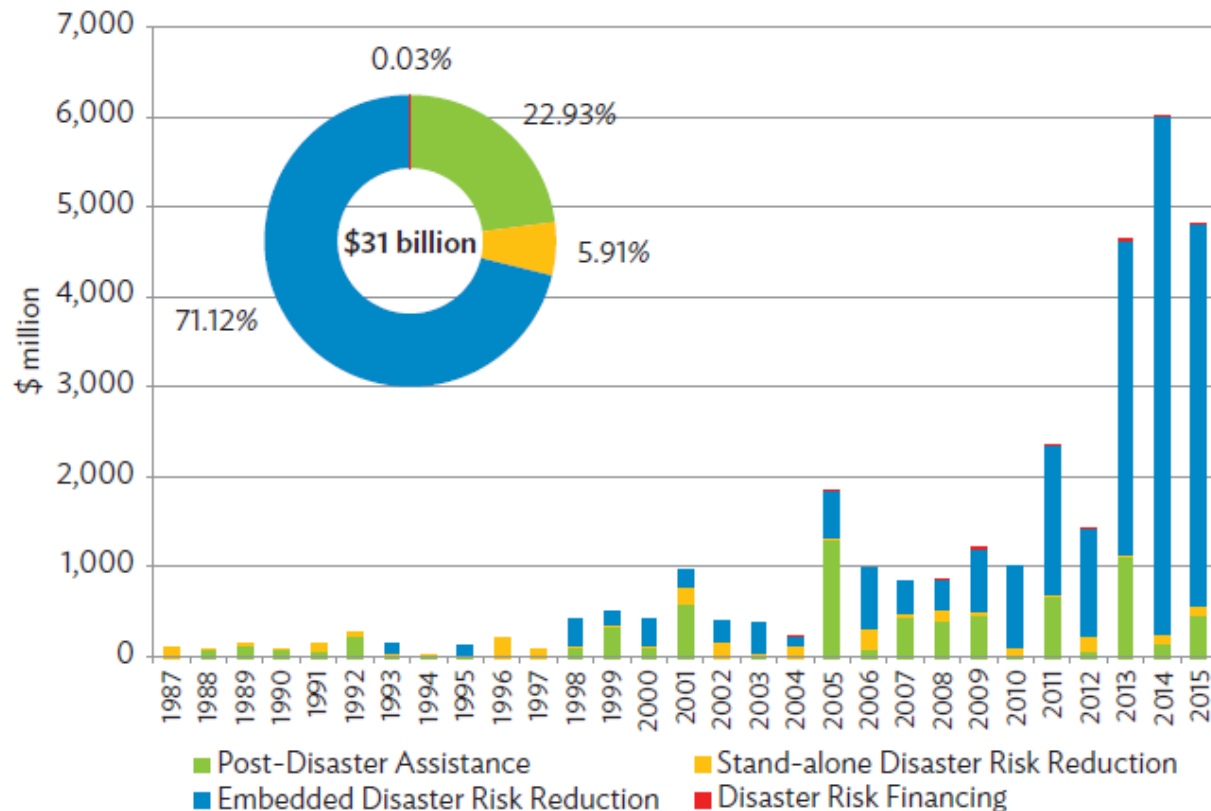- Operational Plan for Integrated Disaster Risk Management 2014-2020:

Figure 11: ADB's Integrated Disaster Risk Management Approach
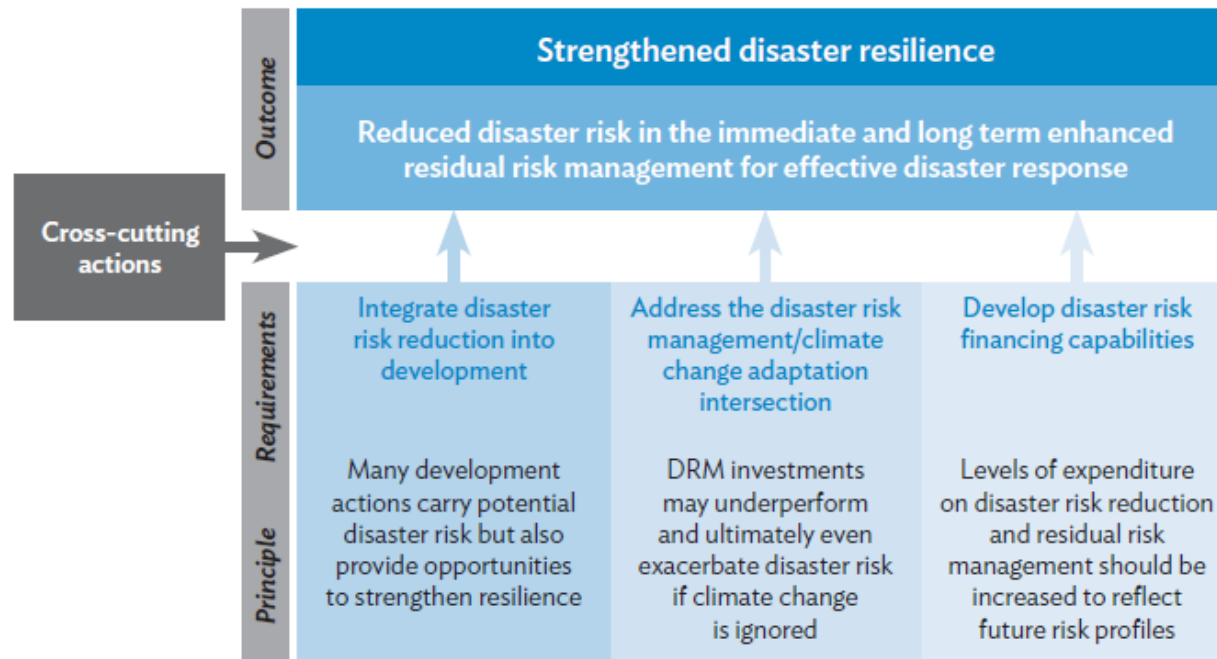
Source: ADB.

Role of ADB

- DRM and DRM related projects are increasing

Figure 12: ADB Disaster Risk Management Operations, 1987–2014

Source: ADB.

Remarks

- Insurability improves within a smaller network but it's difficult to achieve encompassing insurance
- Solutions for market failures:
  - Better national insurance schemes such as mandatory or subsidized market-based disaster insurance programs (Kunreuther & Pauly, 2006; Kellenberg and Mobarak, 2011)
  - Innovative insurance programs such as index insurance products and other microfinance programs can be carefully designed and adopted against disasters (Mobarak and Rosenzweig, 2012)
  - Integrated DRM (mitigation, adaptation, and financing) by MDBs such as ADB
- Multi-country risk pooling mechanisms
  - CCRIF and PCRAFI
  - Emergency financial facilities provided by MDBs such as ADB
- A global encompassing system of pooling the risks of the four types of disasters?