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.

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).
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.
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)


1. Disasters
2. Direct Losses + Lack of market and non-market insurance
3. Making people more risk-averse or present-biased
4. Deterioration of Growth and Poverty Reduction
Disasters as a Development Challenge in Asia

Figure 1
Direct and Indirect Impacts of Disasters

- Direct Losses + Lack of market and non-market insurance
- Making people more risk-averse or present-biased
- Deterioration of Growth and Poverty Reduction
  - 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)
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)
The Market, State, and Community Trinity

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)

<table>
<thead>
<tr>
<th>State</th>
<th>Household A</th>
<th>Household B</th>
<th>50-50 Perfect risk sharing (yet, aggregate shock remains)</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1</td>
<td>1</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>S2</td>
<td>2</td>
<td>1</td>
<td>1.5</td>
</tr>
</tbody>
</table>
Consumption Risk Sharing


- 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

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

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

**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)

\[
\max \{c^t, c^N \} \sum_{j=1}^{N} \lambda \left\{ \sum_{t=1}^{\infty} \sum_{s^t} \left( \frac{1}{1 + \delta^j} \right)^t \pi(s^t) u \left[ c^T_{jt}(s^t), c^N_{jt}(s^t) \right] \right\}
\]

s.t. \[\sum_{j=1}^{N} c^T_{jt}(s^t) \leq \sum_{j=1}^{N} y^T_{jt}(s^t), \forall s^t,\]

\[c^N_{jt}(s^t) \leq y^N_{jt}(s^t), \forall s^t,\]

(1)

\[
\left( \frac{1}{1 + \delta} \right)^t \lambda_j \pi(s^t) \frac{\partial u \left[ c^T_{j}(s^t), c^N_{j}(s^t) \right]}{\partial c^T_{j}(s^t)} = \Lambda^J(s^t), \forall s^t,
\]

F.O.C.
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,

\[ \gamma \Delta \log \left( \frac{c_{it}}{c_{jt}} \right) = \Delta \log (e_{ijt}), \]

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

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

\( \zeta = 0 \) and \( g = 0 \) corresponds to the full consumption risk sharing hypothesis
Consumption Risk Sharing

• Data:

✓ 167 nations from 1972 to 2011


✓ 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, $\Delta \log c_{it}$

<table>
<thead>
<tr>
<th>Estimation method</th>
<th>(I)</th>
<th>(II)</th>
<th>(III)</th>
<th>(IV)</th>
<th>(V)</th>
<th>(VI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Country coverage</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Global</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>East, Southeast, and South Asia</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>East and Southeast Asia</td>
<td>0.774***</td>
<td>0.614***</td>
<td>0.523***</td>
<td>(12.94)</td>
<td>(5.48)</td>
<td>(4.43)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Independent variable</th>
<th>(I)</th>
<th>(II)</th>
<th>(III)</th>
<th>(IV)</th>
<th>(V)</th>
<th>(VI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\Delta \log y_{it}$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td># of natural disasters</td>
<td>-0.000226</td>
<td>0.000106</td>
<td>-0.000912</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td># of technological disasters</td>
<td>0.00110</td>
<td>0.000815</td>
<td>0.000880</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td># of economics crisis</td>
<td>-0.00595**</td>
<td>-0.000928</td>
<td>0.00534</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td># of violence-related disasters</td>
<td>-0.00499**</td>
<td>-0.00143</td>
<td>-0.000314</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td># of lag natural disasters</td>
<td>-0.000493</td>
<td>-0.00140**</td>
<td>-0.00111</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td># of lag technological disasters</td>
<td>0.000778</td>
<td>0.00000651</td>
<td>-0.000369</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td># of lag economics crisis</td>
<td>0.00165</td>
<td>-0.00890</td>
<td>-0.0145*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td># of lag violence-related disasters</td>
<td>0.00104</td>
<td>-0.00308***</td>
<td>-0.00235</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta \log REER_{it}$</td>
<td>0.00432</td>
<td>-0.0548***</td>
<td>-0.0429</td>
<td>0.0157</td>
<td>-0.0149</td>
<td>-0.0544</td>
</tr>
<tr>
<td>(0.11)</td>
<td>(-3.03)</td>
<td>(-0.72)</td>
<td>(1.06)</td>
<td>(-0.43)</td>
<td>(-0.68)</td>
<td></td>
</tr>
<tr>
<td>Constant term</td>
<td>0.0463***</td>
<td>0.0184</td>
<td>0.0459</td>
<td>0.00534</td>
<td>0.00493</td>
<td>0.0148</td>
</tr>
<tr>
<td>N</td>
<td>6,075</td>
<td>819</td>
<td>507</td>
<td>6,075</td>
<td>819</td>
<td>507</td>
</tr>
<tr>
<td>adj. R-sq</td>
<td>0.033</td>
<td>0.029</td>
<td>0.014</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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, $\Delta \log c_{it}$

<table>
<thead>
<tr>
<th>Specification</th>
<th>(I)</th>
<th>(II)</th>
<th>(III)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Method</td>
<td>IV</td>
<td>IV</td>
<td>IV</td>
</tr>
<tr>
<td>District fixed effect</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Commune fixed effect</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>$\Delta \log y_{it}$</td>
<td>0.430***</td>
<td>0.409**</td>
<td>0.181</td>
</tr>
<tr>
<td></td>
<td>(4.300)</td>
<td>(2.509)</td>
<td>(1.240)</td>
</tr>
</tbody>
</table>

Number of observations  | 1,813  | 1,813  | 1,812   |
Number of districts     | -      | 34     | -       |
Number of communes      | -      | -      | 132     |

Note: These 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 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):

\begin{align}
    c_{it} + c_{it}^{d} &= y_{it} + p_{it}^{r} + b_{it} + p_{it}^{b} + \Delta w_{it} - \Delta d_{it} + F_{it}, \\
    -c_{it}^{d} + b_{it} + \Delta w_{it} + F_{it} + p_{it}^{r} + p_{it}^{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).
\end{align}

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

<table>
<thead>
<tr>
<th>Study</th>
<th>Disaster type</th>
<th>Damages</th>
<th>Reallocation of consumption</th>
<th>Borrowing</th>
<th>Dissaving</th>
<th>Labor adjustments</th>
<th>Income transfers</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Horioka et al. (2002)</td>
<td>Overall unexpected events in Japan</td>
<td>Sickness, accidents, disasters, unemployment, bankruptcy</td>
<td>—</td>
<td>Limited</td>
<td>Effective</td>
<td>—</td>
<td>Private transfers</td>
<td>Insurance</td>
</tr>
<tr>
<td>Shoji (2010)</td>
<td>Floods in Bangladesh</td>
<td>Assets</td>
<td>Effective</td>
<td>Effective</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Cameron and Shah (2015)</td>
<td>Earthquakes and floods in Indonesia</td>
<td>Risk tolerance</td>
<td>—</td>
<td>Effective (ROSCA)</td>
<td>Effective (ROSCA)</td>
<td>—</td>
<td>Effective</td>
<td>Less new business or technology</td>
</tr>
<tr>
<td>Heltberg et al. (2015)</td>
<td>Natural and manmade disasters in Afghanistan, China, Lao PDR, Tajikistan, Uzbekistan, and Vietnam</td>
<td>Disasters, employment &amp; health shock, asset &amp; crop loss, household breakup, crime</td>
<td>Effective</td>
<td>Effective</td>
<td>Effective</td>
<td>Effective</td>
<td>Effective</td>
<td></td>
</tr>
<tr>
<td>Gignoux and Menendez (2016)</td>
<td>Earthquakes in Indonesia</td>
<td>Assets and income</td>
<td>Effective</td>
<td>—</td>
<td>Effective</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>
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
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?