Economic Resilience: Methodologies for Quantitative Measures

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Total reported economic losses per year, with major events highlighted 1998-2017

ソース: https://www.preventionweb.net/files/61119_credeconomiclosses.pdf
Case of the Great East Japan Earthquake (2011)

Index and Industrial Production

<table>
<thead>
<tr>
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<th>Severely Damaged Area</th>
<th>Outside the Severely Damaged Area</th>
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<tbody>
<tr>
<td>January, 2011</td>
<td>102.4</td>
<td>100.9</td>
</tr>
<tr>
<td>February, 2011</td>
<td>103.6</td>
<td>101.8</td>
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<tr>
<td>March, 2011</td>
<td>87.5</td>
<td>99.3</td>
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<tr>
<td>April, 2011</td>
<td>89.5</td>
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<tr>
<td>May, 2011</td>
<td>70.4</td>
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<td>June, 2011</td>
<td>86.3</td>
<td>99.7</td>
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<td>July, 2011</td>
<td>97.8</td>
<td>100.9</td>
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<tr>
<td>August, 2011</td>
<td>92.8</td>
<td>97.8</td>
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<tr>
<td>September, 2011</td>
<td>99.2</td>
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<tr>
<td>October, 2011</td>
<td>97.3</td>
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<tr>
<td>November, 2011</td>
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<tr>
<td>December, 2011</td>
<td>98.5</td>
<td>99.9</td>
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</tbody>
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Approach for (short-term) economic loss estimation

- Hazard (Ground motion, Tsunami)
- Production Capacity Losses (supply shock)
- Interregional and intersectoral impacts (incl. supply-chain damages)

Functional Fragility Curve

Monetary term -> production ability

Nakano, 2011

Lifeline Resilience Factor

Kajitani and Tatano, 2005
Earthquake spectra, 2009
Consistency

Non-Manufacturing

Manufacturing

Recovery of Production Capacity

Based on the Survey by Nakano et al. 2011 (Manufacturing 700, Non-Manufacturing 1300)
Example of Production Capacity Loss Estimation (Transport. Manf. in Fukushima)

Consistent with Observed Production (same to many sectors located at severely damaged prefectures)

Spatial CGE (Computable General Equilibrium) Model for Disaster Analysis

What types of assumptions hold for real allocation of goods?
⇒ Many extensions for disaster impact analysis
Findings for Building Disaster Impact Assessment Model (Model Closures)

- Putty-Clay assumptions in the damaged regions
  - Critical factor damage (labor or capital) determines value-added function: Cobb-Douglas→Leontief
  - Restriction of capital and labor movements among regions and sectors
  - Setting the lower elasticity of substitution parameters for the interregional trades (especially for automobiles, precise machinery)
- the downward price rigidity in the labor market (labor is not fully utilized if demand decrease.)
- no change of nominal income among regions (rigid consumption assumption)

Basically, price is not real but just signal and used only for the scarce goods allocation.

Production Structures
Estimated VS Observed Productions

elasticity of substitution parameters for the interregional trades:

Automobile parts: 0 (Leontief)
Other sectors: 1/3 times ordinary
Conclusions

• Functionality is a key to connect the physical damages to (socio-)economic models.
• Economic models themselves should be arranged/extended for the disaster impact analysis
• Flow losses (income losses) is an indicator of recovery status (one of resilience measures) while stock losses (property losses) are not time dependent measures.
Applications and Challenges

Applications to
• Benefit of countermeasures
• Immediate economic loss estimation and responses
• Parametric cat bond/insurance

Research challenge exists in
• Applicability to Different Types of Disasters
• Dynamic/Long-run model