

Economic Resilience: Methodologies for Quantitative Measures

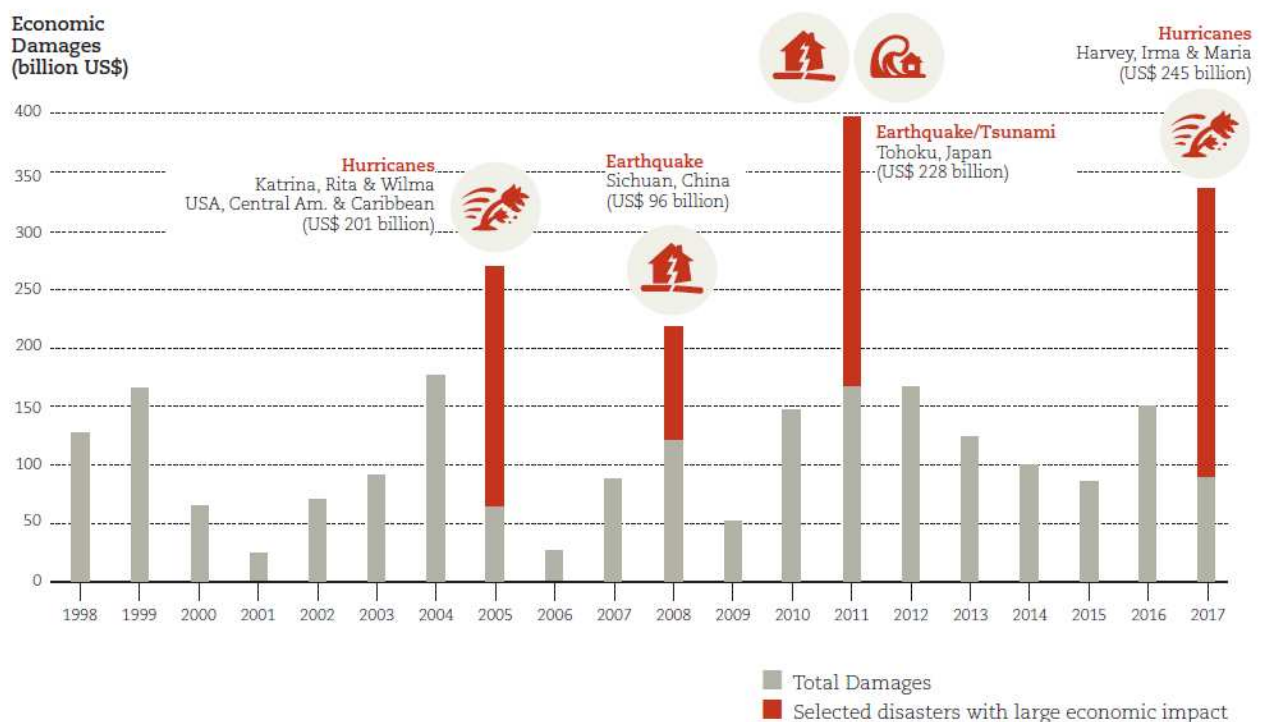
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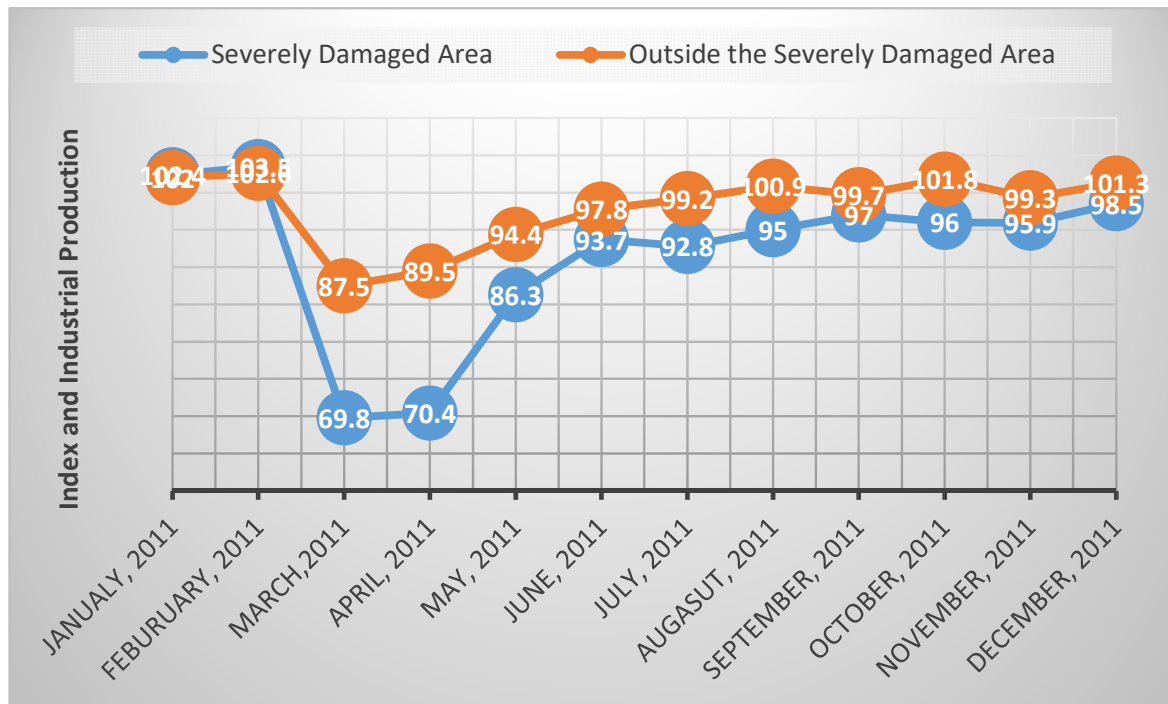
Hirokazu Tatano

Disaster Prevention Research Institute, Kyoto University

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

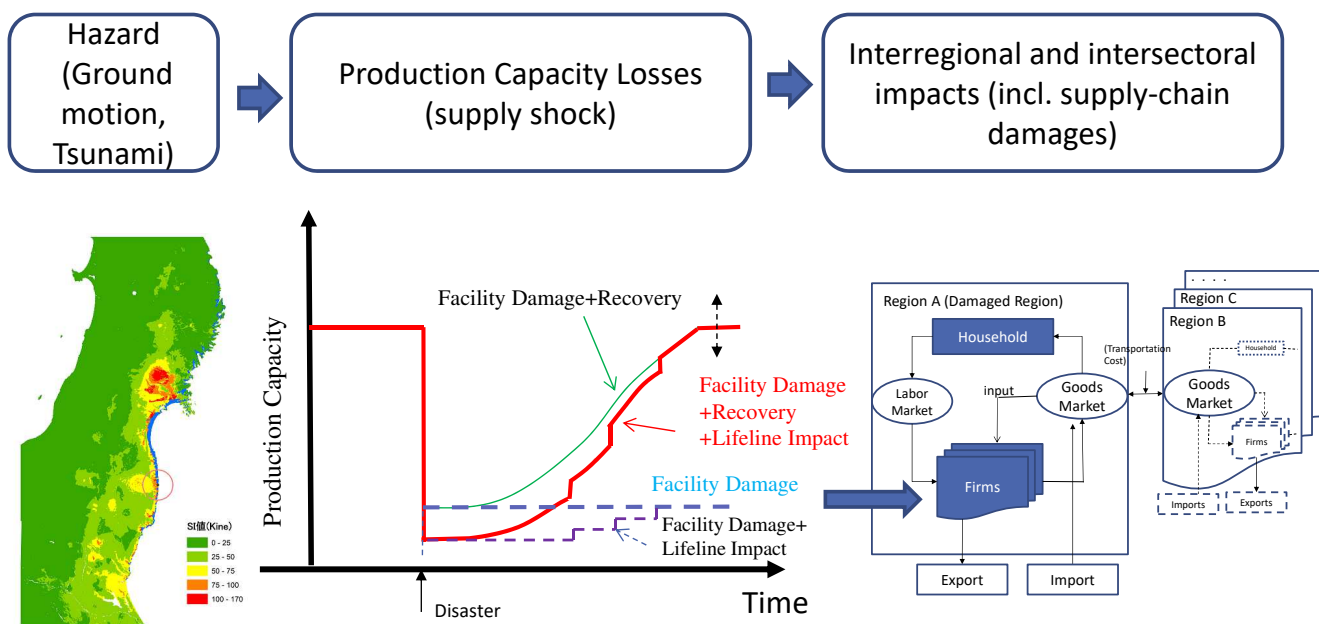


Case of the Great East Japan Earthquake (2011)



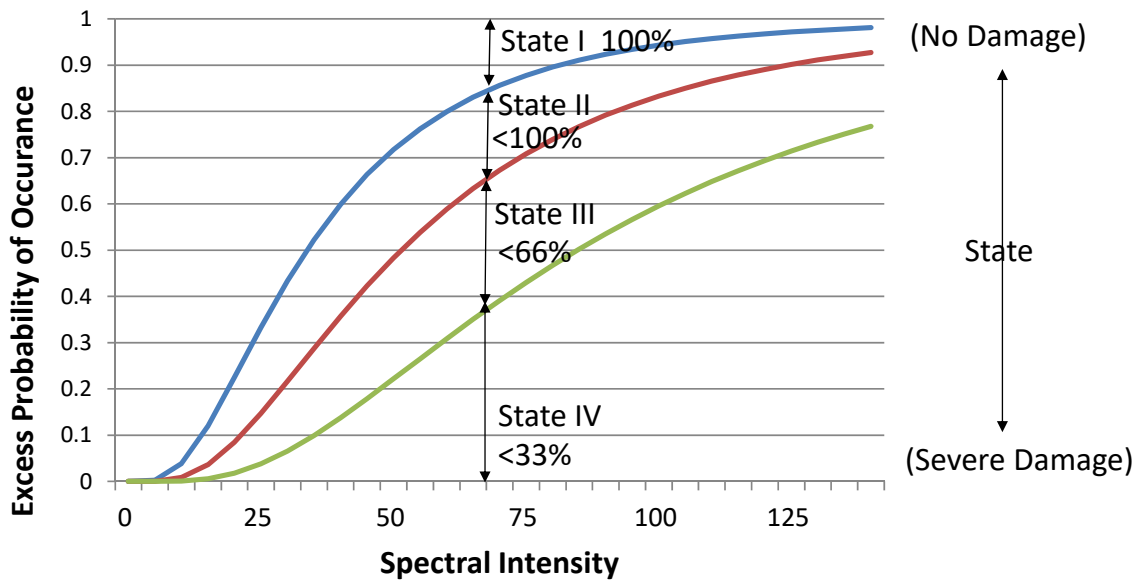
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Approach for (short-term) economic loss estimation



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Functional Fragility Curve

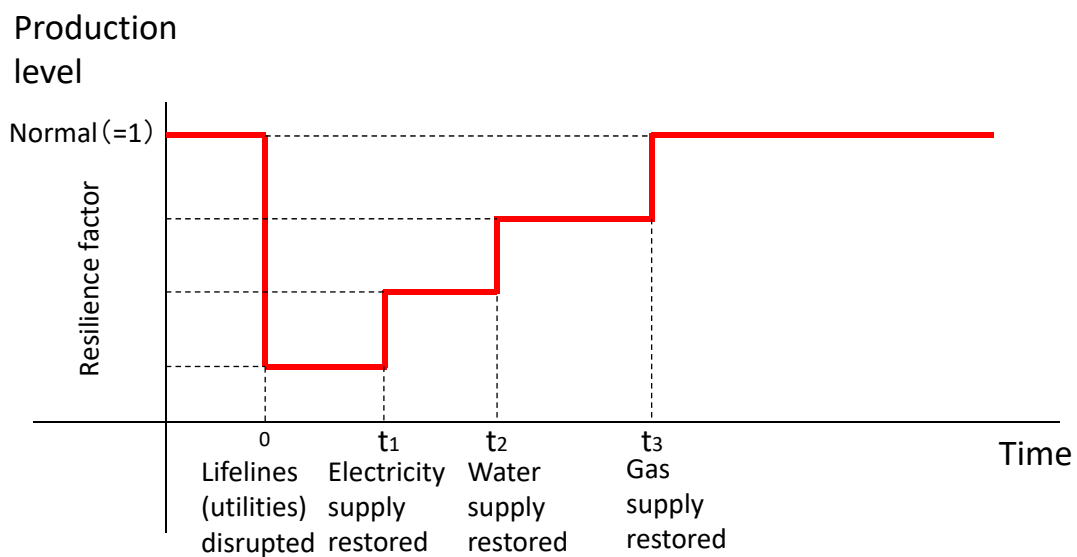


Monetary term -> production ability

Nakano, 2011

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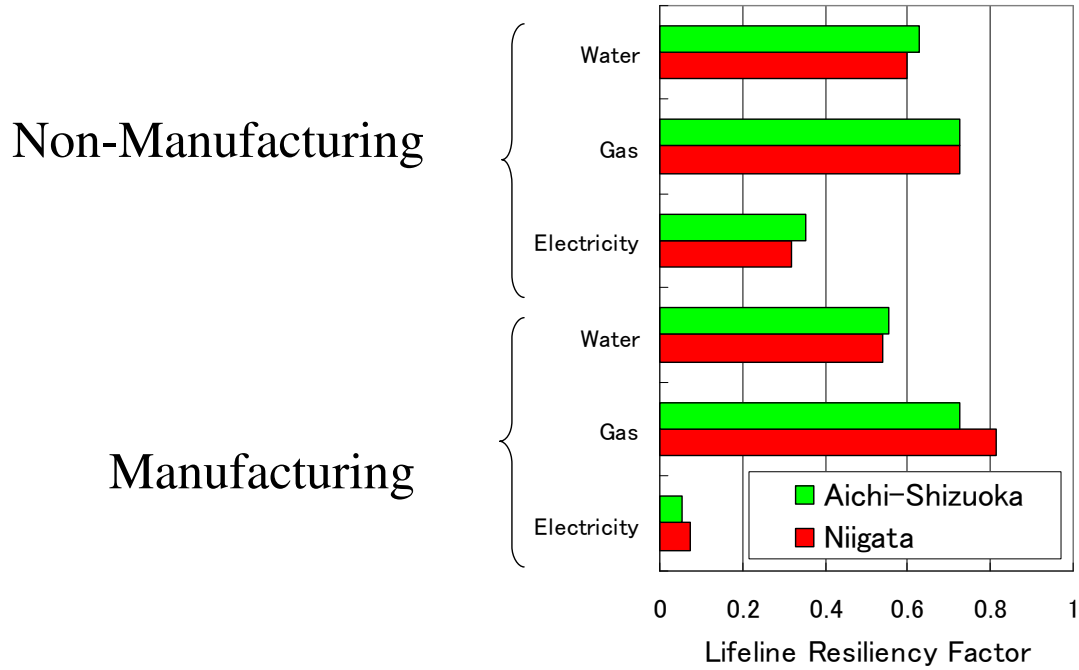
Lifeline Resilience Factor



Kajitani and Tatano, 2005
Earthquake spectra, 2009

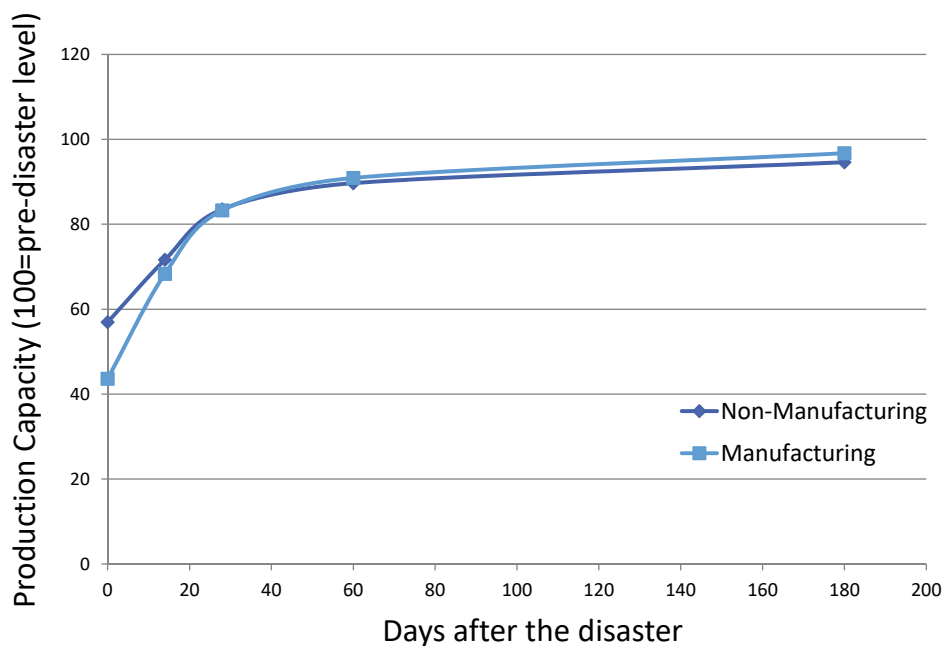
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Consistency



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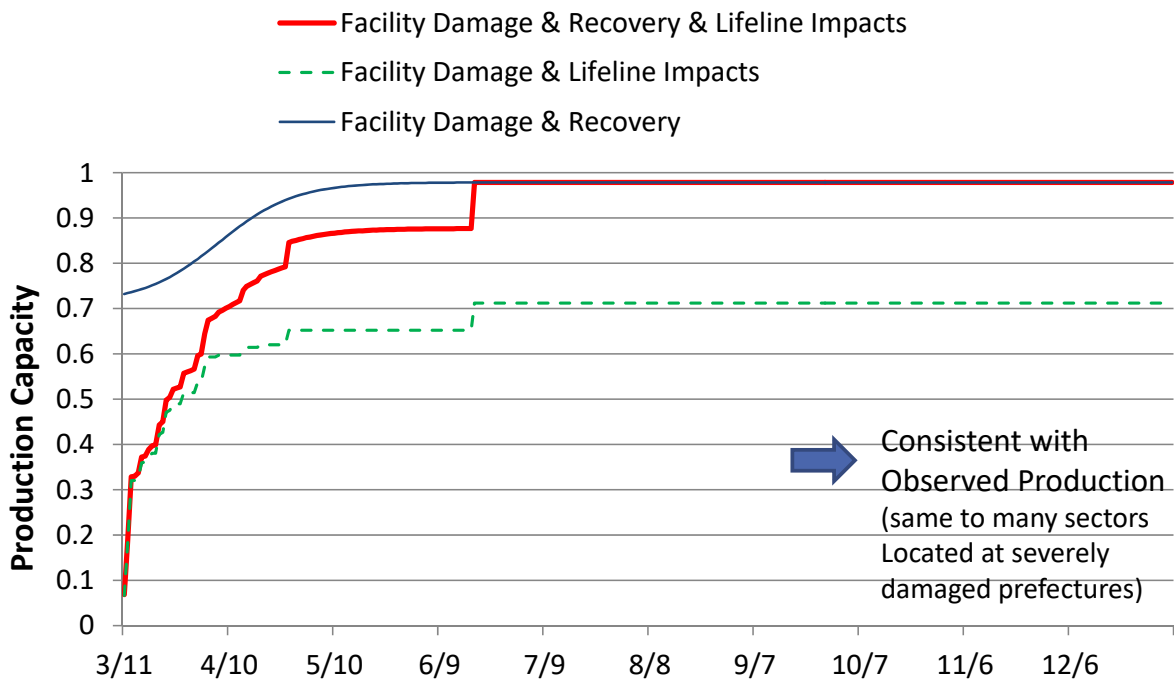
Recovery of Production Capacity



Based on the Survey by Nakano et al. 2011 (Manufacturing 700, Non-Manufacturing 1300)

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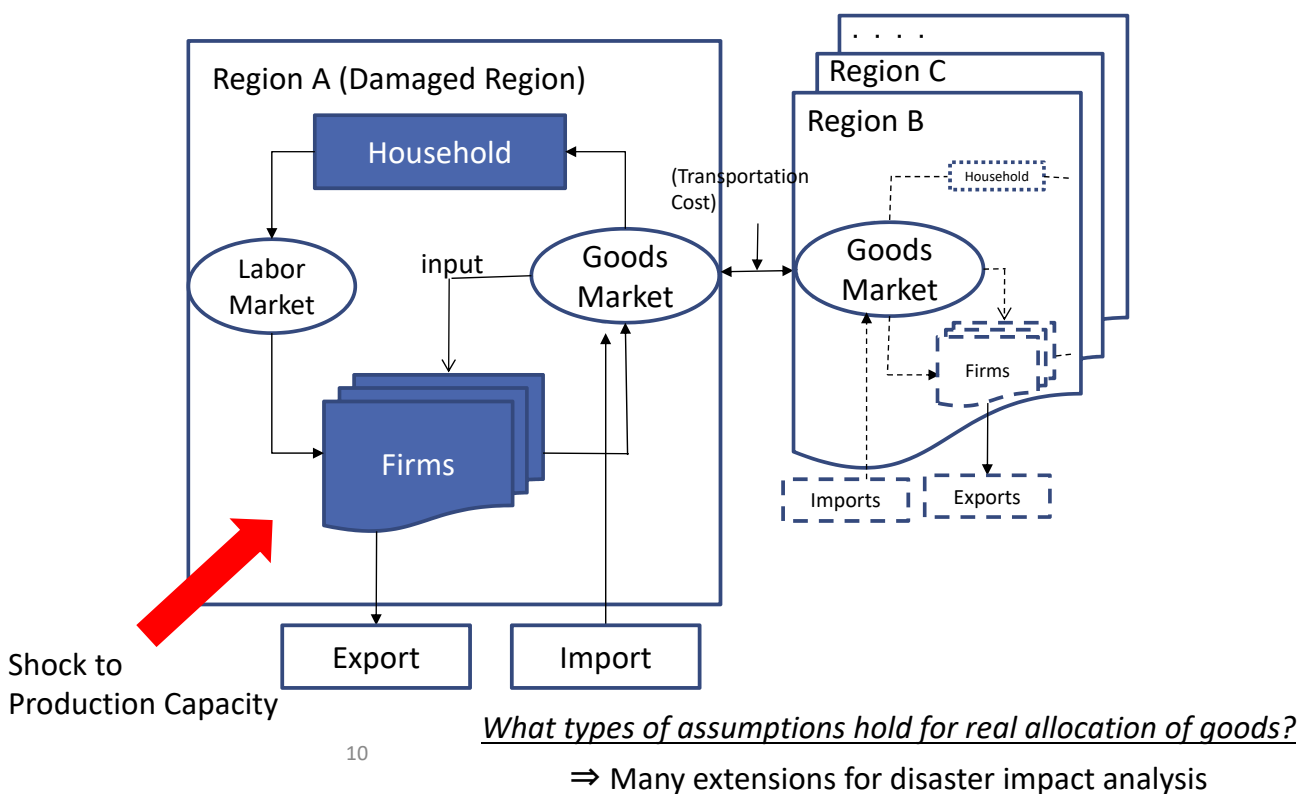
Example of Production Capacity Loss Estimation (Transport. Manf. in Fukushima)



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ESR, 2014

Spatial CGE (Computable General Equilibrium) Model for Disaster Analysis



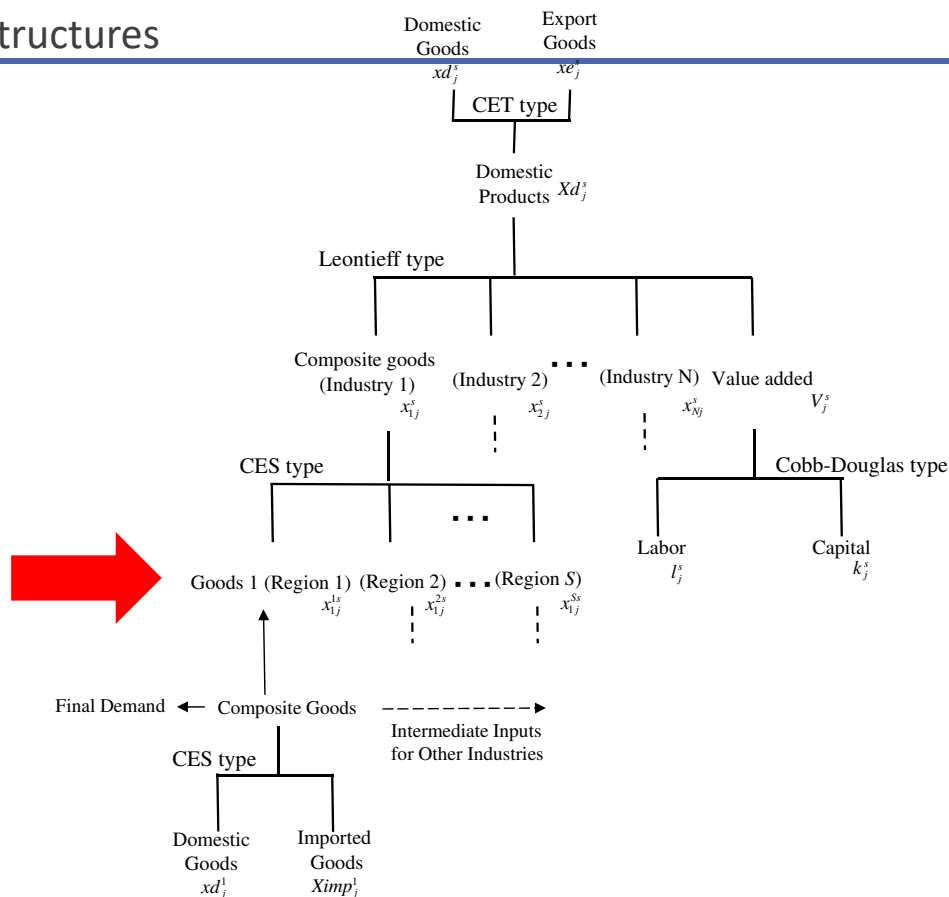
Findings for Building Disaster Impact Assessment Model (Model Closures)

- Putty-Clay assumptions in the damaged regions
 - Critical factor damage (labor or capital) determines value-added function) : Cobb-Douglous->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.

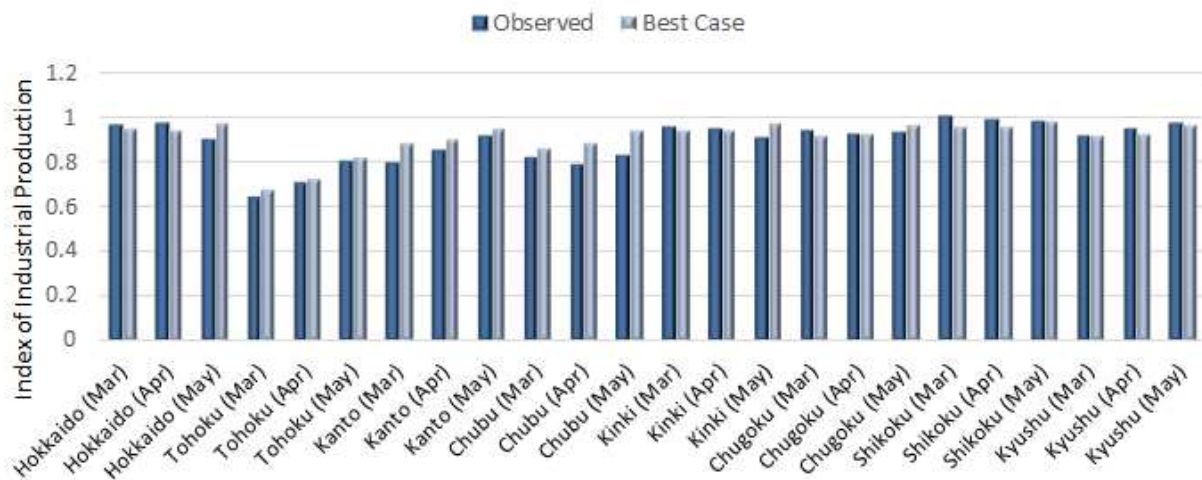
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Production Structures





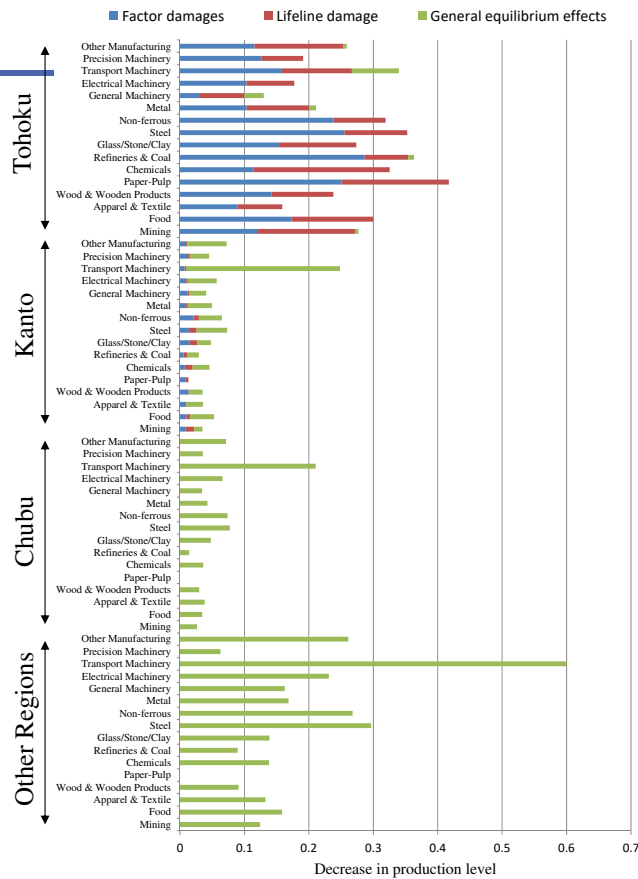
Estimated VS Observed Productions



elasticity of substitution parameters for the interregional trades:

Automobile parts:0 (Leontief)

Other sectors: 1/3 times ordinary



Factor Damage:
Loss of capital and labors

General Equilibrium Effects:
Rippling impacts due to supply-chain damages, losses of demands etc.

Three month average

Other regions: sum of averaged production loss

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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