Models for Economic Impact Analysis of Disasters

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Volcanic Eruptions

Terrorist Atta

Pandemics

Conditions

HAEMORRHAGIC FEVER

PNEUMONIA

MENINGITIS

ENCEPHALITIS

MERS

MEASLES

RUBELLA

ZIKA

WEST NILE VIRUS

YERSINIA PESTIS

MALARIA

EBOLA

CHOLERA

YELLOW FEVER

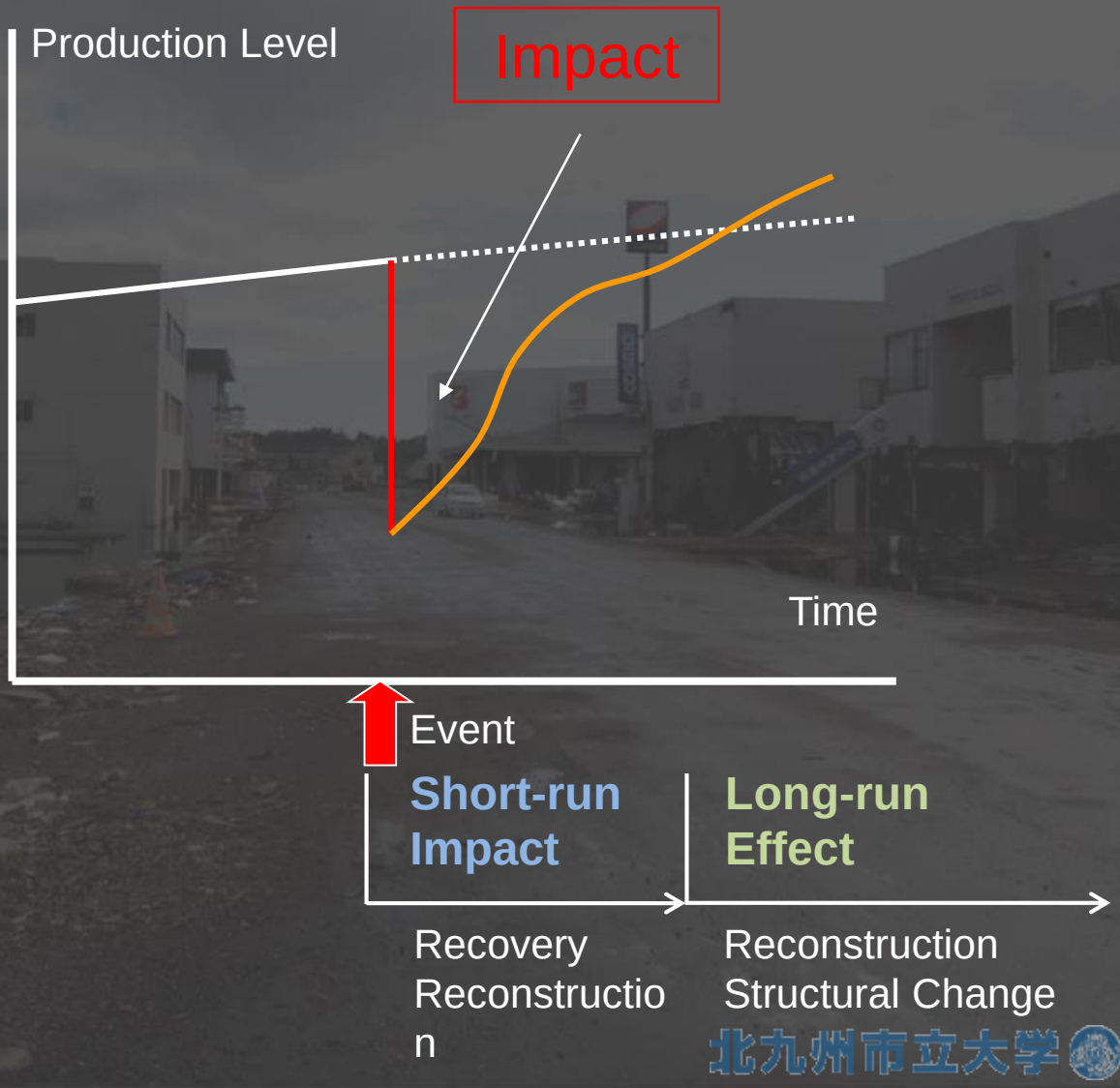
LASSA FEVER

SARS

RIFT VALLEY FEVER

Climate Change

Economic Impacts of Disasters



Economic Impacts of Disasters

Destruction of Physical Properties:

Production facilities, buildings

Infrastructure (roads, lifelines, etc.)

Human capital (labor)

(Economic) Damages

measured by assessing damaged property values

Economic Impact: Damages

This estimate was released three months after the event.

These estimates were released just two weeks after the event.

2011 East
Tsunami (JPY trillion)

	East Japan Great Earthquake (2011)			Kobe Earthquake (1995)
	Cabinet Office (Disaster Management Division)	Cabinet Office (Economic Analysis Division)		Ministry of Land Development
		Case 1 Equivalent damage rate to Kobe Earthquake	Case 2 Severer damage rate than Kobe Earthquake	
Buildings, houses, equipment, etc.	10.4	11.0	30.0	6.3
Lifeline facilities (utilities)	1.3	1.0	2.0	0.6
Infrastructure facilities	2.2	2.0	3.0	2.2
Others (agriculture, fisheries, forestry)	3.0	2.0	3.0	0.5
Total	16.9	16.0	25.0	9.6

Economic Impacts of Disasters

Disruption of Activities:

- Disruption of productions
- Transportation delays
- Lost wages
- Decreased demand (consumptions)

(Economic) Losses

- estimated using economic models

Economic Impact: Losses

2011 East Japan Earthquake and (hypothetical) Tokyo Great Earthquake

(JPY trillion)

		East Japan Great Earthquake (2011)	(hypothetical) Tokyo Great Earthquake
		Cabinet Office (Disaster Management Division)	Cabinet Office (Disaster Management Division)
Damages	Buildings, houses, equipment, etc.	10.4	42.4
	Lifeline facilities (utilities)	1.3	0.2
	Infrastructure facilities	2.2	4.7
	Others (agriculture, fisheries, forestry)	3.0	0.0
	Damage Total	16.9	47.3
Losses	Higher-order Effects	not estimated	47.9

Damages and Losses

Damages: value of damaged capital stock

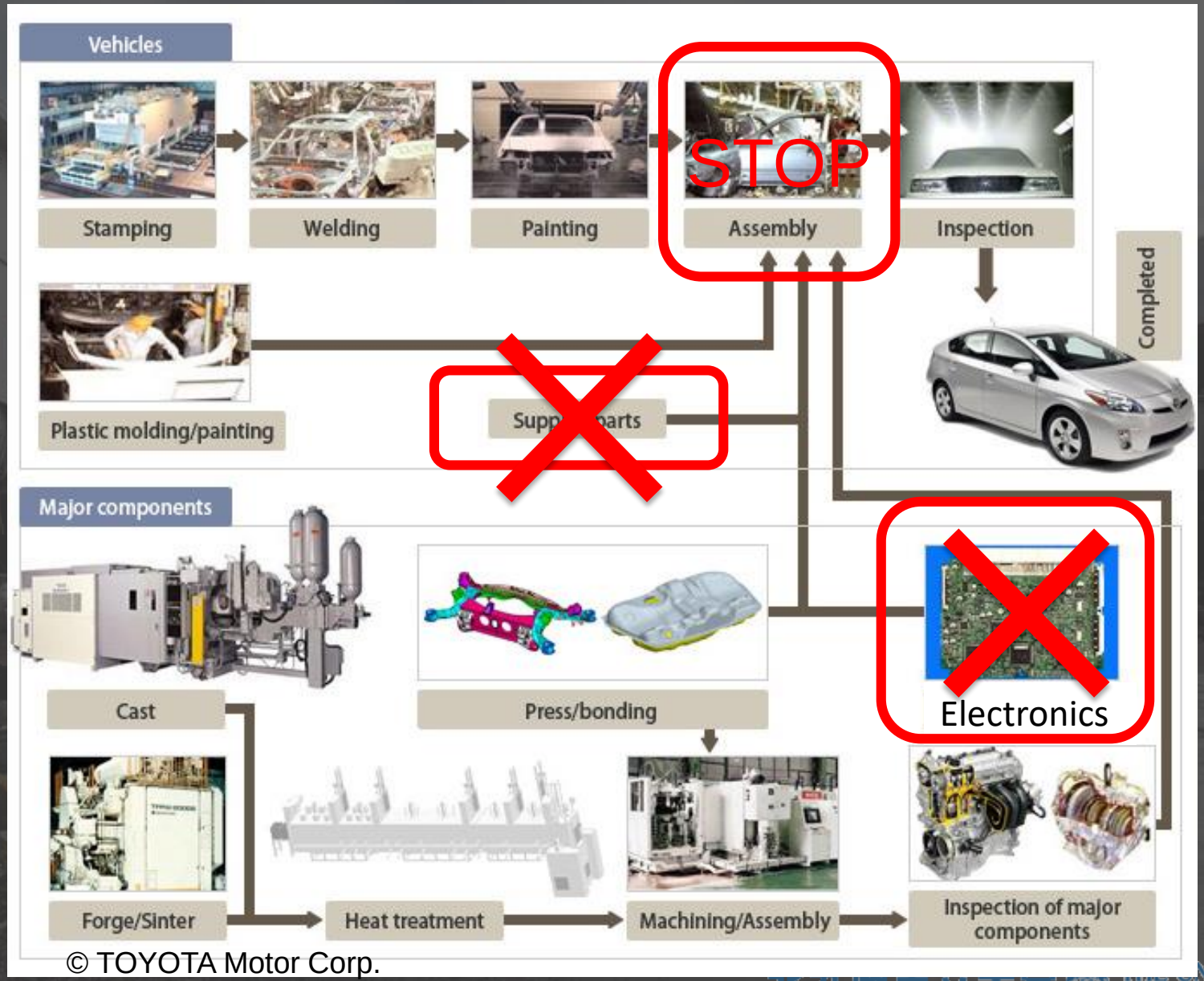
Losses: lost production opportunities (flows)

These should not be added together.

Losses are more useful and can be compared with macroeconomic indicators, such as GDP.

Losses: Propagation of Impact

Impact through Supply Chains



Five Types of Losses

Oosterhaven's (2017) classification:

1) Decrease of production (supply)

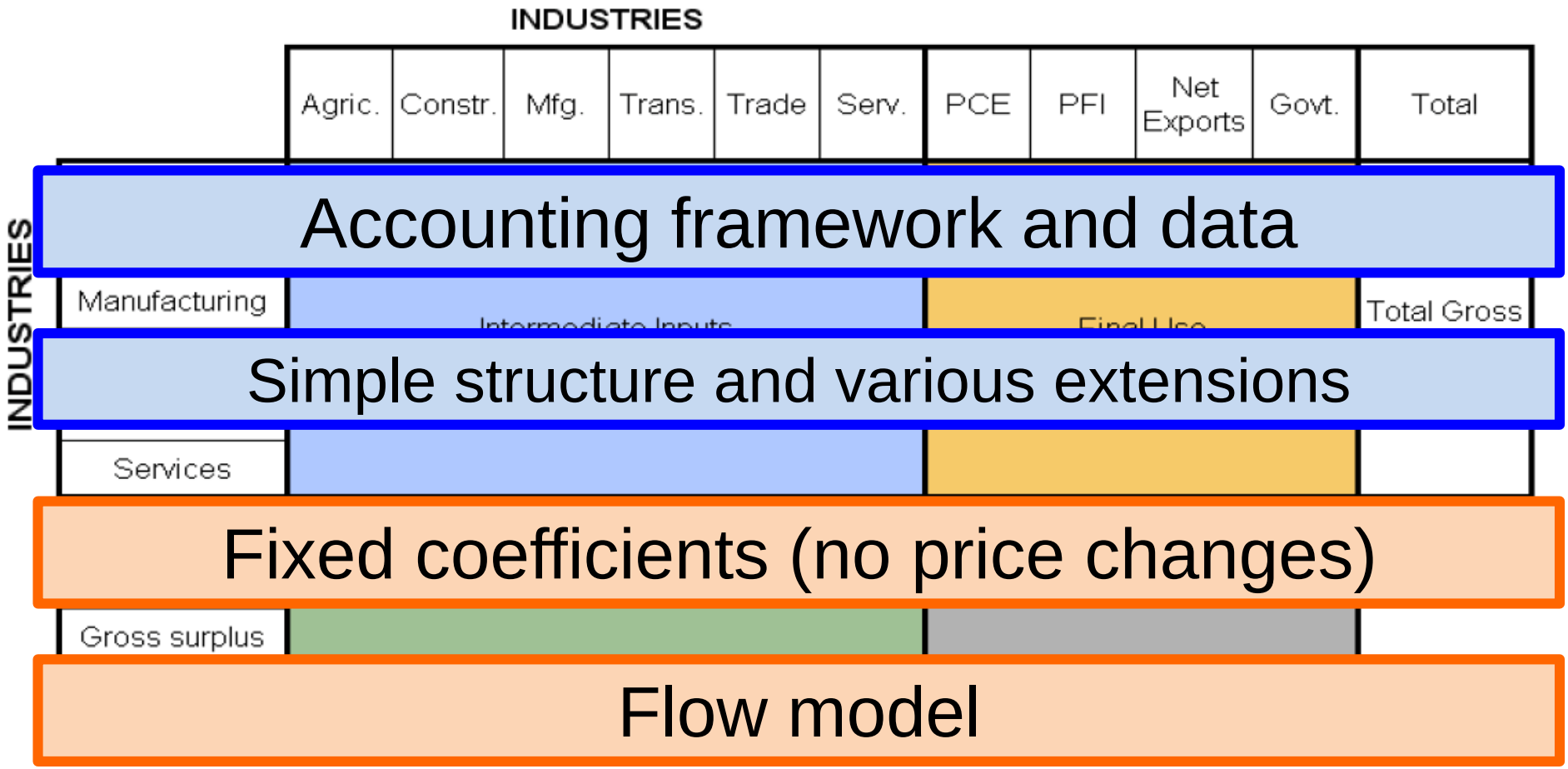
2) Forward effect of supply shortages

3) Substitution effect for replaceable goods

4) Decline of intermediate and final demands

5) Backward and positive effects from recovery and reconstruction

Models: Input-Output Model



Application of Input-Output Model

2004 Indian Ocean Earthquake and Tsunami (Okuyama, 2010)

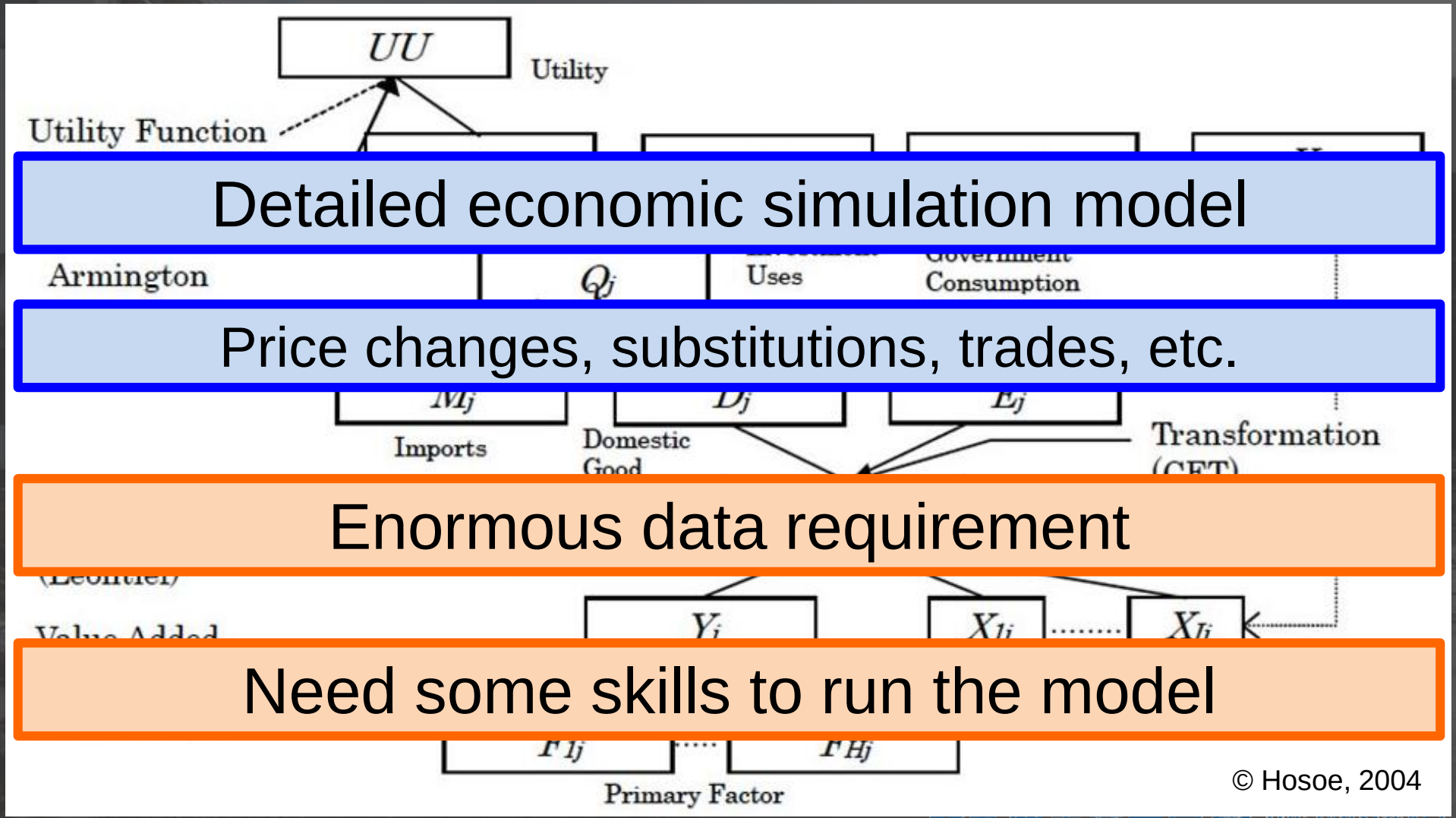
Use of 2000 Asian International IO Table (IDE-JETRO)

Spatial distribution of total impacts of 2004 Indian Ocean earthquake and tsunami (in 2007 million US dollars)

	Sectors in model	Indonesia	Thailand	Malaysia	Philippines	Singapore	China	Taiwan	Korea	Japan	USA	Total
Output impact	Agriculture	672	228	2	1	0	19	2	3	8	13	948
	Mining	69	33	5	0	0	7	0	0	1	4	118
	Manufacturing	814	872	36	7	33	96	42	59	230	120	2,307
	Utilities	30	132	1	1	1	6	1	2	11	7	192
	Construction	20	3	0	0	0	1	1	0	4	2	30
	Trade & transport	370	401	5	2	7	14	9	7	64	47	926
	Services	412	1,535	9	2	9	14	15	19	110	114	2,239
	Total	2,388	3,205	58	14	50	156	69	90	428	306	6,761
Income impact		1,219	1,240	22	5	12	39	24	26	154	143	2,855

Source: ADPC

Computable General Equilibrium Models: CGE Model



Detailed economic simulation model

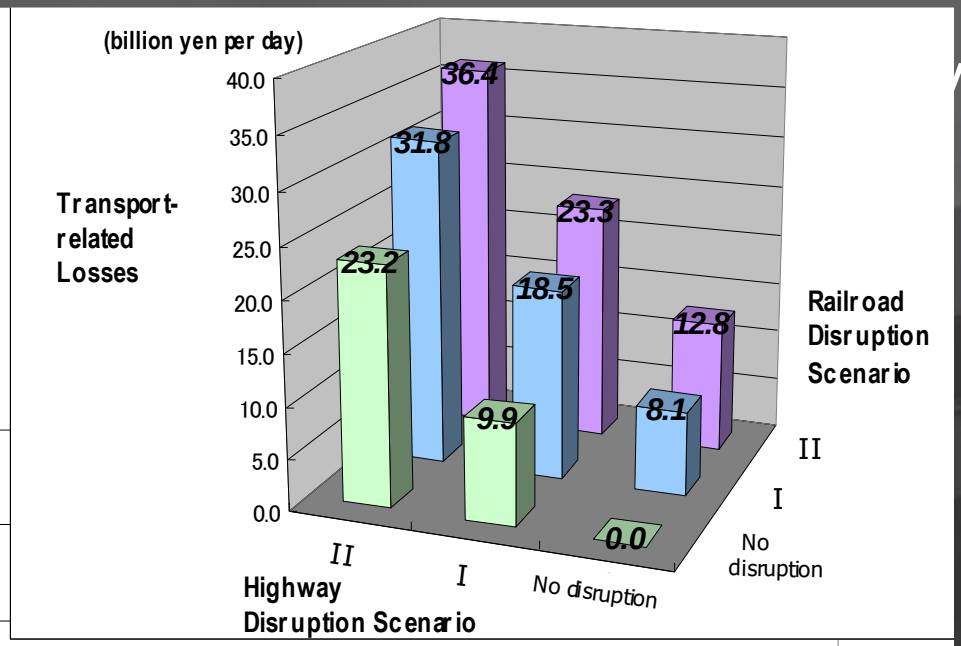
Price changes, substitutions, trades, etc.

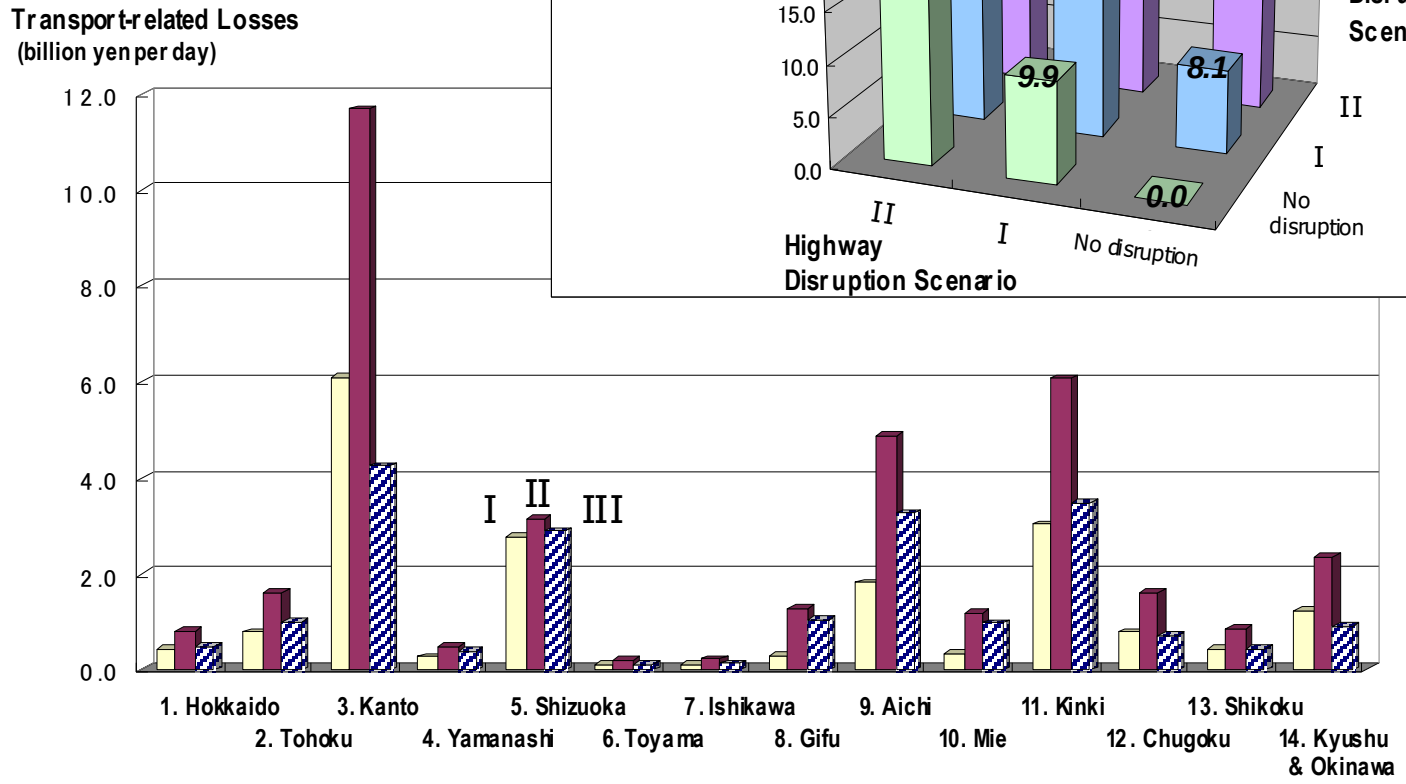
Enormous data requirement

Need some skills to run the model

Application of CGE Model

I: Route A and (a) are disrupted.
II: Two major routes are disrupted.
III: Based on II, the detour routes are upgraded.





Models: Econometric Model

$$KOBE_t = \beta_0 + \beta_1 JPN_t + \beta_2 JPN_{t-1} + \beta_3 KOBE_{t-1} + \varepsilon_t$$

Significance of the earthquake on GRP (KOBE as dependent variable)

Statistically rigorous and stochastic estimation

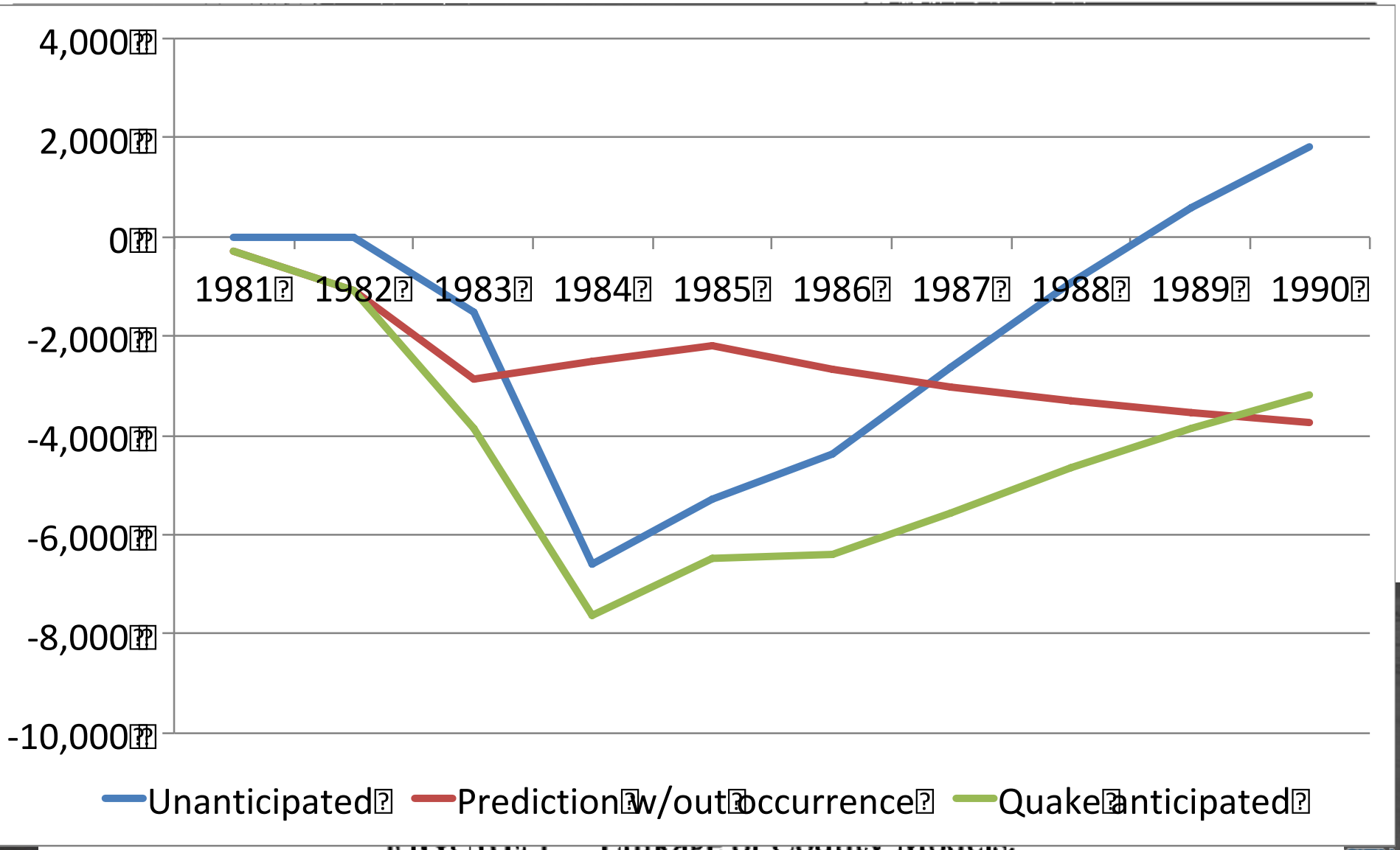
Constant	0.030				
	(0.056)				
KOBE (t-1)	0.808***	0.852***	0.877***	0.919***	0.942***
	(0.138)	(0.110)	(0.104)	(0.083)	(0.074)
D94			-0.066**		-0.062***
Number of observations	31	31	31	31	31

Forecasting capability for long-run impact

Based on historical trends

Unable to distinguish between direct losses and higher-order (indirect) effects

TABLE 6: Simulation Results for Total Population—Charleston SMSA



Ellson et al., 1984

Which Model to Use?

Purpose and timing:

- Pre-hazard (policy evaluation)
  - detailed assessment needed
    - extended IO or CGE models
- Post-hazard (budget determination)
  - quick and aggregated
  - long-run implications
    - IO model, Econometric model

Which Model to Use?

Particular aspect:

- Transportation, lifelines, trades
  - Detailed simulation of the aspect
    - integrated IO models
    - spatial CGE model
- Demographic changes
  - Simulation of migration
    - extended IO model
    - spatial CGE model
    - Econometric model

Final Remarks

- Models reflect only limited aspects of the reality.
- Models are assumption driven.
- Know the advantages and limitations of models.
- Interpret the results carefully.
- The more sophisticated models become, the more precise input data will be required. (West and Lenze, 1994)