

Economic Loss Assessment of Capital Loss and Transportation Disruption from an Earthquake

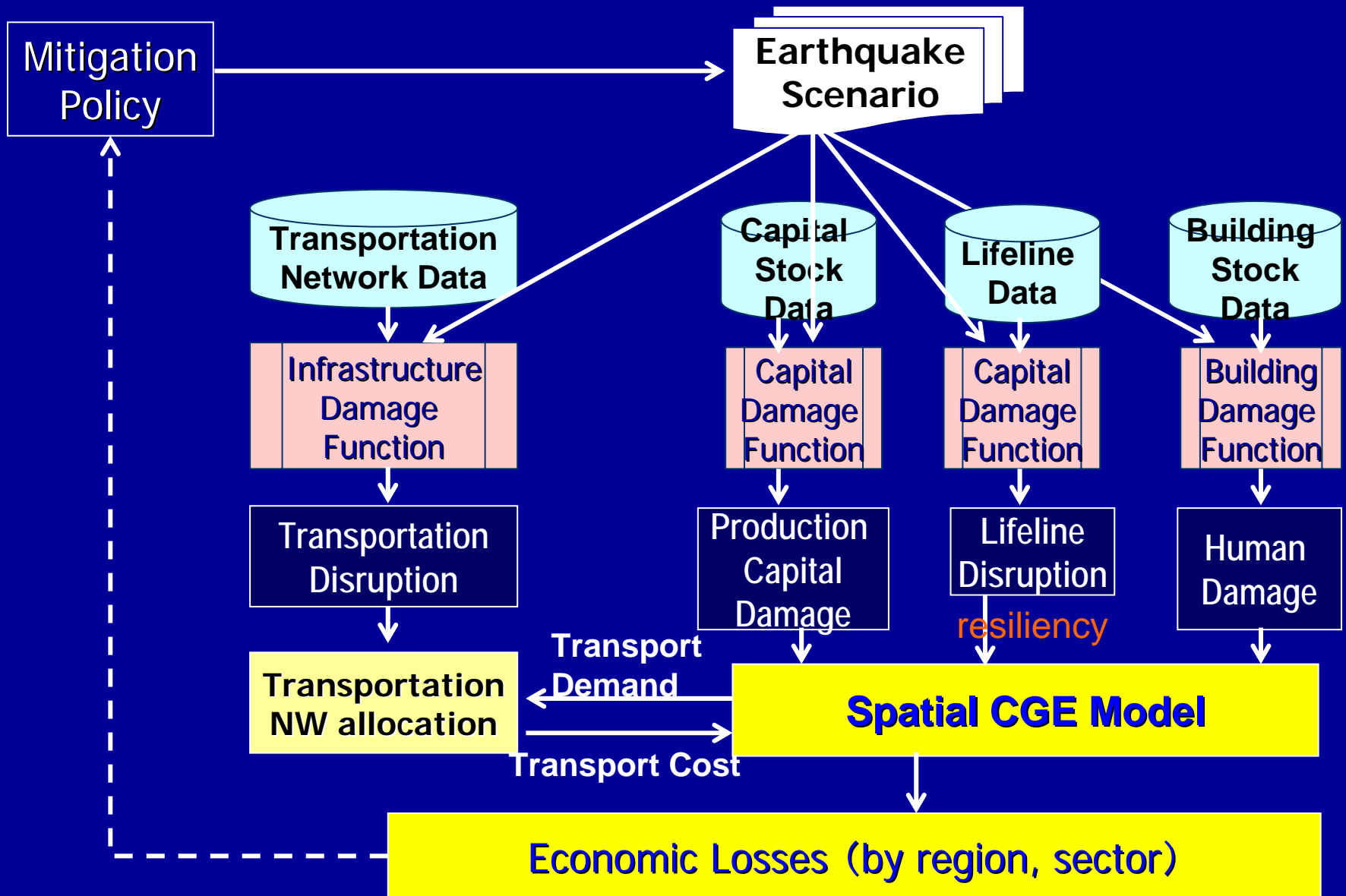
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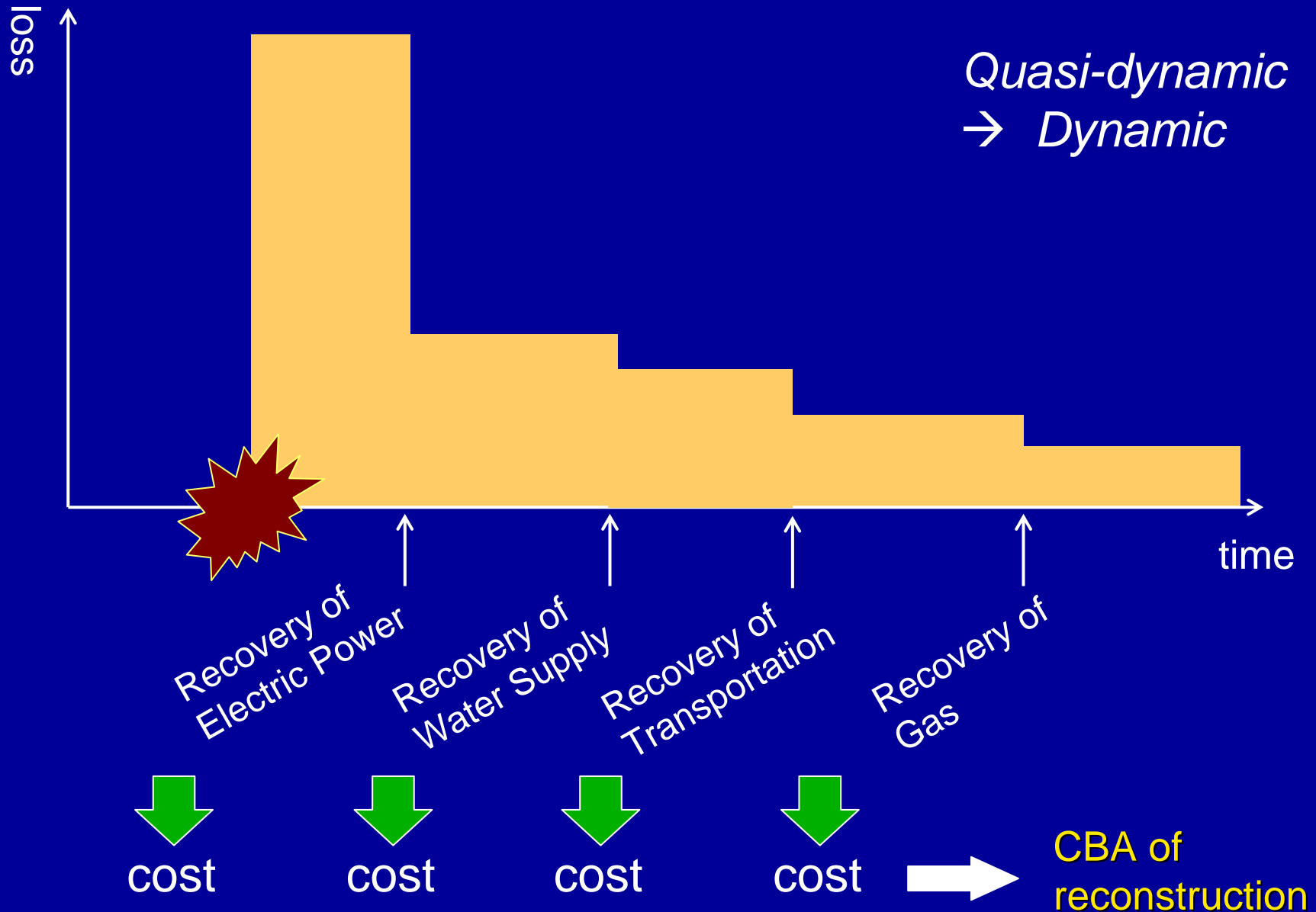
Overall Picture of Our Loss Estimation Model



Overall Picture of Our Loss Estimation Model -2

- **Progress made**
 - the impacts of transportation network disruptions.
 - Further, the network levels of development implied the importance of network redundancy at the interregional level
- **What kind of data is needed for the analysis?**
 - Basic socio-economic data (e.g. I-O tables)
 - Additional data to specify;
 - Some of unknown parameters
 - Scenario describing state of damage / recovery
 - Posteriori Survey is ongoing in Niigata.

Overall Picture of Our Loss Estimation Model -3



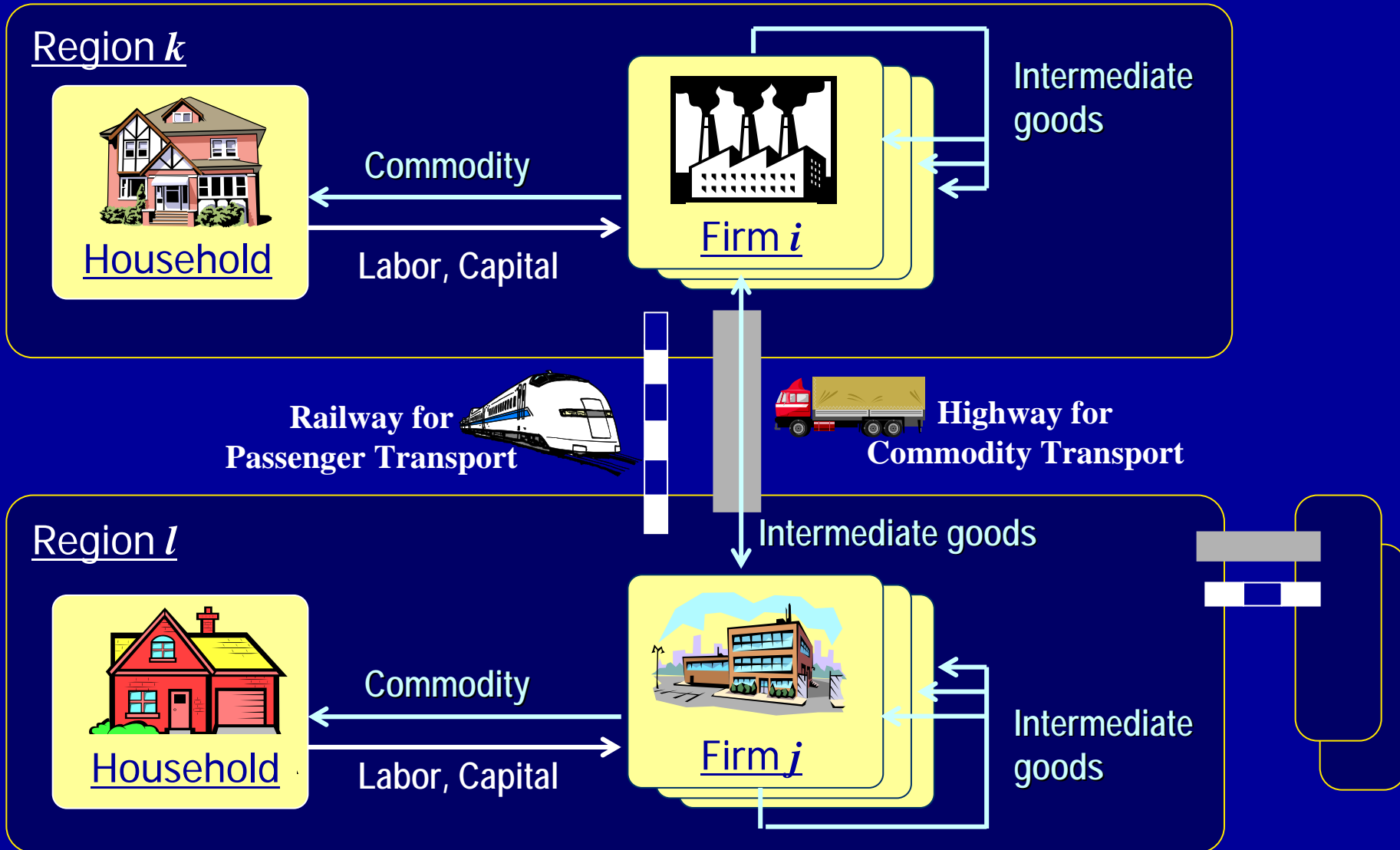
Computable General Equilibrium Approach

- **Advantages** (as compared to I-O analysis)
 - flexibility as a model: it enables us to set a firm's production function and household's utility function depending on a the purpose of the analysis.
 - resource constraints, the behavior of consumers, price information in equilibrium
 - Easy to reflect disruption/ recovery scenarios in the relevant variables.

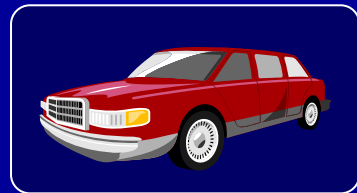
This Presentation Covers;

- Regional economic impacts due to interregional transportation disruption and capital loss, through a case study of Niigata-Chuetsu Earthquake 2004.
- A spatial computable general equilibrium model is formulated which integrates a transportation model that can estimate two types of interregional flows of freight movement and passenger trips.

Regional Economic System

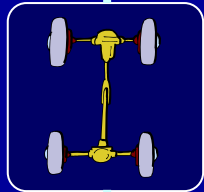
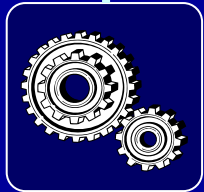


Production Structure of Firms



Output

Leontief type



...



Intermediate Goods

Compound Factor
Forming Value-added

Cobb-Douglas type

Fundamental
Compound Factor

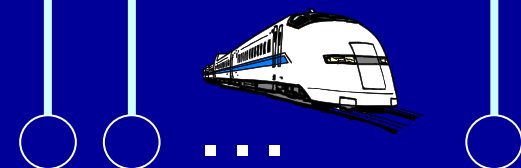
Knowledge

Cobb-Douglas type

Cobb-Douglas type

Labor

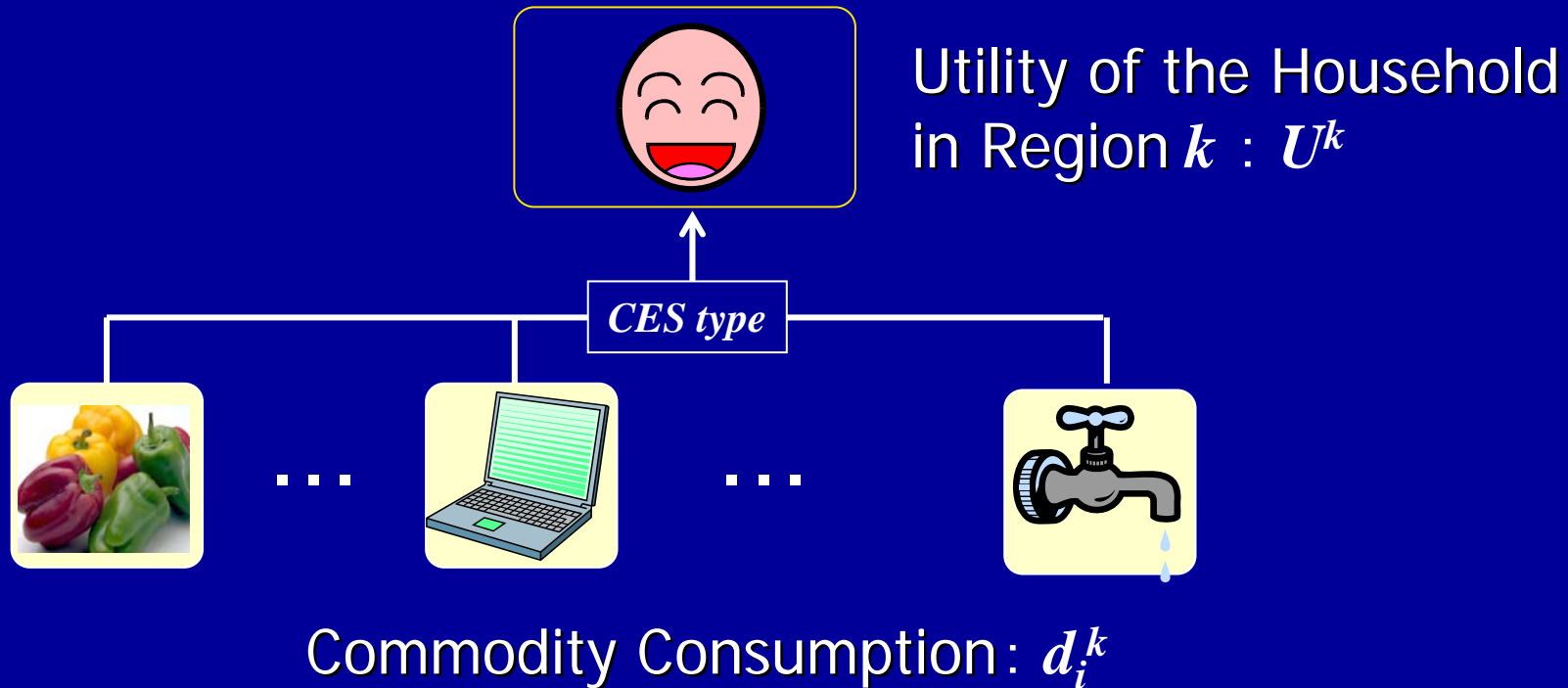
Capital



Business Trip

**Purchased from
other/the same
region**

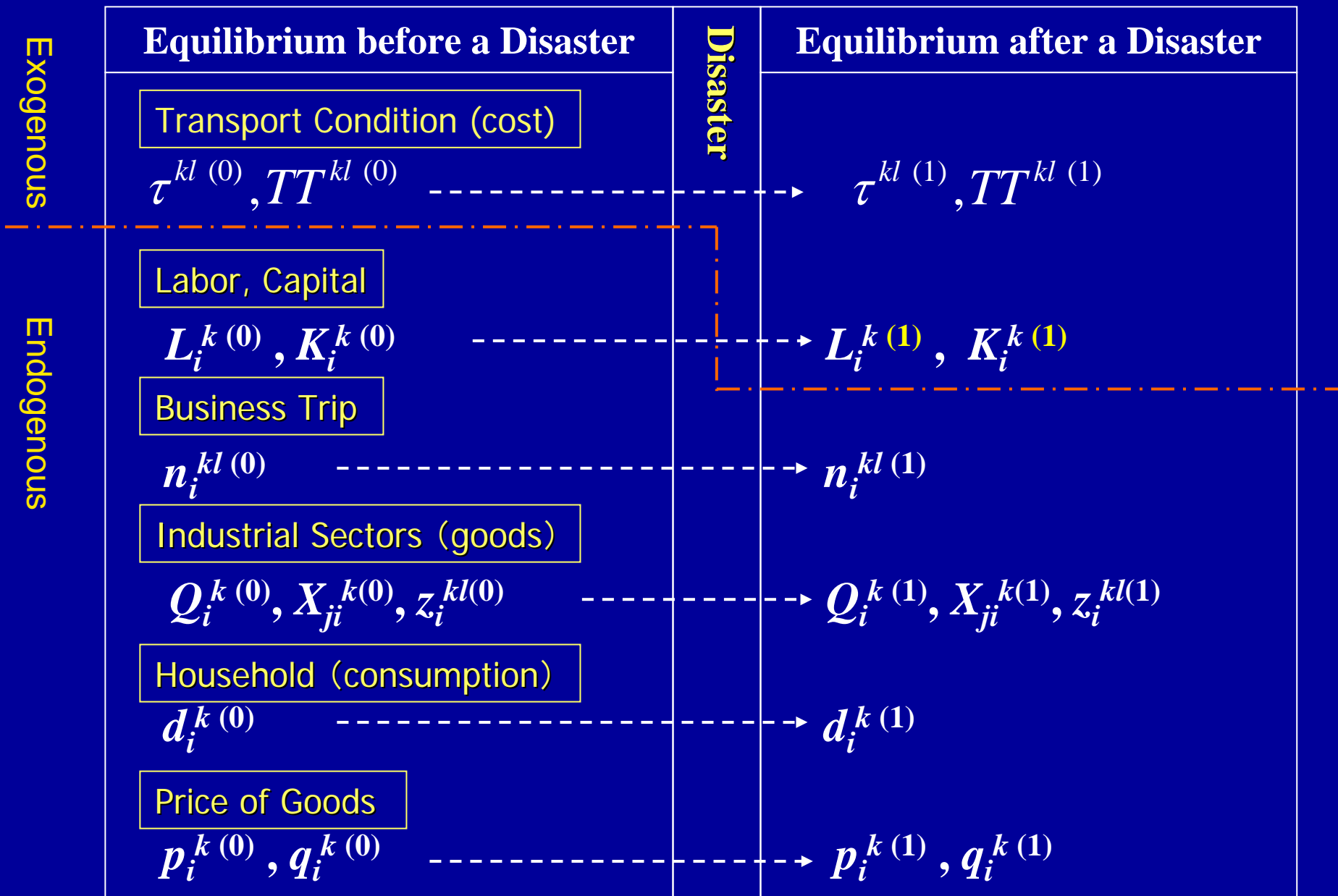
Consumption Model of Household



$$U^k = \max \left[\sum_{i=1}^M (\gamma_i^k)^{\frac{1}{\varphi}} (d_i^k)^{1-\frac{1}{\varphi}} \right]^{\frac{\varphi}{\varphi-1}}$$

subject to $\sum_{i=1}^M q_i^k d_i^k = y^k (= w^k L^k + rK^k)$

Variables on Equilibrium Conditions



Short-run Equilibrium

- Assumption on Capital Loss
 - **NO** Reflection of productivity change on Household income
 - Competitive Market: Firms that lost production capital do **NOT** withdraw from the market. Firms cannot put capital loss on commodity production prices.
 - Consequently, the firms' profits will be negative. They are the losses of industrial sectors.

International Trade

$$s_i^{kl} = \frac{Q_i^k \exp\{-p_i^k \psi_i^{kl}\}}{\sum_m Q_i^m \exp\{-p_i^m \psi_i^{kl}\}}$$

s : Trade Coefficient

Q : Total supply of commodity

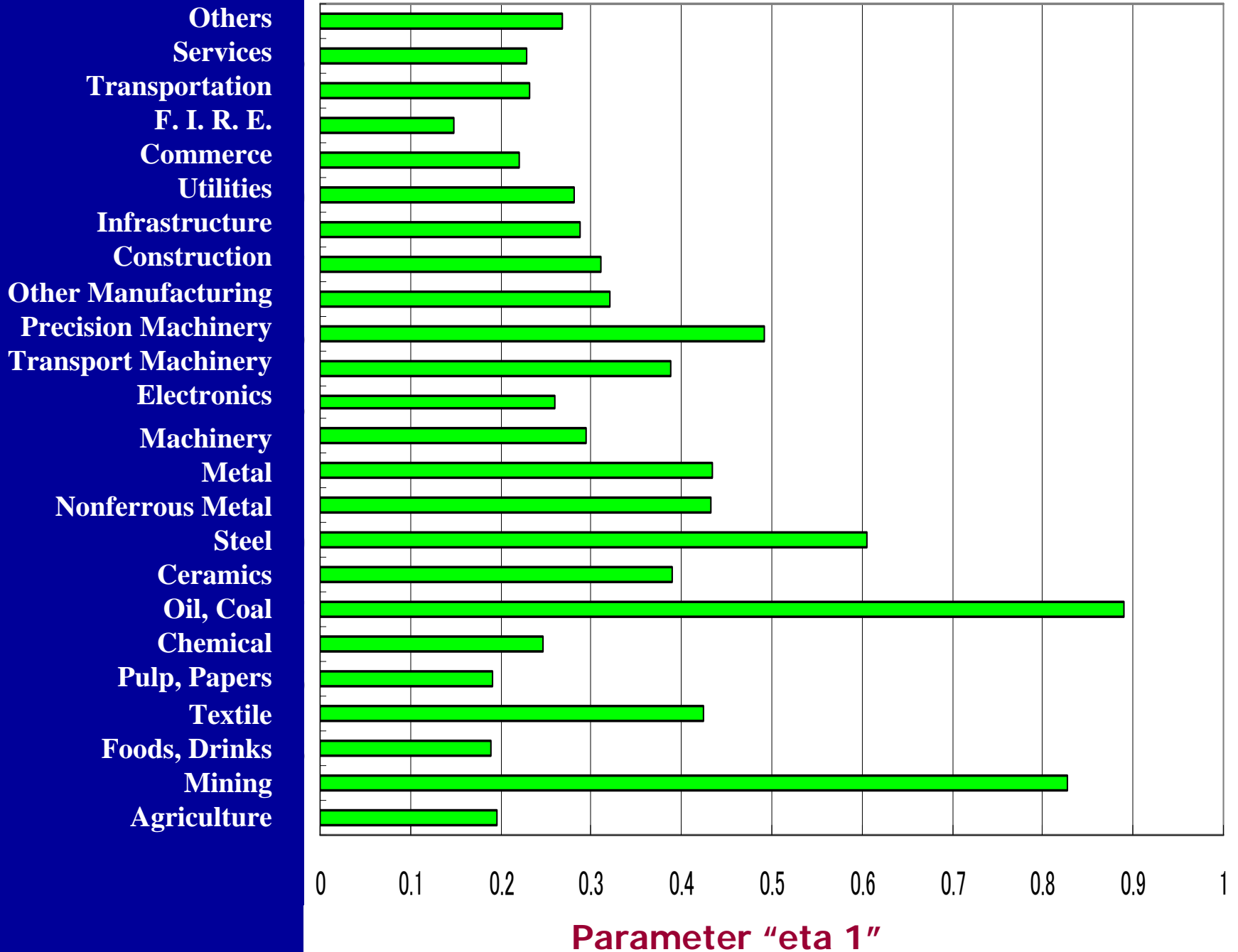
p : Prices of commodity

$$E[\psi_i^{kl}] = \eta_{0i} + \eta_{1i} TT^{kl}$$



TT : Transit time of Commodity
(set from timetable of highway network)

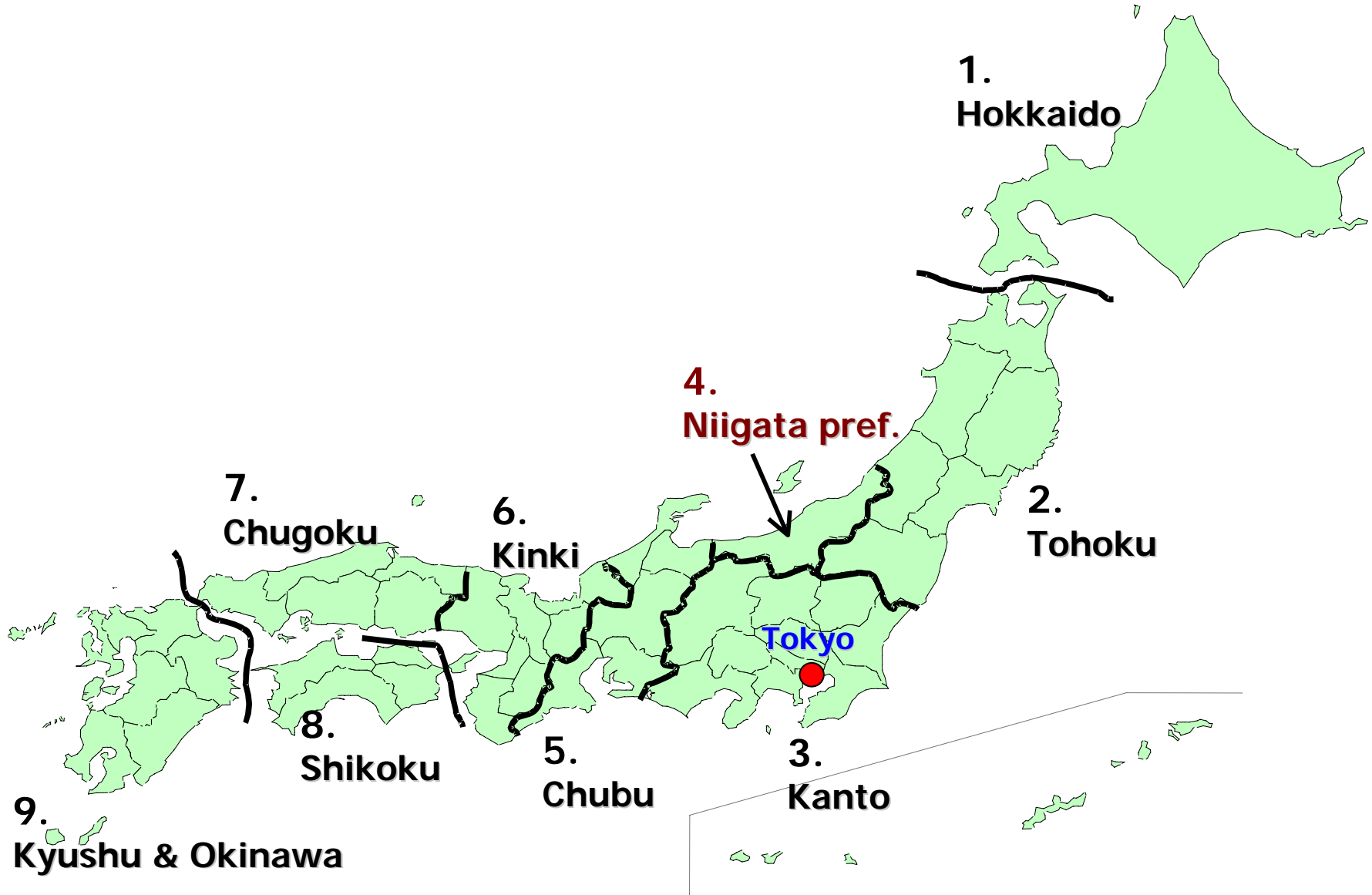
Industrial sector	eta 0 (P-value)	eta 1 (P-value)
Agriculture	3.037 (0.00)	0.195 (0.00)
Mining	1.844 (0.00)	0.828 (0.00)
:	:	:



Case Study: Niigata-Chuetsu Earthquake 2004



9 Zones for Loss Estimation



Traffic Volume of Expressways

① Kan-etsu Exp.Way
(Nagaoka - Nagaoka JCT)

Traffic Volume	20,200
(previous year)	22,000
difference	-1,800
ratio	0.92

② Joshin-etsu Exp. Way
(Shinano-machi - Myoko Kogen)

Traffic Volume	21,900
(previous year)	18,800
difference	3,100
ratio	1.16



③ Kan-etsu Exp. Way
(Numata - Tsukiyono)

Traffic Volume	7,500
(previous year)	18,400
difference	-10,900
ratio	0.41

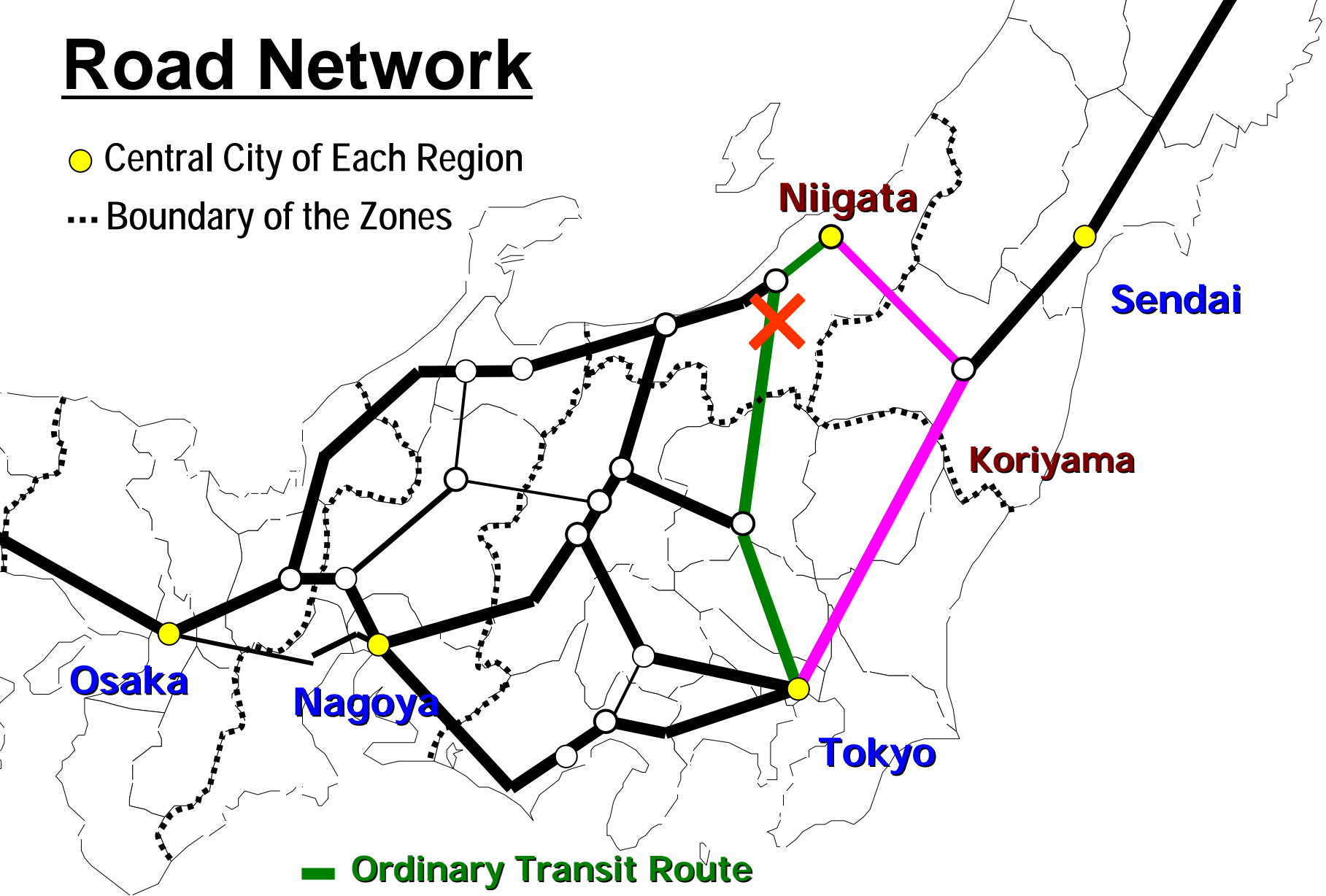
④ Ban-etsu Exp. Way
(Nishi-Aizu - Tsukawa)

Traffic Volume	9,600
(previous year)	6,400
difference	3,200
ratio	1.50

Road Network

● Central City of Each Region

... Boundary of the Zones



— Ordinary Transit Route

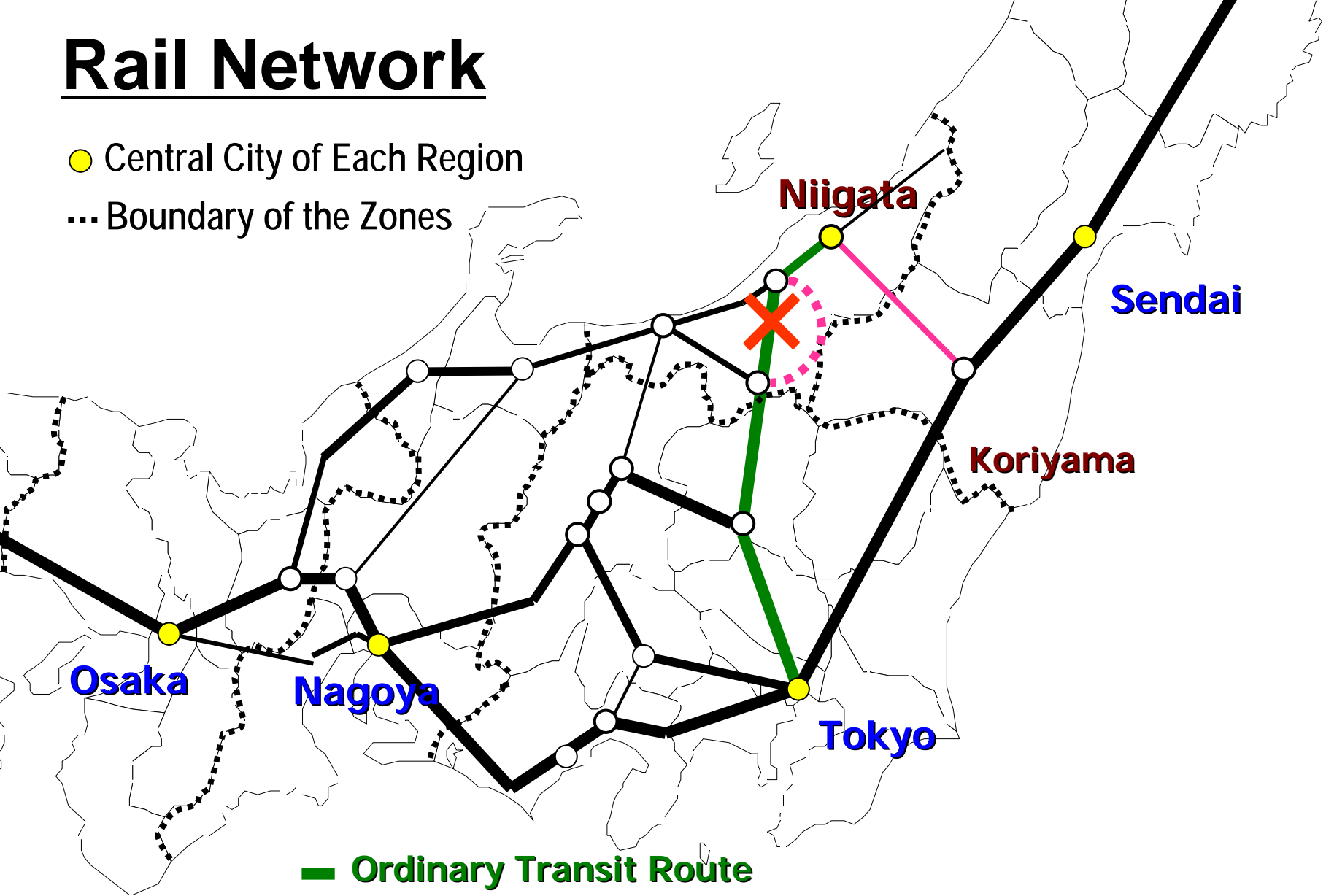
— Detour in the Disaster

Route Choice Rule: The Shortest Path

Rail Network

● Central City of Each Region

... Boundary of the Zones



— Ordinary Transit Route

— Detour: by Bus

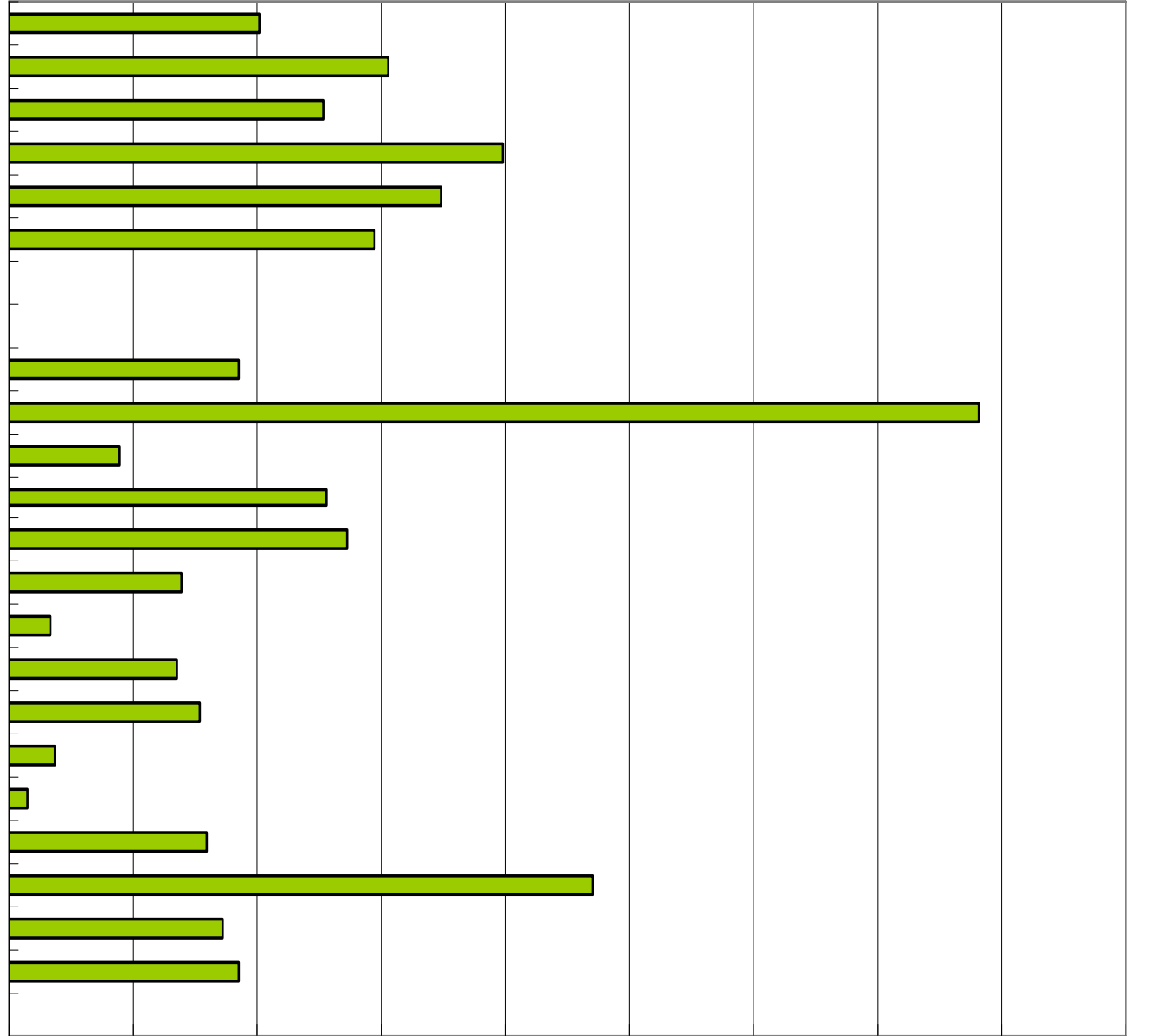
Route Choice Rule: The Shortest Path

Capital Loss Scenario

- Scenario Setting

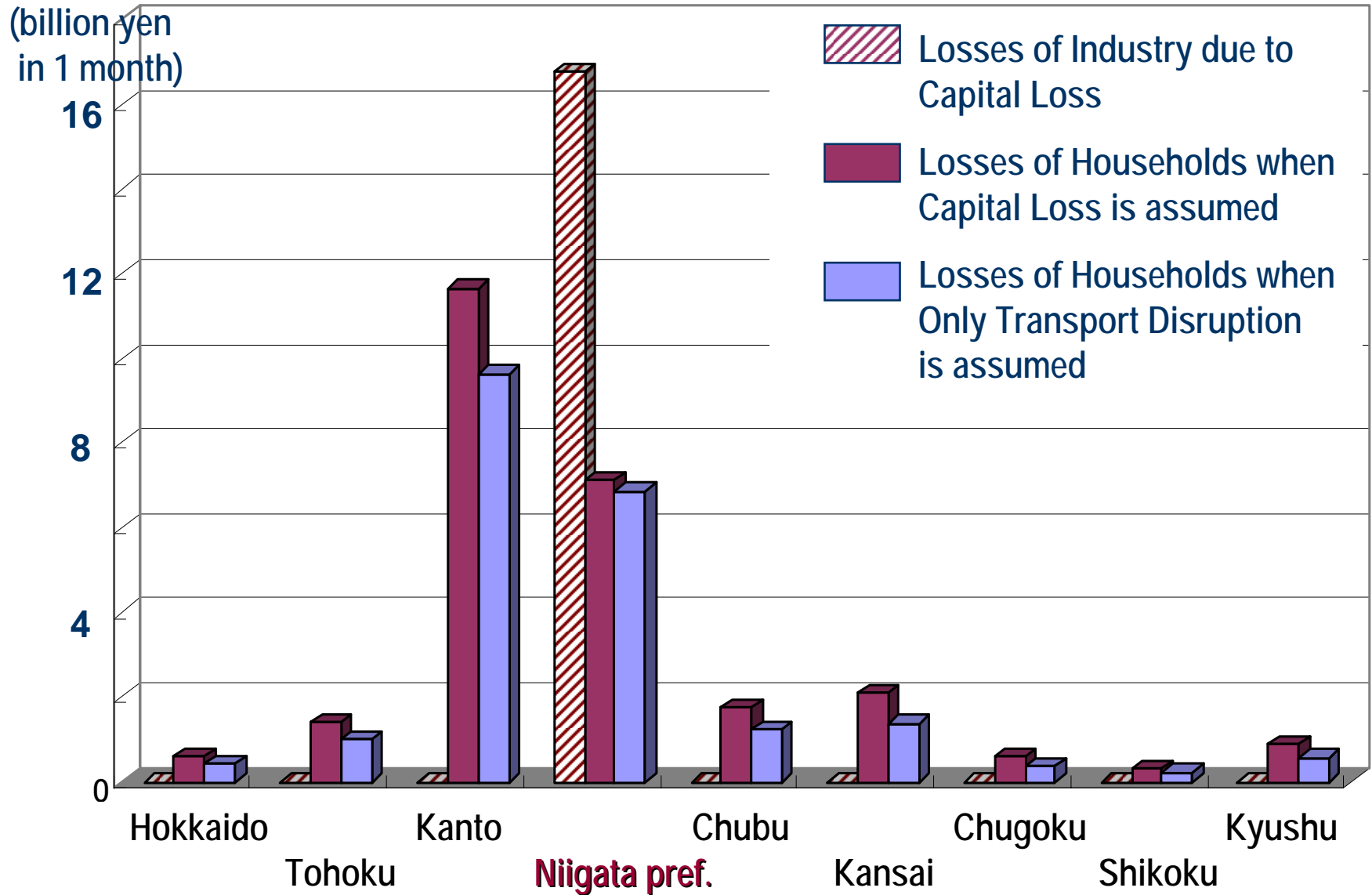
- Survey (by municipality) on Dwelling Houses affected is used to estimate damage ratio of dwelling houses. (A)
- Decrease of production is assumed with (A) and weight parameter from zonal production level (industrial statistics). (B)
- Find the ratio of conducive capital loss (alternatively, capital available in disaster time) so that it satisfies (B).

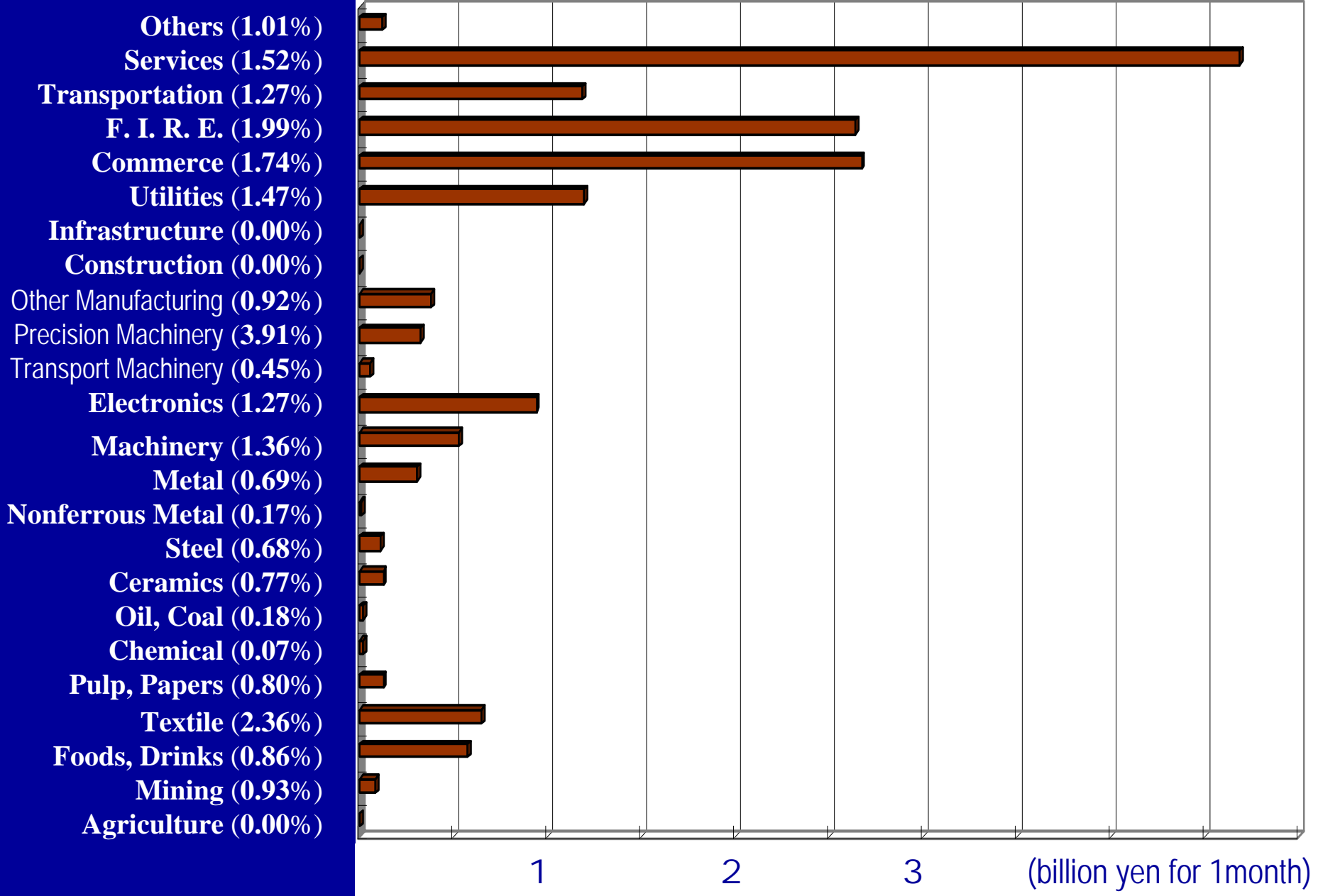
Others (1.01%)
Services (1.52%)
Transportation (1.27%)
F. I. R. E. (1.99%)
Commerce (1.74%)
Utilities (1.47%)
Infrastructure (0.00%)
Construction (0.00%)
 Other Manufacturing (0.92%)
Precision Machinery (3.91%)
 Transport Machinery (0.45%)
Electronics (1.27%)
Machinery (1.36%)
Metal (0.69%)
Nonferrous Metal (0.17%)
Steel (0.68%)
Ceramics (0.77%)
Oil, Coal (0.18%)
Chemical (0.07%)
Pulp, Papers (0.80%)
Textile (2.36%)
Foods, Drinks (0.86%)
Mining (0.93%)
Agriculture (0.00%)



1 2 3 4 (%)
Losses in Percent of Industrial Sectors

Estimated Losses





Losses of Industrial Sectors in Niigata Pref.

Conclusion of the Case Study

- **Introduction of loss estimation framework based on a spatial CGE model**
 - Economic impacts of transportation disruption and capital losses, that are spilled over regions. way of thinking that industrial sectors have losses.
 - The estimated loss would be larger if the level of network was poorer.
- **Technical aspects of the model**
 - two types of interregional flows of freight movement and passenger trips, a short-run equilibrium that labor and capital movements are restricted during disaster time.

Remaining Factors to be Considered

- **Impacts of lifeline disruption**
 - Resiliency is an important factor to be concerned.
 - Using existing survey results, including resiliency factor, estimating substitution parameter of production function is ongoing.
- **Impacts of human damage**
 - Deaths, Evacuation,...
 - How do these change effect on the socio-economic system, e.g. "labor input" or "household utility" ?
 - What should be concerned in loss estimation context?



