Sustainable Innovation Global Business: Case Studies of Infrastructure Business

Kazuyuki Motohashi

Department of Technology Management for Innovation, The University of Tokyo

http://www.mo.t.u-tokyo.ac.jp/

Shifting sources of economic growth

Adapted from Financial Times
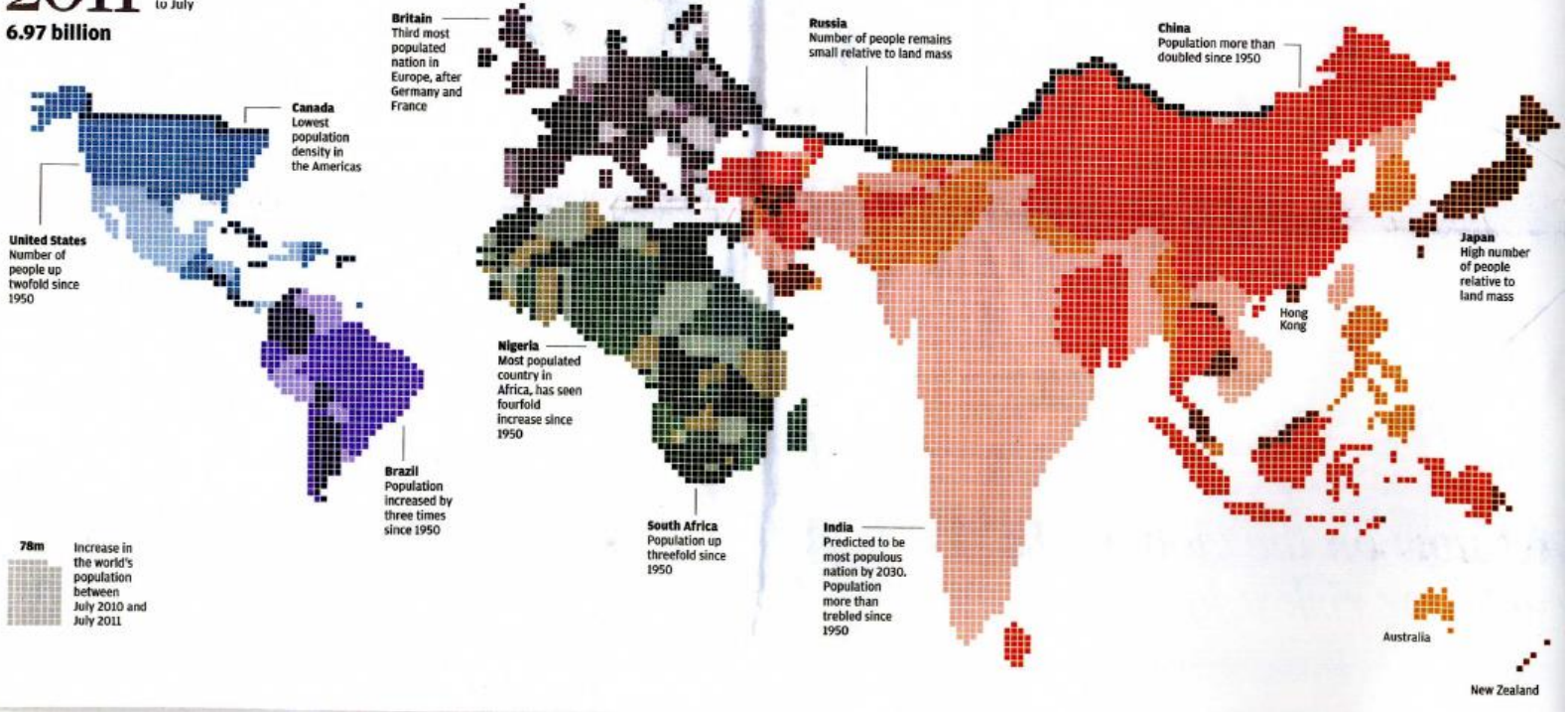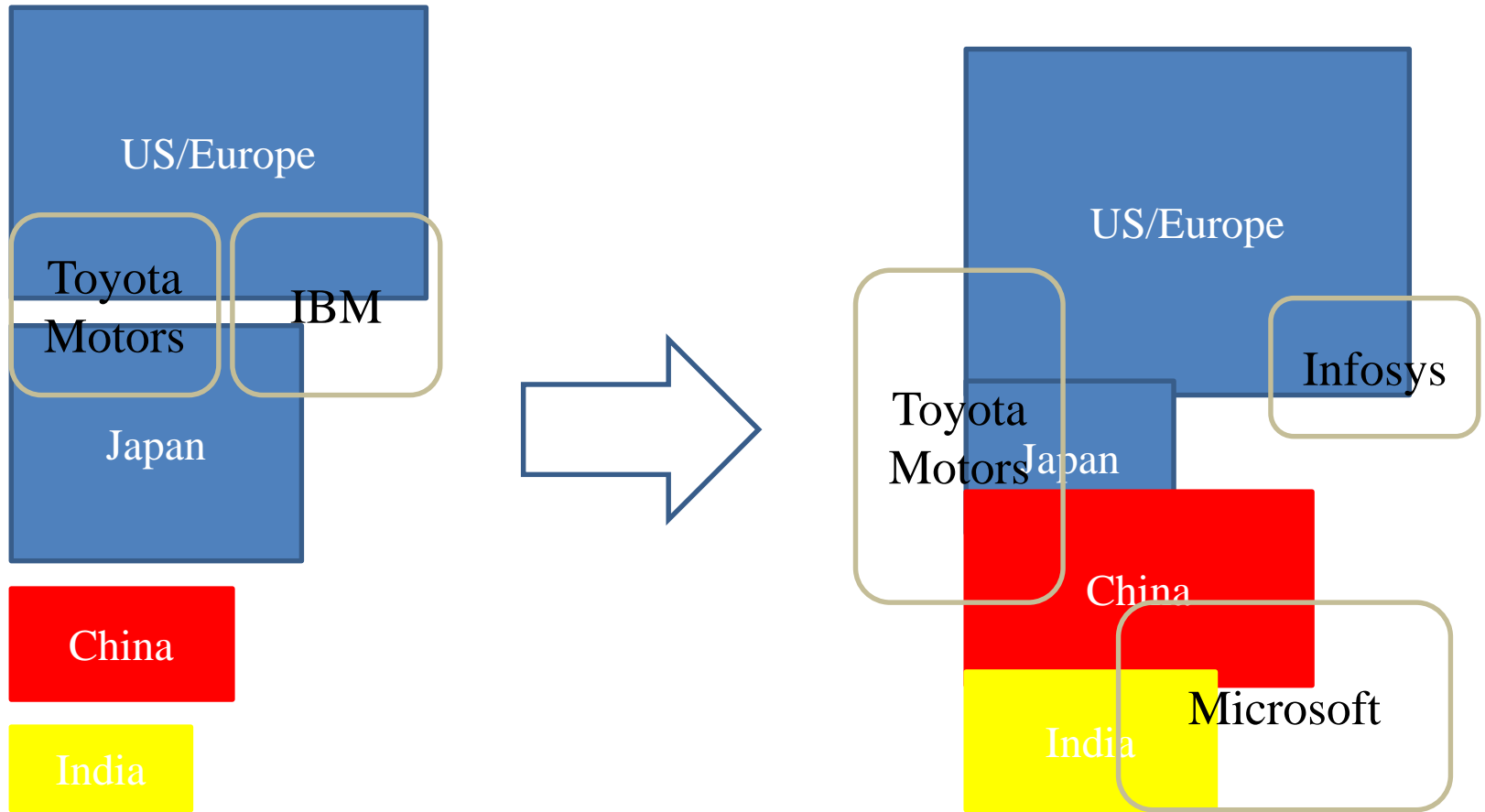
GDP (US dollar)
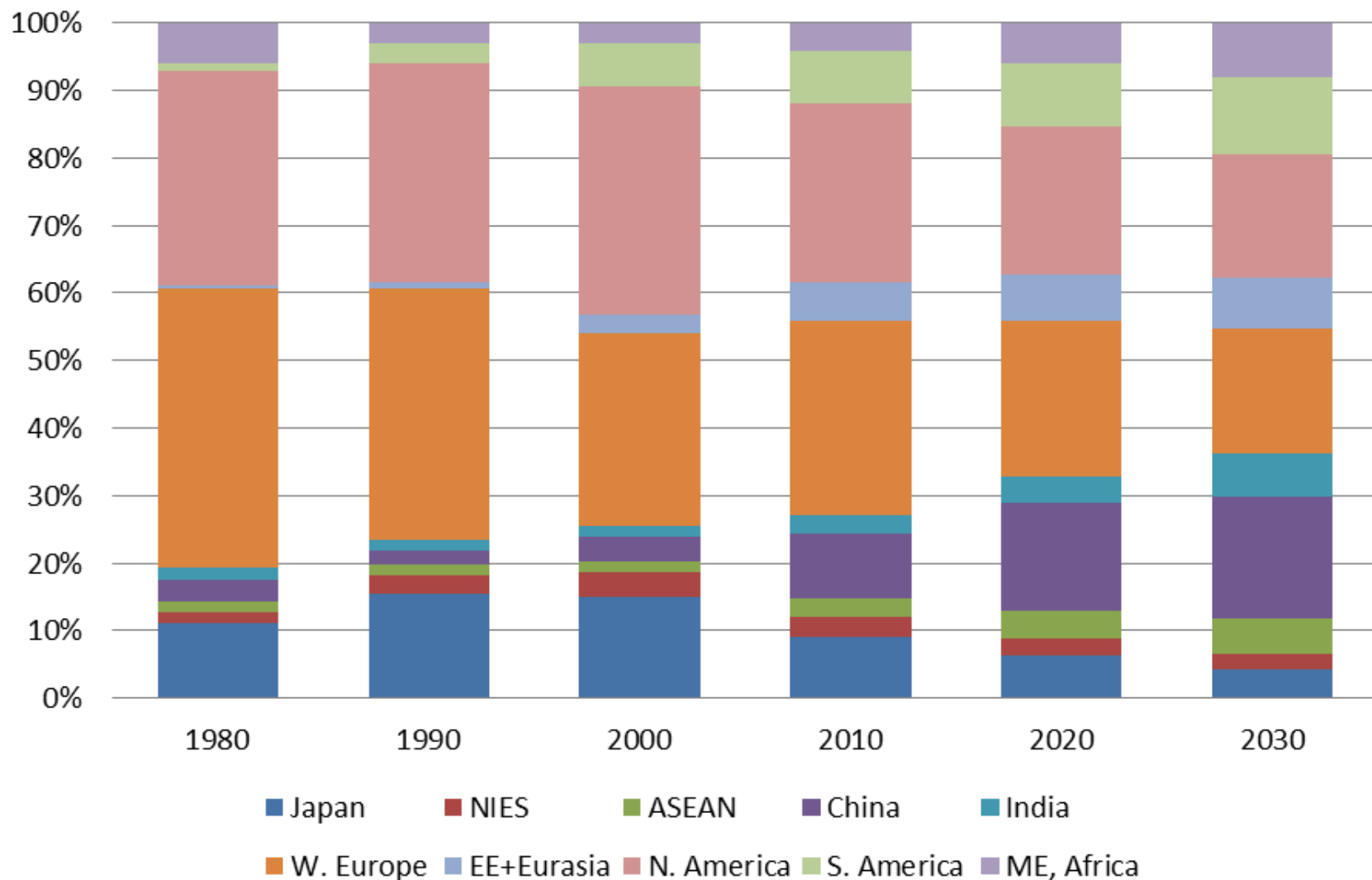
# What is Globalization and why?

Global Business in Emerging Economies

Growing opportunity, but high risk (uncertainty)

- Demand fluctuation : volatilities in GDP growth rate, stock market returns, exchange rate, real estate price ….

- Lack of market institutions, intermediaries : Regulations in capital, labor ..., lower capacity in layers, consultants, accountants …, lack of proper IPR regime..

- Government intervention into market transactions: major business opportunities in government related business (such as public procurement, SOE lead economies such as China, Russia…)

Risk and uncertainty in global business
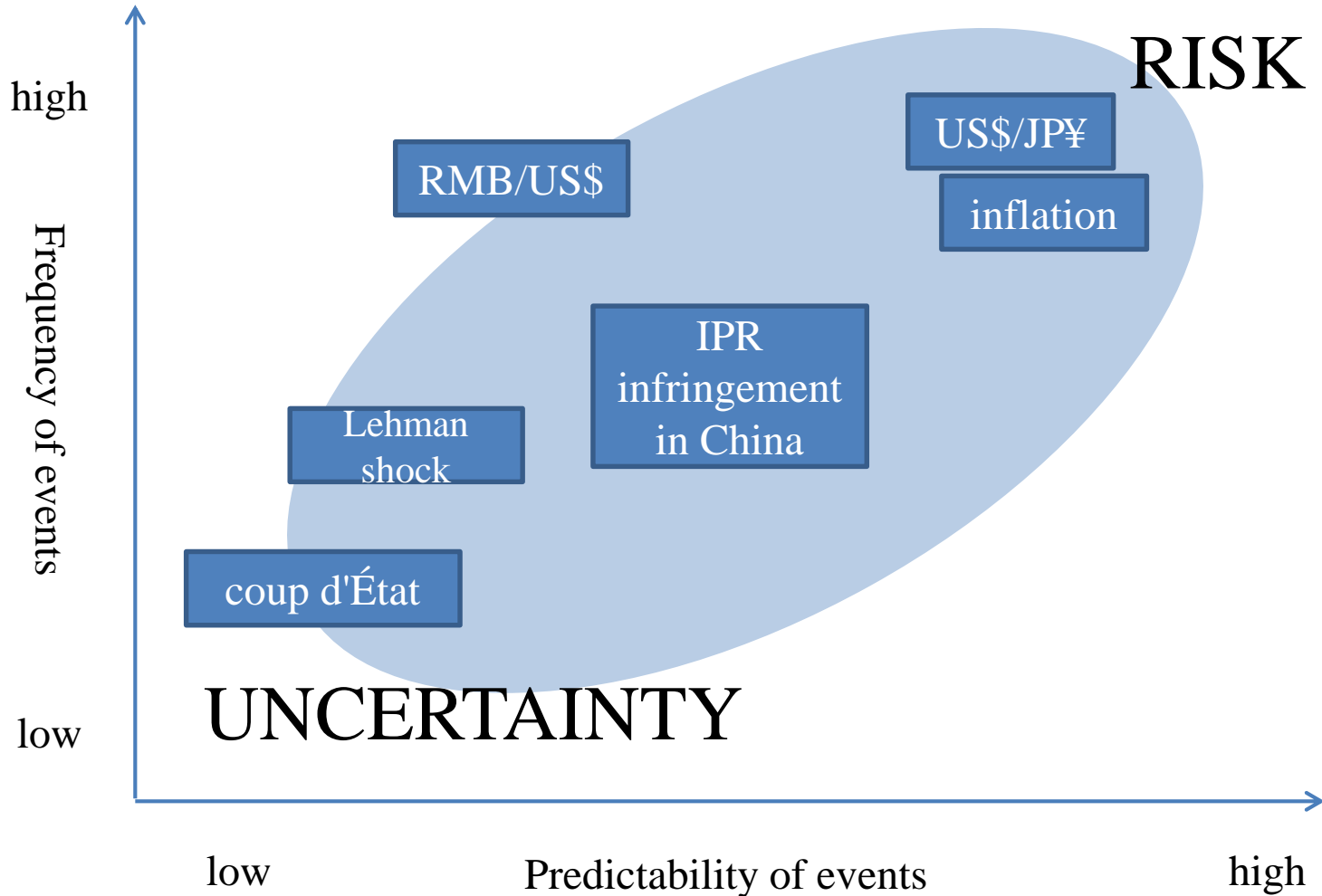
Complex system case: global infrastructure business

- Infrastructure development needs in Asia until 2020 reaches $8 trillion due to urbanization (METI estimates).
- Public money cannot cover such amount, so that PPP (public private partnership) is needed.
- Analyzing infrastructure business is important
  - Risk analysis and simulation
  - Business modeling with relevant players

($ billion)

Water and sewage

Roads

Airports, harbors, and railways

Communications

Energy

Types of PPP
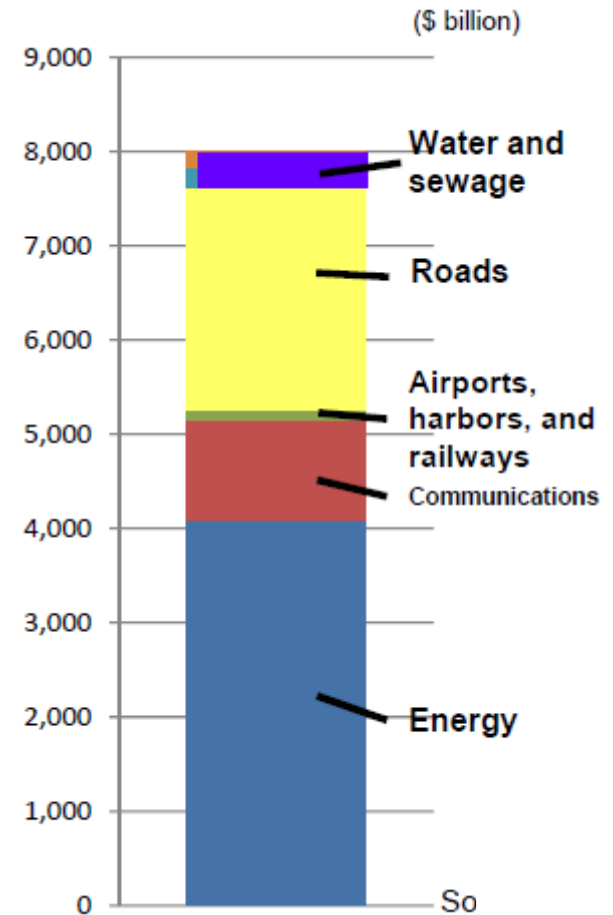
Design → Build → Operation
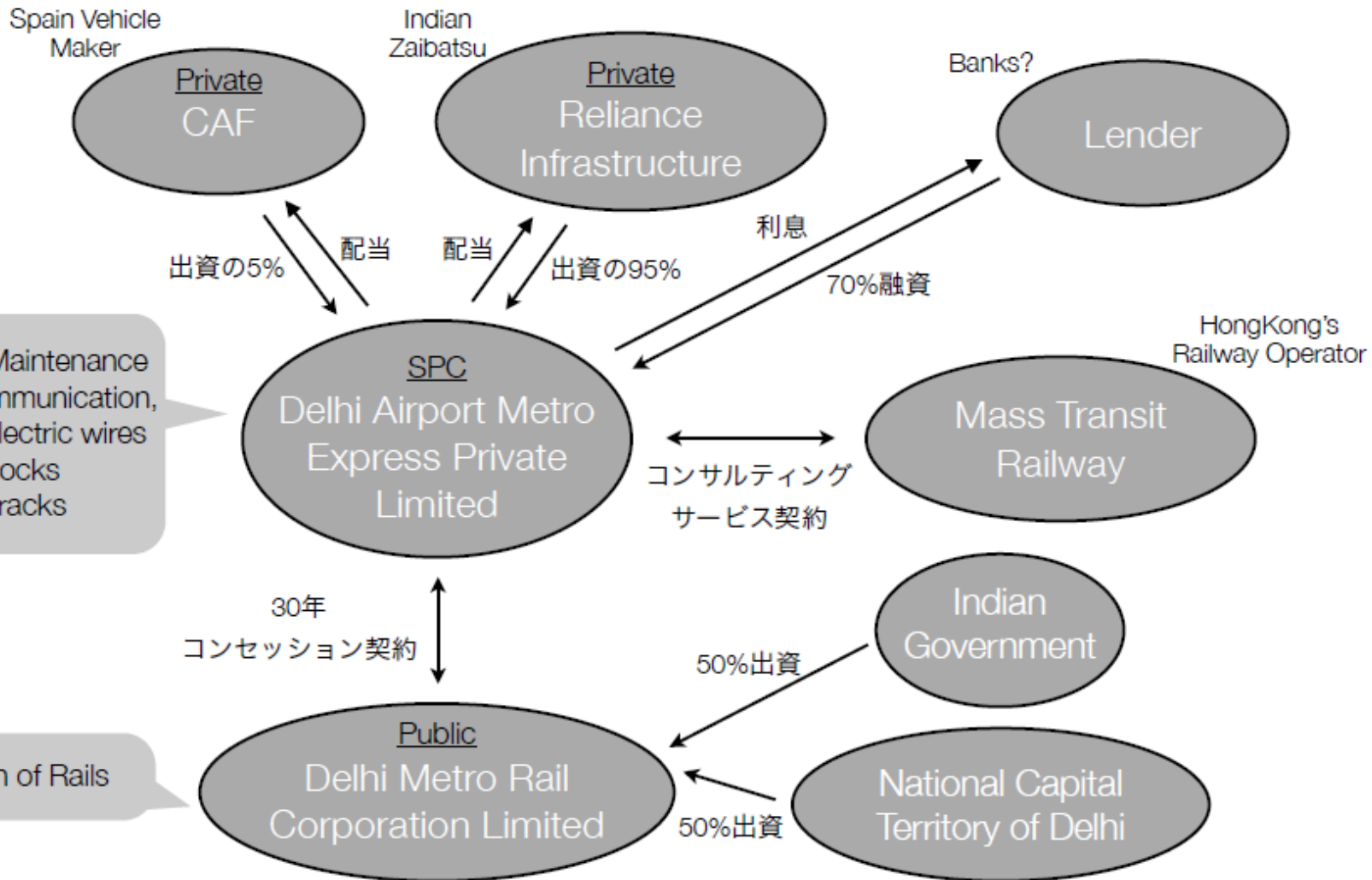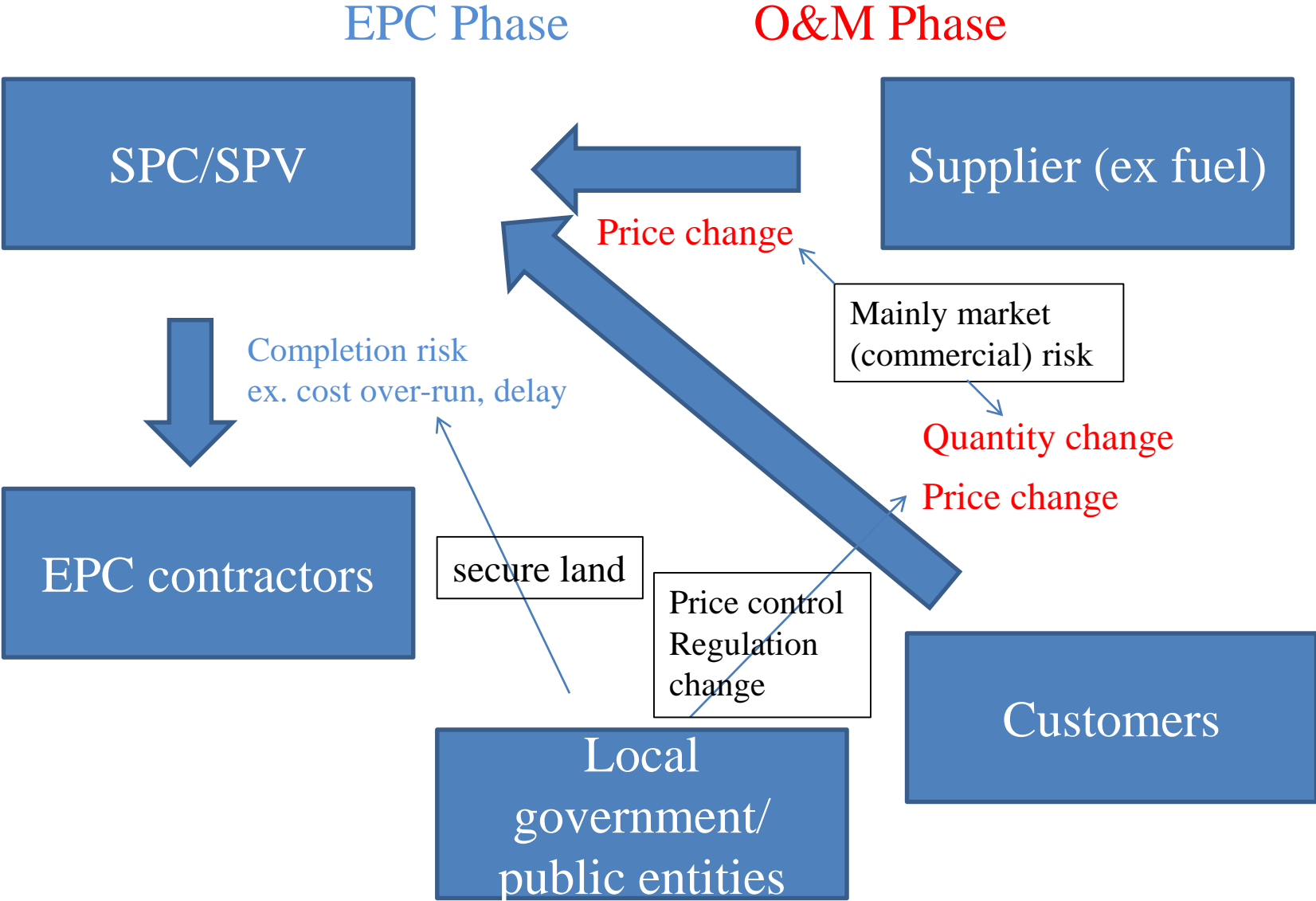
- BOT (Build Operate Transfer): concession contract
- BOO (Build Own Operate)
- Leasing: Public leases out for private, affermarge
- Joint Venture
- Operations or management contract
- Cooperative arrangement: public supports to private

Formation of infrastructure PPP project
(case of Delhi metro airport line)

Risk factors in infrastructure business

EPC Phase   O&M Phase

SPC/SPV   Supplier (ex fuel)

Price change

Completion risk
ex. cost over-run, delay

Mainly market
(commercial) risk

Quantity change

Price change

EPC contractors

secure land

Price control
Regulation
change

Customers

Local
government/
public entities

Risk or uncertainty?
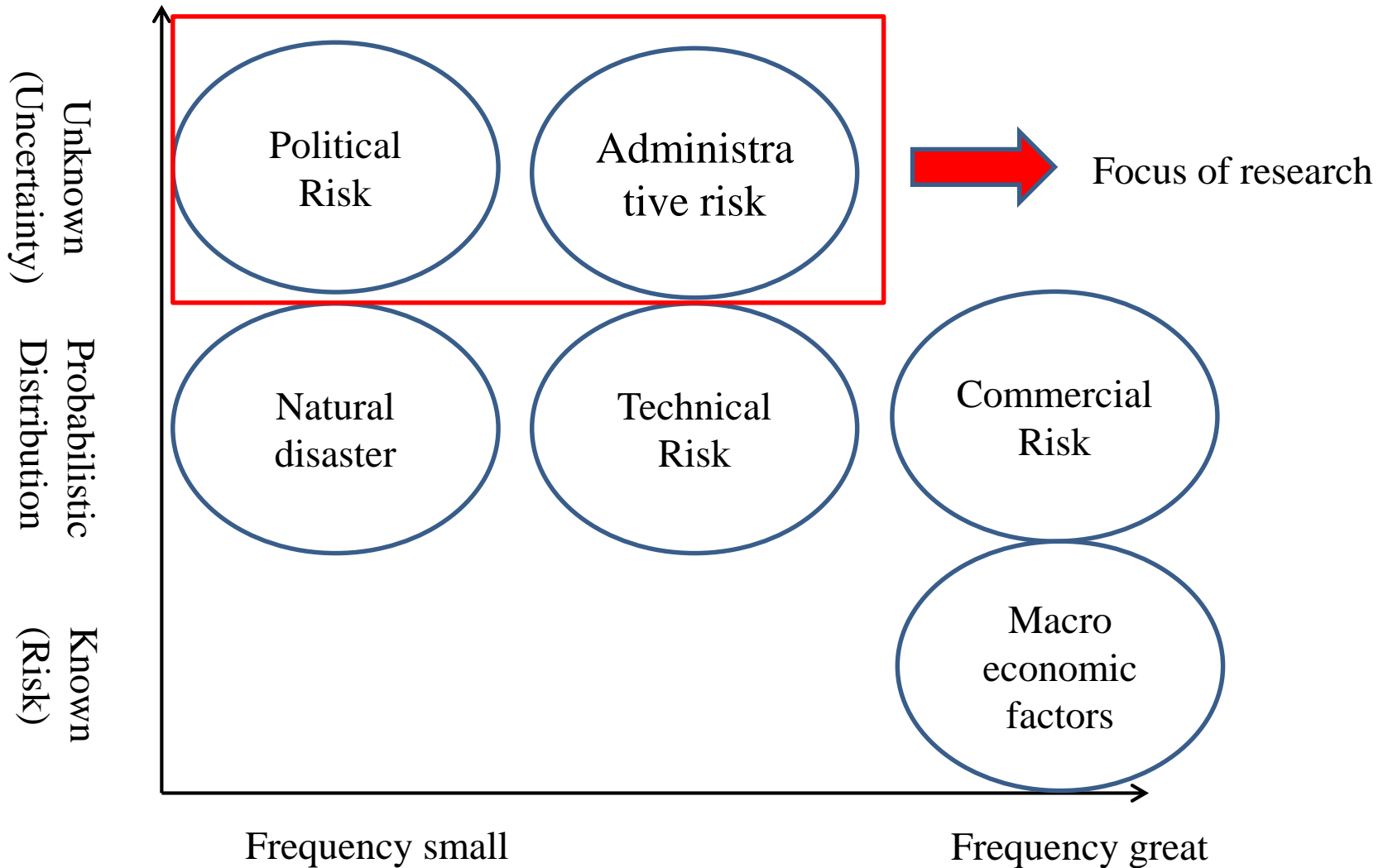
Case Base Approach
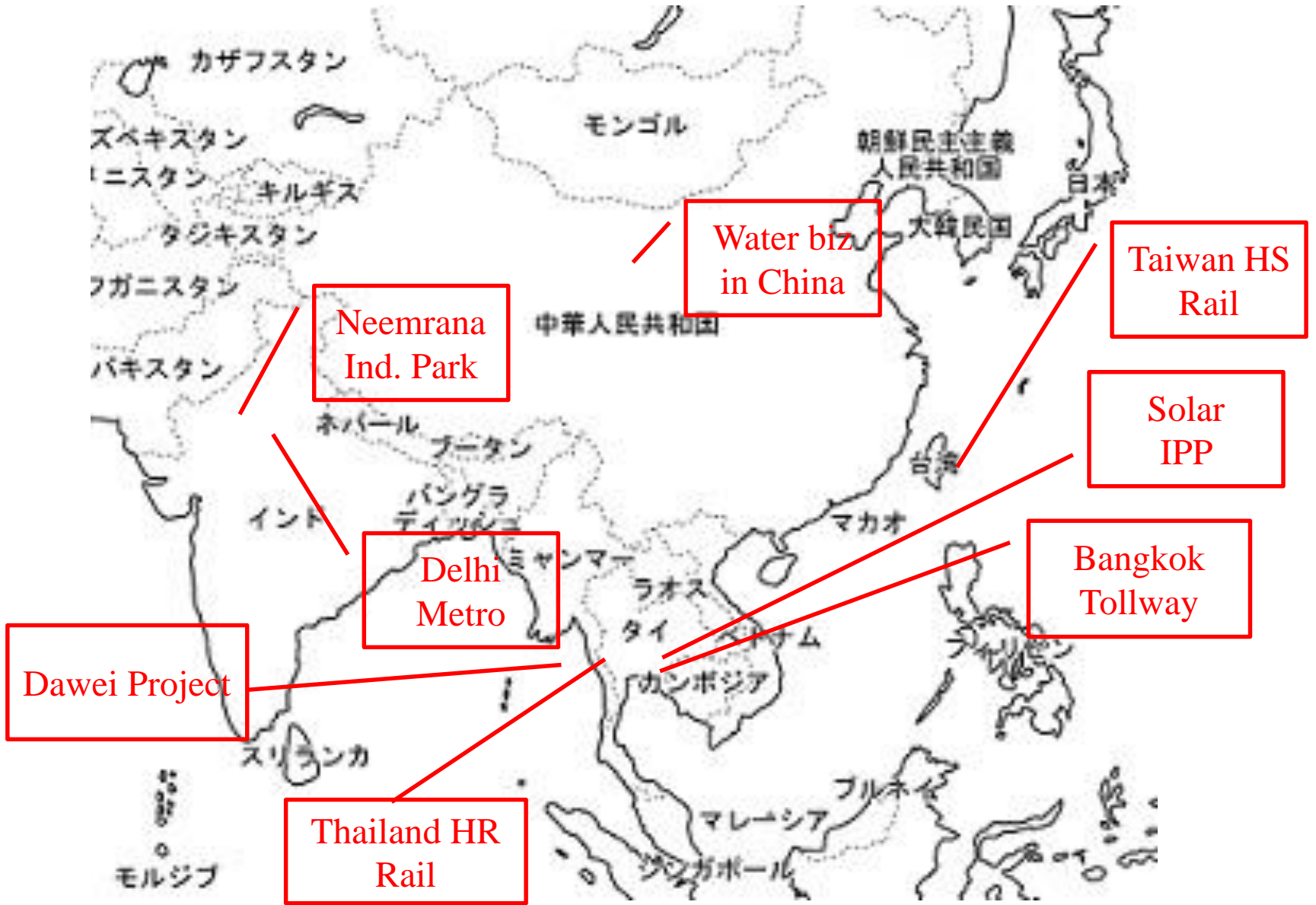
Case: Bangkok Toll Way Project

Source: BECL

プロジェクトのステークホルダー

出資者（50億Bahts）:
熊谷組　65%
アジア開発銀行　5%
チョーカンチャン社　5%
タイ国内銀行　20%
王室財産管理局　5%

融資者（200億Bahts）:
タイ国内銀行団　71%
外国銀行団　25%
アジア開発銀行　4%

2

8

タイ政府

内務省

SPC:
BECL(250億Bahts)

公共部門:
ETA（タイ高速道路公社）

プロジェクトマネジャー
熊谷組

インターナショナル
建設会社S
納入業者S

ETA Engineers

独立設計審査

独立証明審査

設計会社　英国
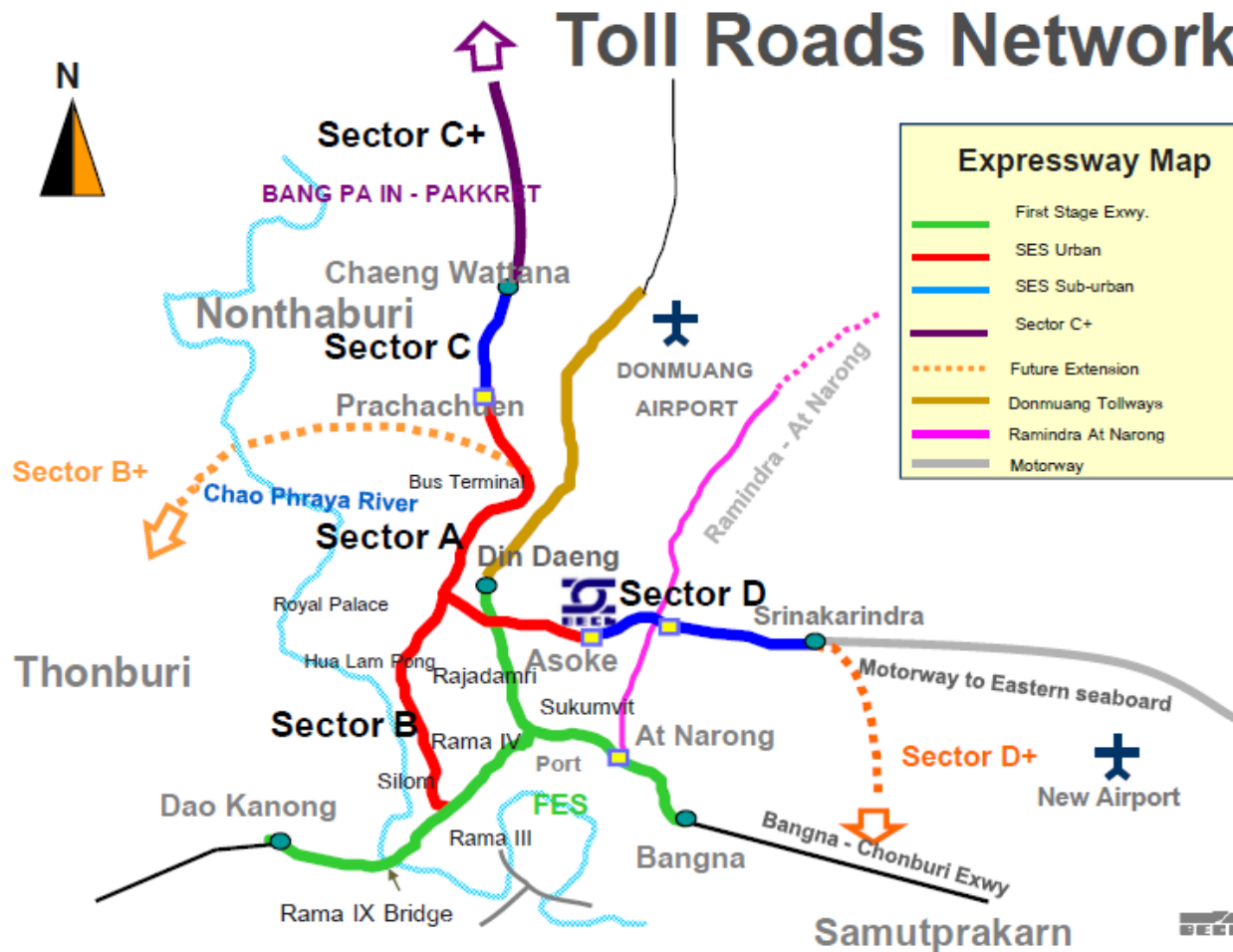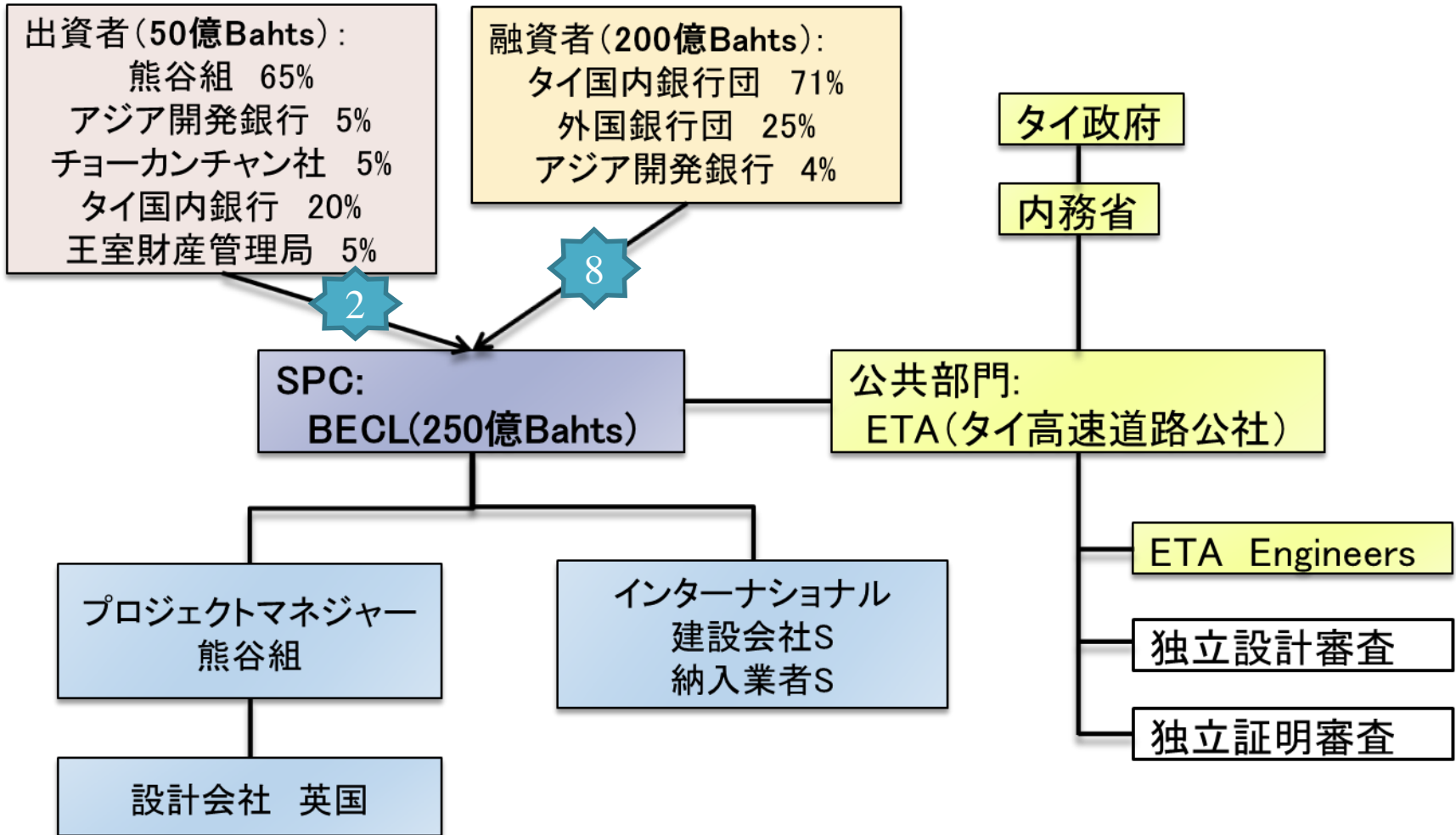
Financial Risk Factors

収入	
売上高	単価(A)×利用台数(B)×収入分配率(C)
単価(A)	前頁参照
CPI	ある会計年度のCPI＝当該前会計年度のCPI×(1＋インフレ率)
インフレ率	確率変数により設定
利用台数(B)	施設キャパシティ×施設利用率
施設キャパシティ	1日につき68万台
施設利用率	確率変数により設定
収入分配率（C）	前項参照

支出	計算方法
運営に関連する費用	運営前、運営期間に分けて、各項目を計上（詳細略）
支払利息	工事着工の翌年から20年間計上、変動金利を用いる。
	元金均等返済によって返済する
金利	LIBOR＋3%の変動金利、LIBORの推移は確率変数により設定
減価償却費	600百万Bを毎年計上（30年均等償却）

Monte Carlo Simulation Results (Conventional Risk Analysis)
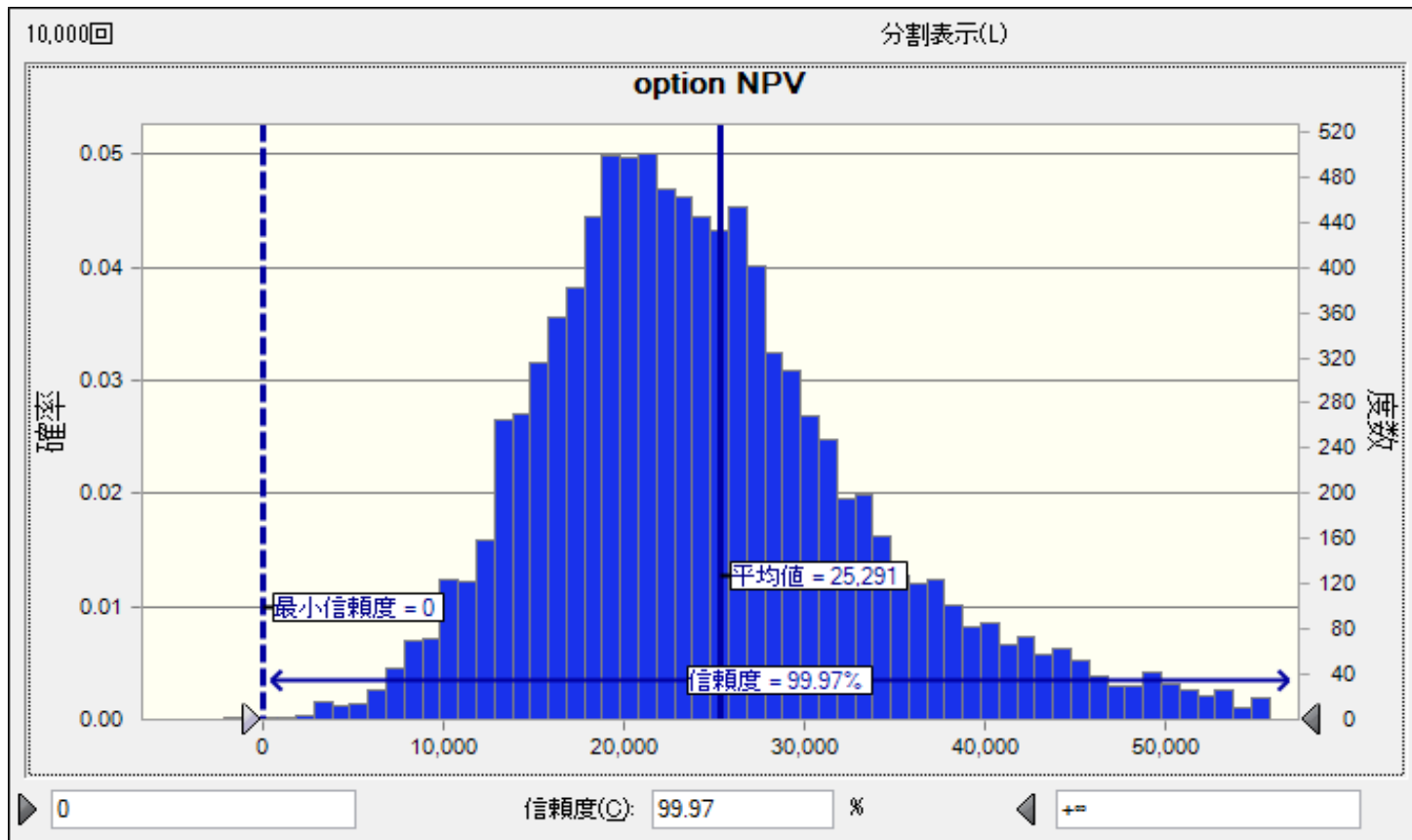
But, reality is more complicated (political and administrative risk)

- Government stopped toll price increase

1987 (at the time of bidding)	Military government by General: Prem Tinsulanonda
1988	Change of prime minster
1990/3	No increase from 10B to 20B
1991/2/23	Military coup d'etati
1992/10	New administration by general election (increase 10B to 15B)
1992/11 Completion of PC part～	Rejection by the government to 30B

BECL was profitable even by these government actions

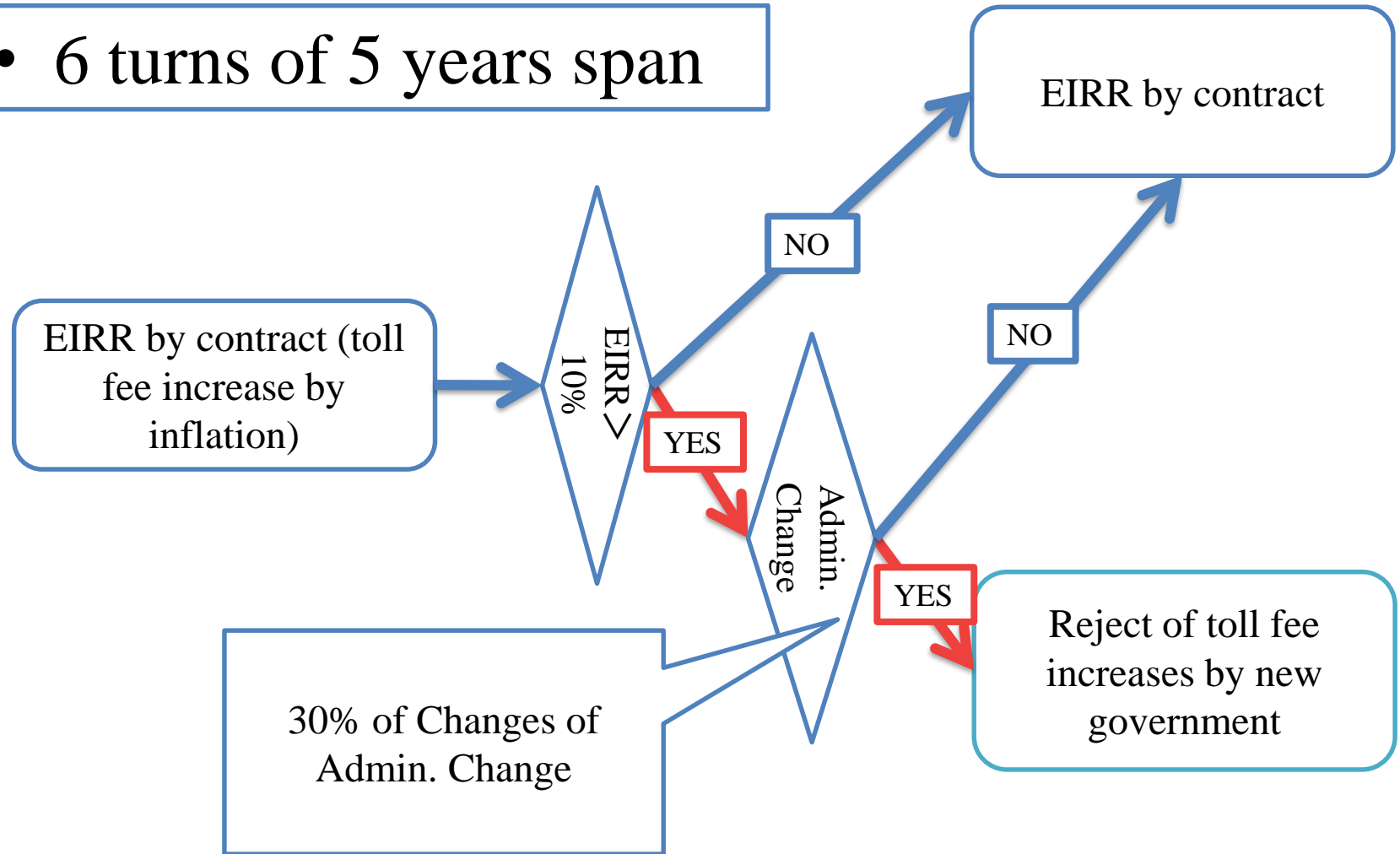# Quantitative analysis of Bangkok Highway project

- Political uncertainty in Thailand
  - 17 times administrative change from 1932 to 1988
  - Coup d'etait in every three years from 1932 to 1992
  - Currently under political disputes

▶ Bangkok 2nd Highway project
  ▶ Affected by administrative change of Thai government in 1980's
  ▶ International dispute resolution process is still underway

Modeling Political Risk

- 6 turns of 5 years span

EIRR by contract

EIRR by contract (toll fee increase by inflation)

EIRR> 10%

NO

Admin. Change

NO

YES

YES

30% of Changes of Admin. Change

Reject of toll fee increases by new government

Use of real option theory for evaluation

- Option: The government reject toll price increase proposal if **EIRR is no less than 10%**

	NPV(mil Baht)	Project IRR(%)	EIRR(%)	LLCR
Base case				
Average	36,473	10.7	11.7	2.105
S.D.	15,301	1.8	4.0	0.611
With option				
Average	25,291	9.4	9.0	1.673
S.D.	10,885	1.6	3.6	0.430

▸ Project IRR is still high (10.7% -> 9.4%)

▸ EIRR: The probability of no less than 5.6% (Thailand TB rate) is also high (95.14%⇒86.71%)

▸ LLCR: The probability of no less than 1.5 decreases (85.28%⇒63.39%)
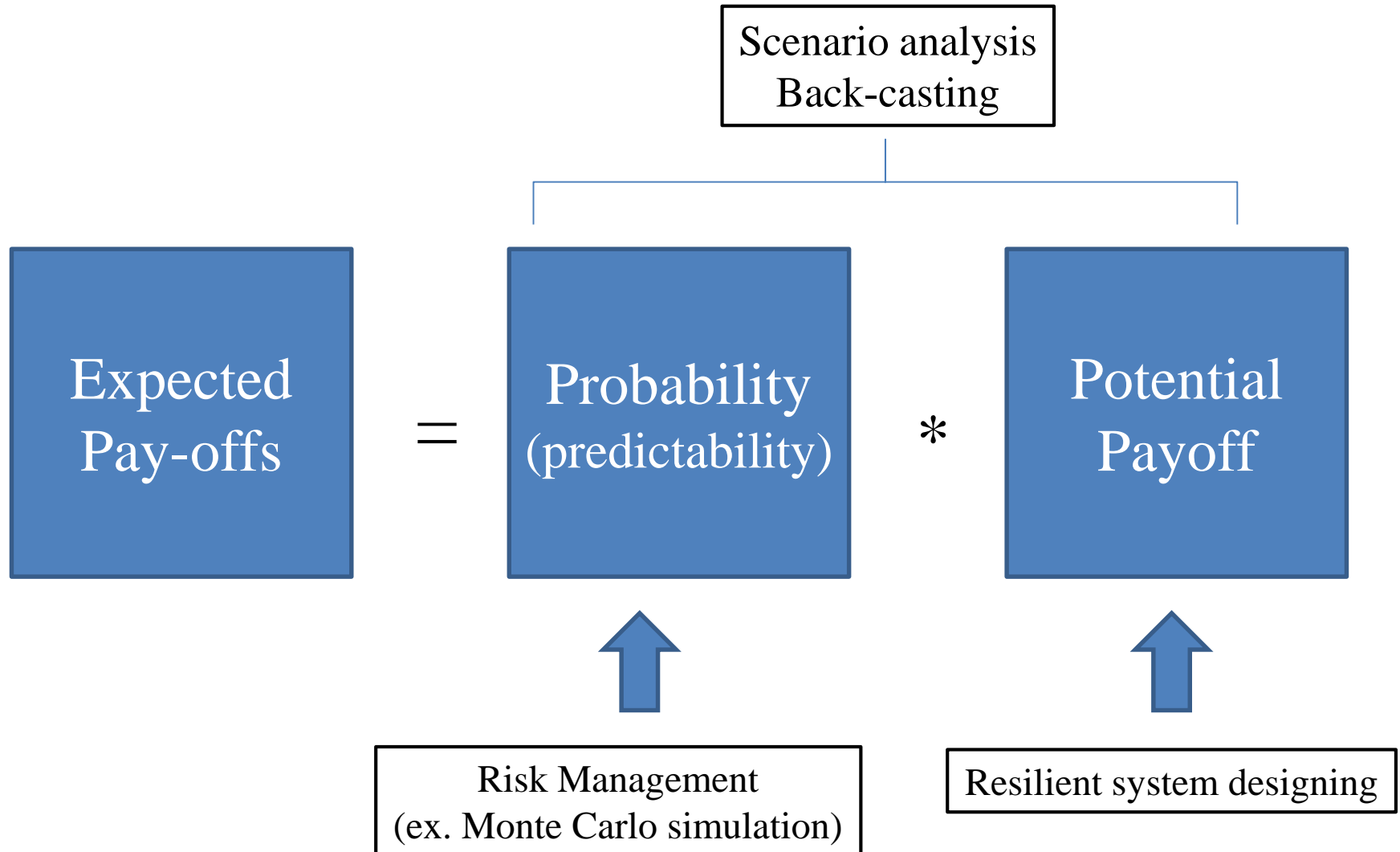
Political risk simulation

> ▸ What happens if political risk increases or decreases
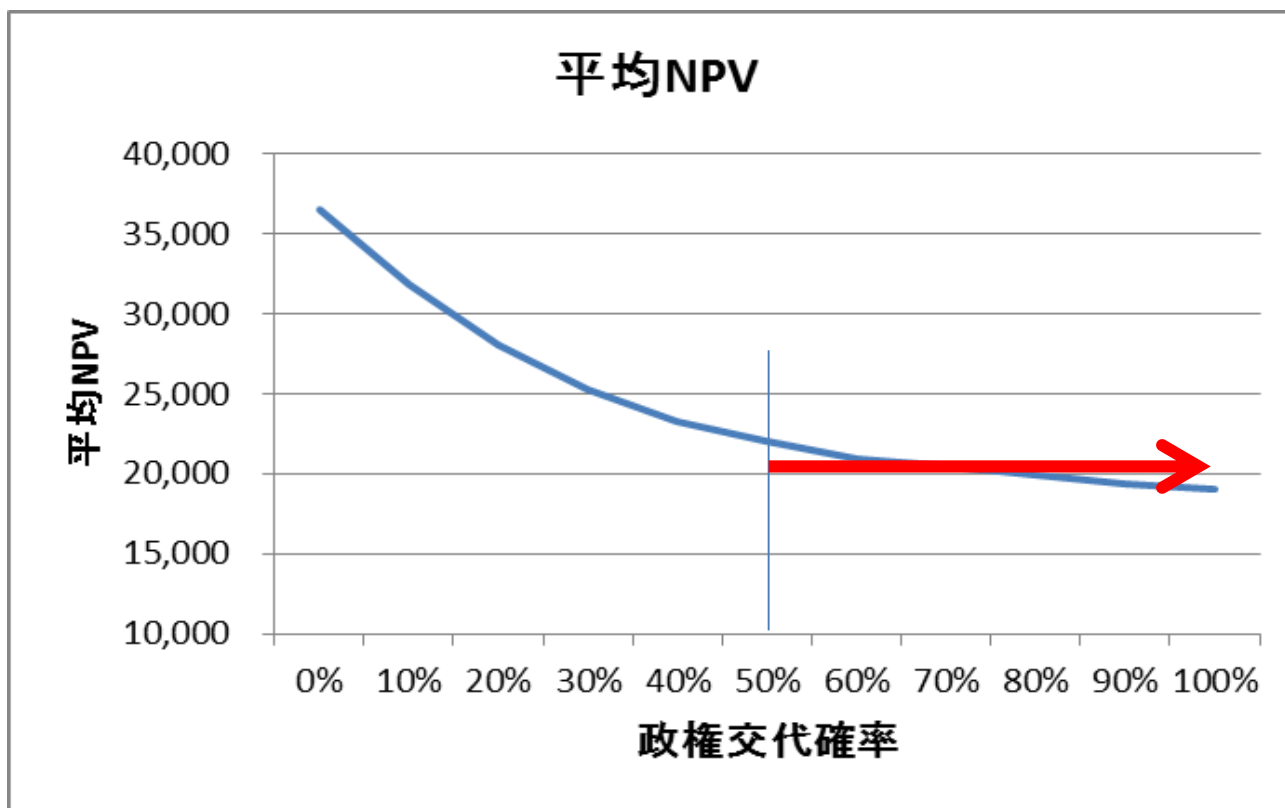
Implications toward resilient system

- Risk analysis, such as MC simulation (NPV analysis) required risk identification with probability distribution information (assumption)
- Real option approach to political risk: one of risk management tools
- There may be some risk hedge tools as well (such as insurance)
- However, what if (unpredictable) uncertainty?
  - Ex-ante resiliency: Investigating risk sharing scheme, such as ODA scheme (Japanese government intervention in overseas contract via overseas development aide formation)
  - Ex-post resiliency: Exit strategy of project (increasing liquidity of stock, relationship with secondary market players etc)

What is resilient engineering?

Scenario analysis
Back-casting

Expected
Pay-offs

$=$

Probability
(predictability)

$*$

Potential
Payoff

Risk Management
(ex. Monte Carlo simulation)

Resilient system designing

Resilient and system approach is required for some questions

	Impact: Clearly Defined	**Impact: Not Clear**
Risk (Predictability）	Commercial risk, financial risk to infrastructure project	Exchange rate change impact on overall global infrastructure project
Uncertainty （Less predictable)	Political risk at infrastructure project	Is it appropriate to use out tax money for infrastructure export?

→ Ex-Ante prevention

→ Ex- Post Resiliency

Monte Carlo Simulation   System's Approach

Complex system of PPP project
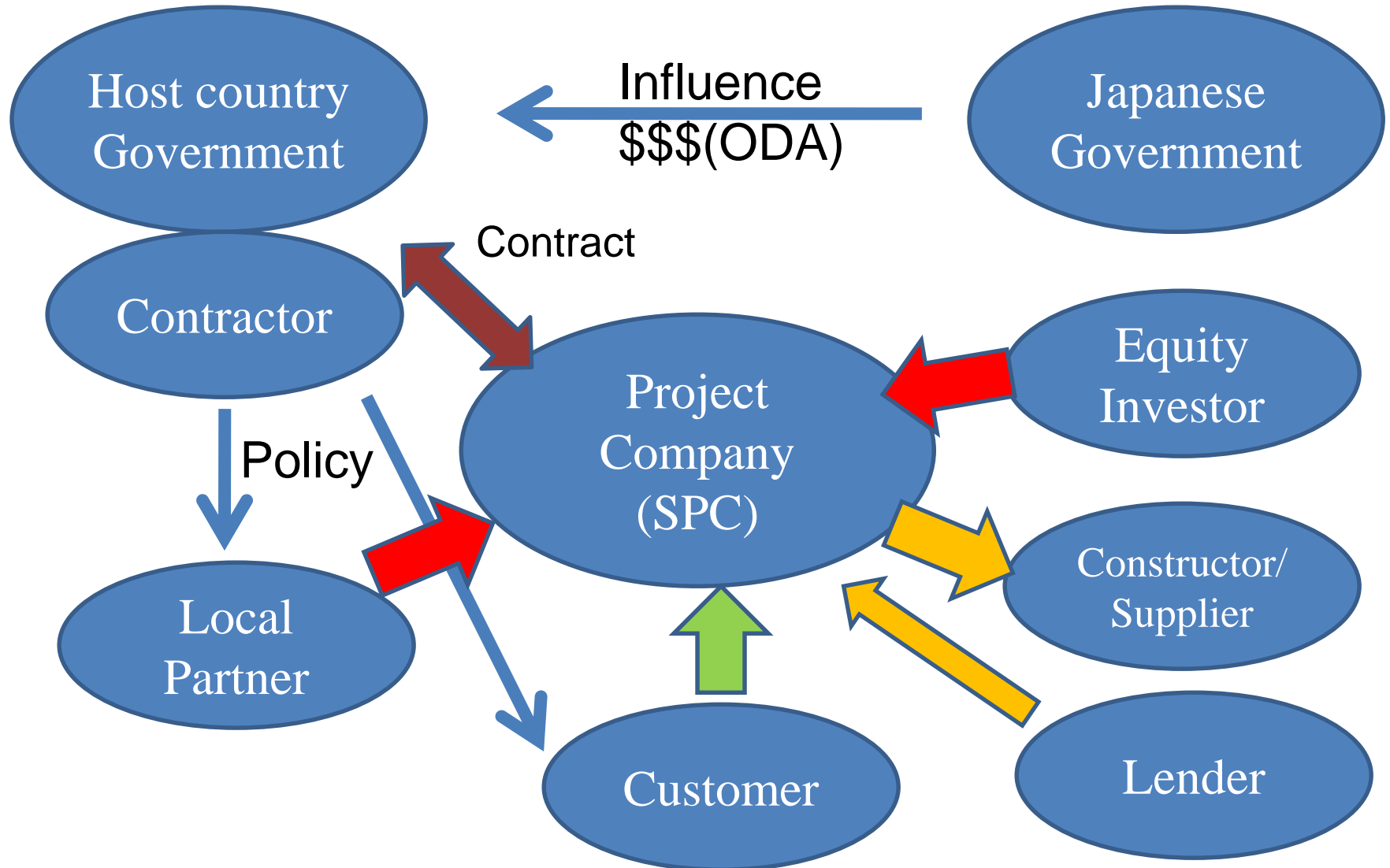
Question for 1 page report

Can you explain briefly the concept of resilient system design by using some example? You can use the today's case of infrastructure development as an example, but you can also create your own example.

Resilient and system approach is required for some questions

	評価関数が明確	評価軸の多様性
リスク（事前確率分布予測）	インフラプロジェクト事業性（NPV）に対するインフレの影響	インフラ官民連携プロジェクトの成功度に対する金利変動の影響
不確実性（予測不可能)	インフラプロジェクト事業性（NPV）に対する政権交代の影響	インフラ官民連携プロジェクトの成功度に対する政権交代の影響

→ リスクマネジメント

→ レジリエント設計

モンテカルロ
シミュレーション

システム分析
（例えばABM）