# Green Transition, Fiscal Soundness, and Sustainability of Infrastructure Investments

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Outline

1, AI and DX: Impact on the Asian economy
2, Infrastructure Finance and Maintenance
3, Comparison of Various Green Policies
4, Fiscal Sustainability and Aging Population
5, Crowdfunding and regional development
6, Equivalence of Various Green Policies
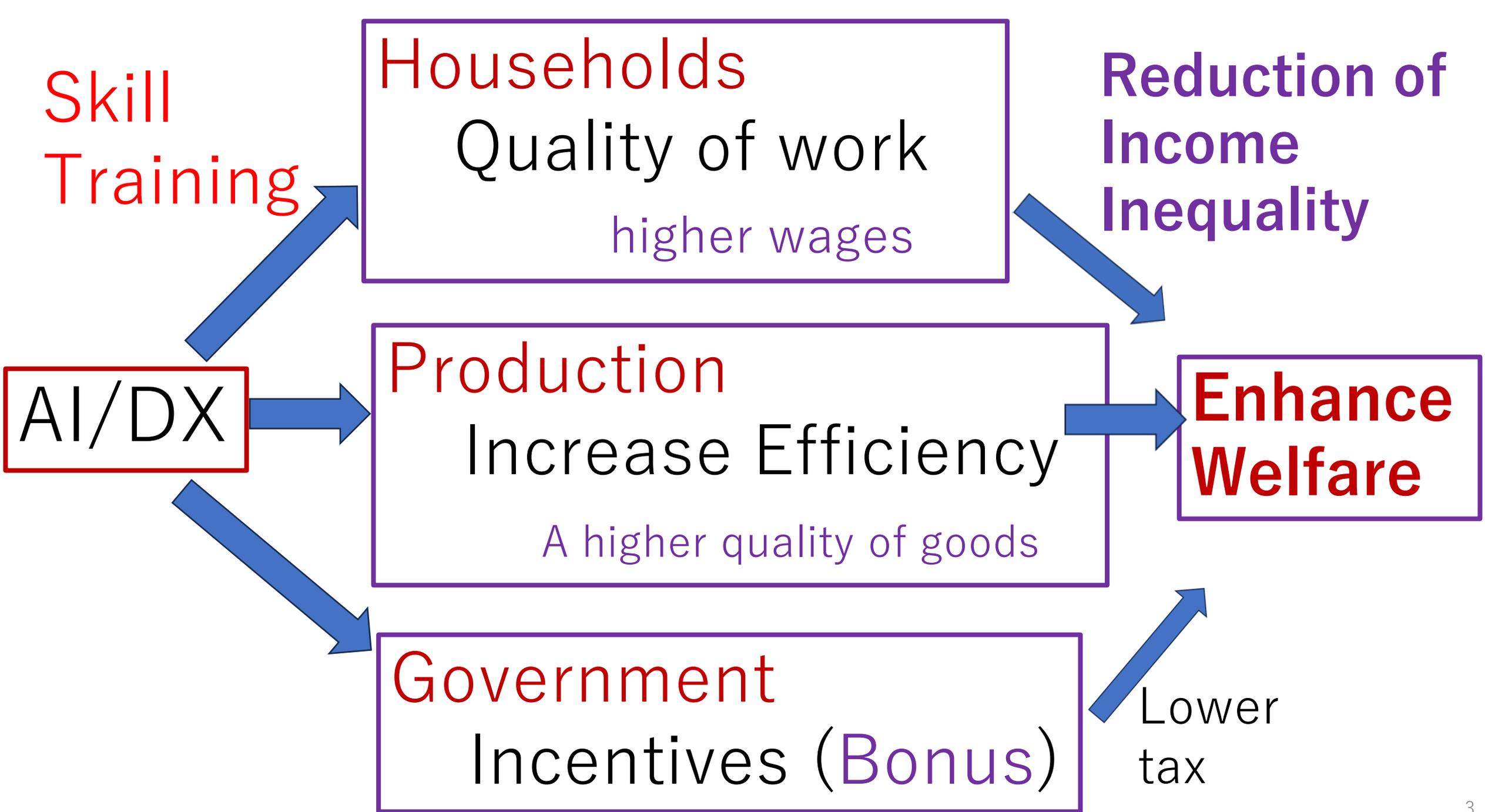
Economic Model with AI & DX

(1)**Households:** **Welfare increase**

U（C, H）: Increase by Remote ork and AI
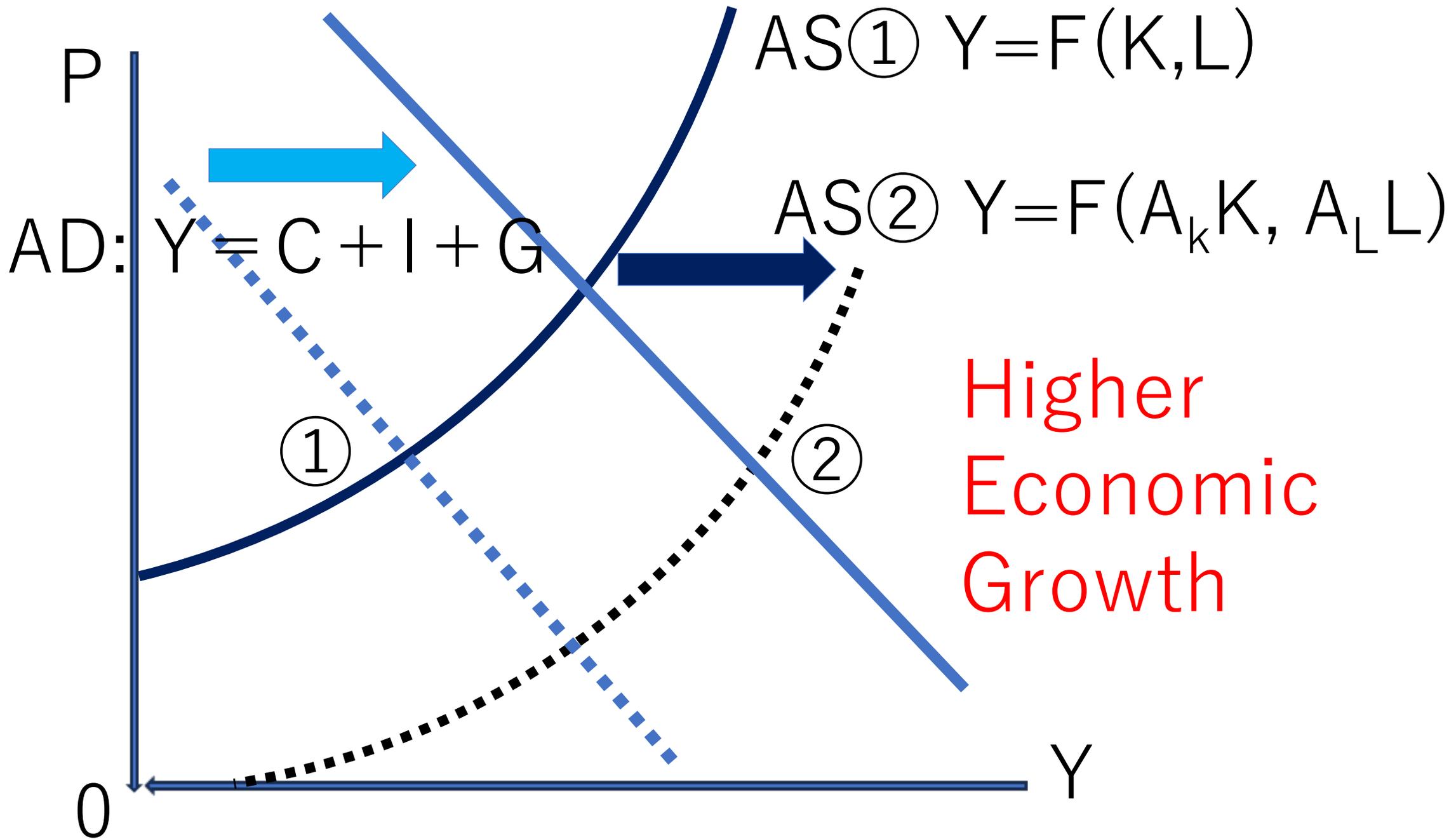
sub. to $C + P_H H + S = wL + rS_{t-1} - TAX$

(2)**Production Sector:** **Productivity increase**

$Y = F(A_k K, A_L, L)$ Technological Progress

(3)**Government Sector:** **Better efficiency**

$G = TAX + GB$ Efficient Government

P

AS① Y=F(K,L)

AD: Y=C+I+G

AS② $Y=F(A_k K, A_L L)$

①

②

Higher Economic Growth

0

Y

2, Spillover Effects of Public Utilities

Increase of Spillover Tax Revenues

New Housing & Offices

School

Restaurant

Manufacturing

Water Supply

Economic Effects of Infrastructure

Effects on GDP

L= Labor   **Agricultural sector**

Kp = Private Capital   **Manufacturing sector**

Kg = Infrastructure   **Services' sector**

(GDP) Y = F (Kp, L, Kg,)

Increase in Tax Revenues

Property Tax, Corporate Tax

Income Tax, Sales Tax

$$Y = F(K_P, L, K_G) \tag{1}$$

Where K_p is private capital, L stands for labour and K_G is stock of infrastructure investment. The general type of production function is a translog production function.

$$\ln Y = \alpha_0 + \alpha_1 \ln K_P + \alpha_2 \ln E + \alpha_3 \ln K_G + \beta_1 \frac{1}{2}(\ln K_P)^2 + \beta_2 \ln K_P \ln L + \beta_3 \ln K_P \ln K_G$$
$$+ \beta_4 \frac{1}{2}(\ln L)^2 + \beta_5 \ln L \ln K_G + \beta_6 \frac{1}{2}(\ln K_G)^2 \tag{2}$$

In Equation (3), the first term on the right comes under the direct effect, where an increase in marginal productivity is due to new infrastructure investment. The second term is the spillover effect regarding the private capital, and the third represents the spillover effect related to the labour input. The productivity effect of infrastructure is expressed in marginal productivity.

$$\frac{dY}{dK_G} = \frac{\partial F(K_P, L, K_G)}{\partial K_G} + \frac{\partial F(K_P, L, K_G)}{\partial K_P}\frac{\partial K_P}{\partial K_G} + \frac{\partial F(K_P, L, K_G)}{\partial L}\frac{\partial L}{\partial K_G} \tag{3}$$

Spillover effects of Japan 1956-2010
Direct Effect = 32%
Spillover Effects = 68%

|	1956-60	1961-65	1966-70	1971-75	1976-80	1981-85
Direct effect of infrastructure investment	0.696	0.737	0.638	0.508	0.359	0.275
Spillover effect through private capital (Kp)	0.452	0.557	0.493	0.389	0.270	0.203
Spillover effect through employment (L)	1.071	0.973	0.814	0.639	0.448	0.350
Spillover effects of infrastructure investment (percentage)	68.644	67.481	67.210	66.907	66.691	66.777 **%**
	1986-90	**1991-95**	**1996-2000**	**2001-05**	**2006-10**	
Direct effect of infrastructure investment	0.215	0.181	0.135	0.114	0.108	
Spillover effect through private capital (Kp)	0.174	0.146	0.110	0.091	0.085	
Spillover effect through employment (L)	0.247	0.208	0.154	0.132	0.125	
Spillover effects of infrastructure investment (percentage)	66.222	66.200	66.094	66.122	66.139 **%**	

Source: (Nakahigashi and Yoshino, 2016[3]).

Figure 5.6: Conflict of Interest between Users and Investors

Users → Infrastructure ← Private Investors

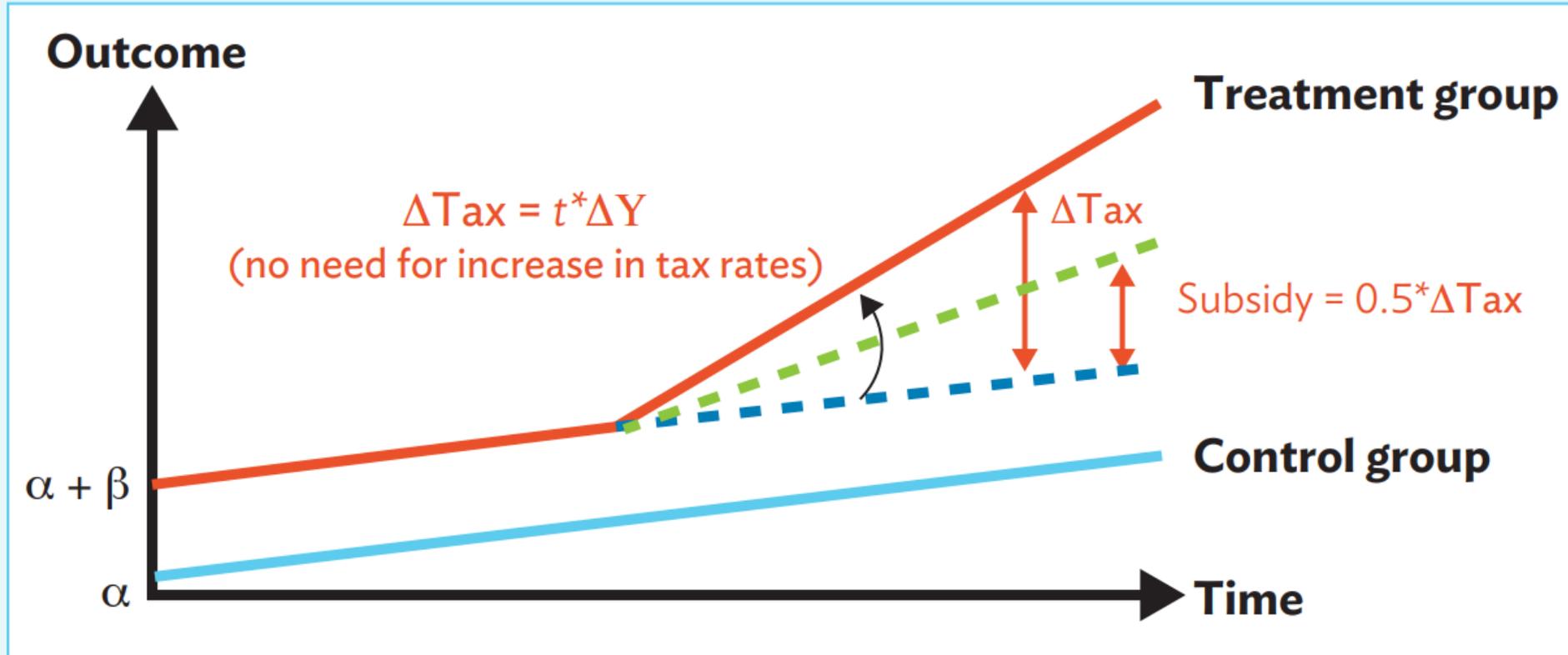low fee   high rate of return

Conflicts
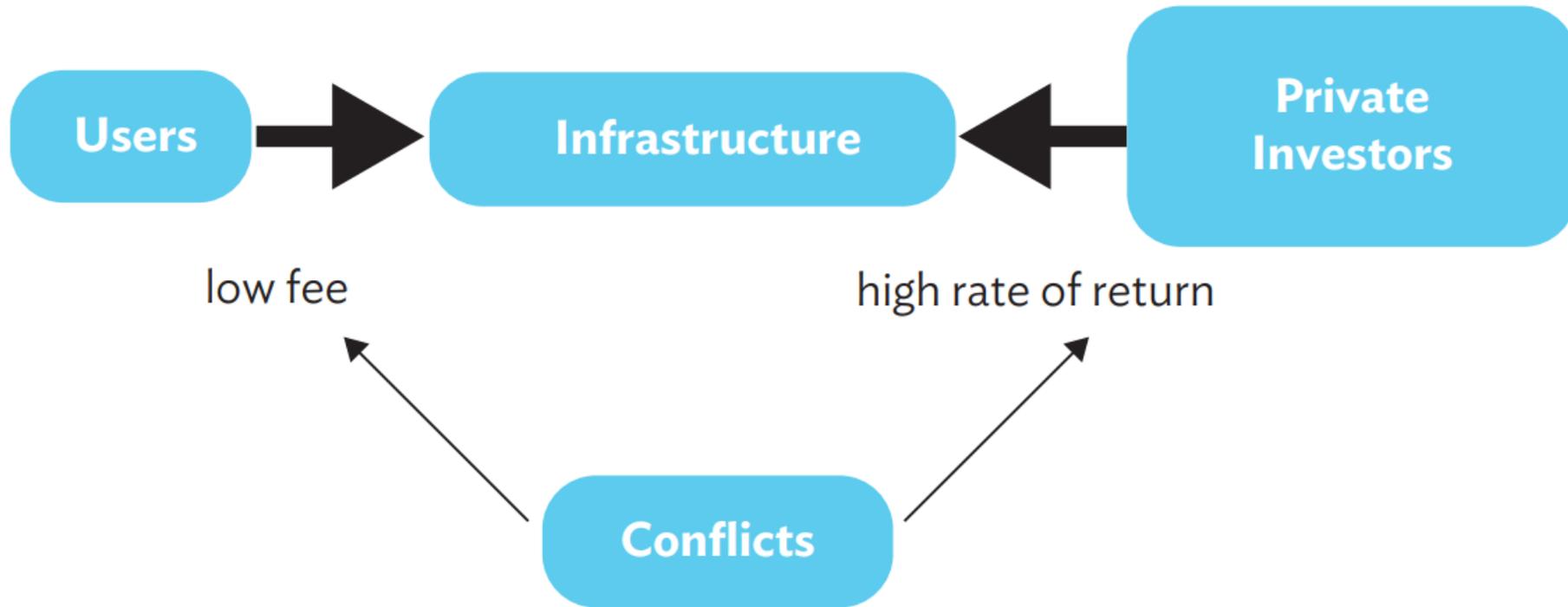
Yoshino, N., S. Lakhia, and J. T. Yap. (2021). "Financing Sustainable Infrastructure Investment in ASEAN+3". in Guinigundo, D., Kawai, M., Park, C. Y., Rajan, R. S. Redefining Strategic Routes to Financial Resilience in ASEAN+3. Manila, Philippines, ADB.

Injection of a fraction of tax revenues gained from spillover effect
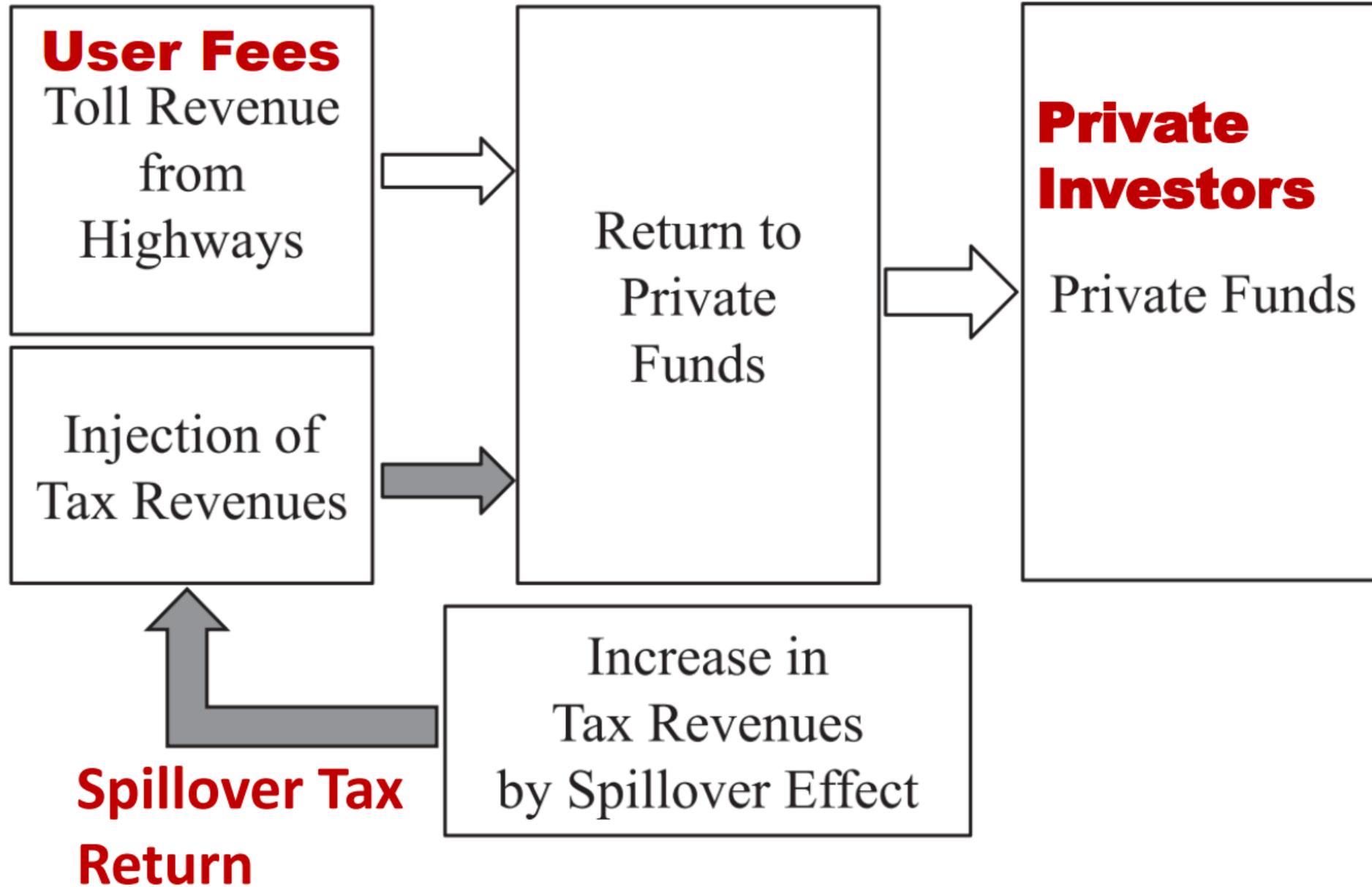
Give Incentives to Infrastructure Developers to increase regional economic impacts

Diagram of Spillover Tax Revenues

$\Delta \text{Tax} = t * \Delta Y$
(no need for increase in tax rates)

ΔTax

Subsidy = 0.5*ΔTax

Treatment group

Control group

Outcome

$\alpha + \beta$

α

Time

Source: Yoshino, Abidhadjaev, and Nakahigashi (2019).

Indian GSM (Global System for Mobile Communications)
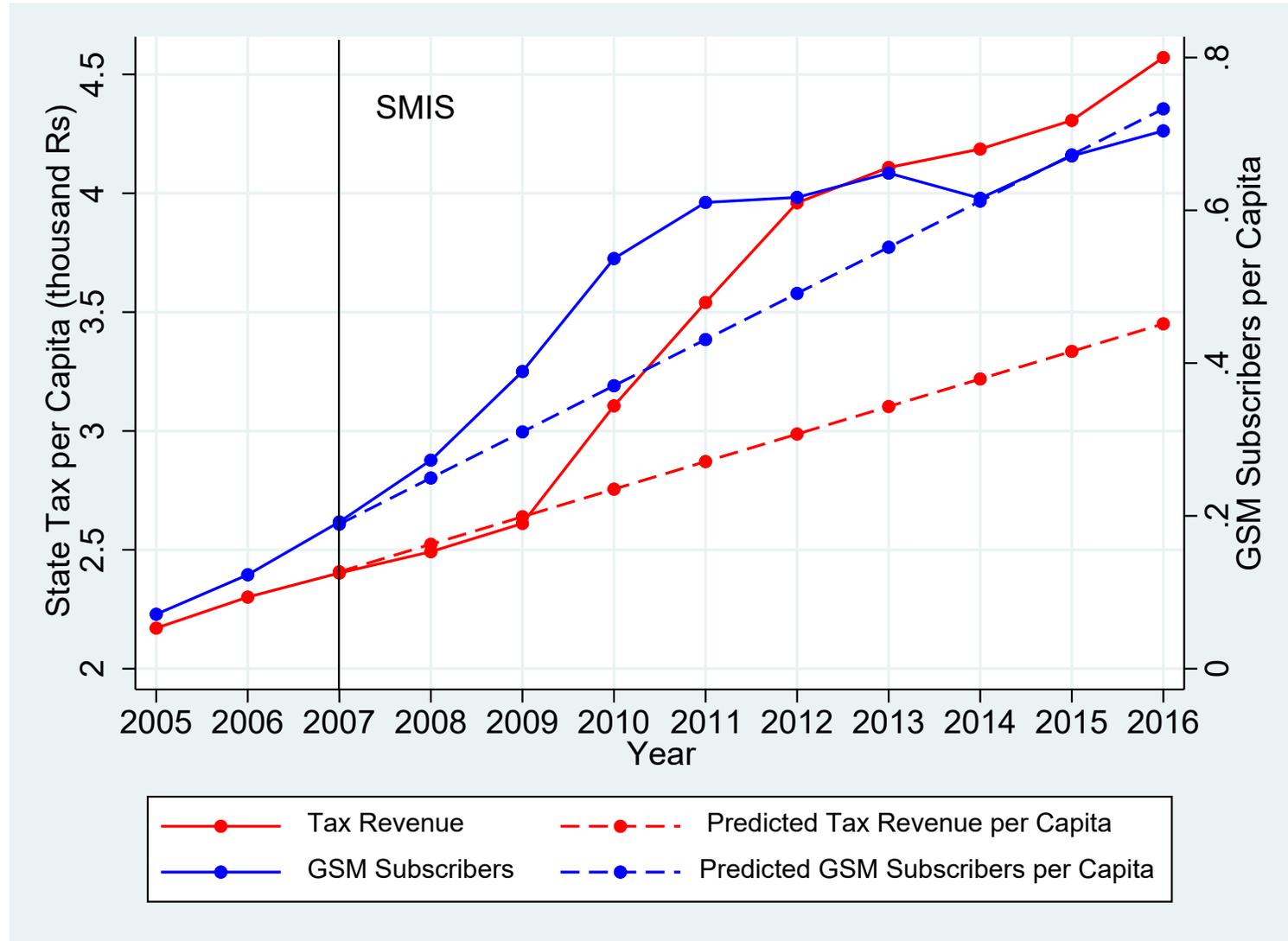
Policy Implications Digital Infrastructure India's case

- One way to ensure that private sector remains attracted to infrastructure development is to provide a steady stream of income for them. We argue that that could be achieved by sharing the spillover effects of ICT infrastructure on taxes obtained by the government with the investors/operators of the infrastructure

- The amount of tax revenues to be shared by the gov't with the investors can be calculated using

Based on our estimation, if 50 % of increased tax revenues were returned to mobile operators, the rate of return will rise about 14.2%

Increased by 14.2%

Source: Yoshino et. al. (2019)

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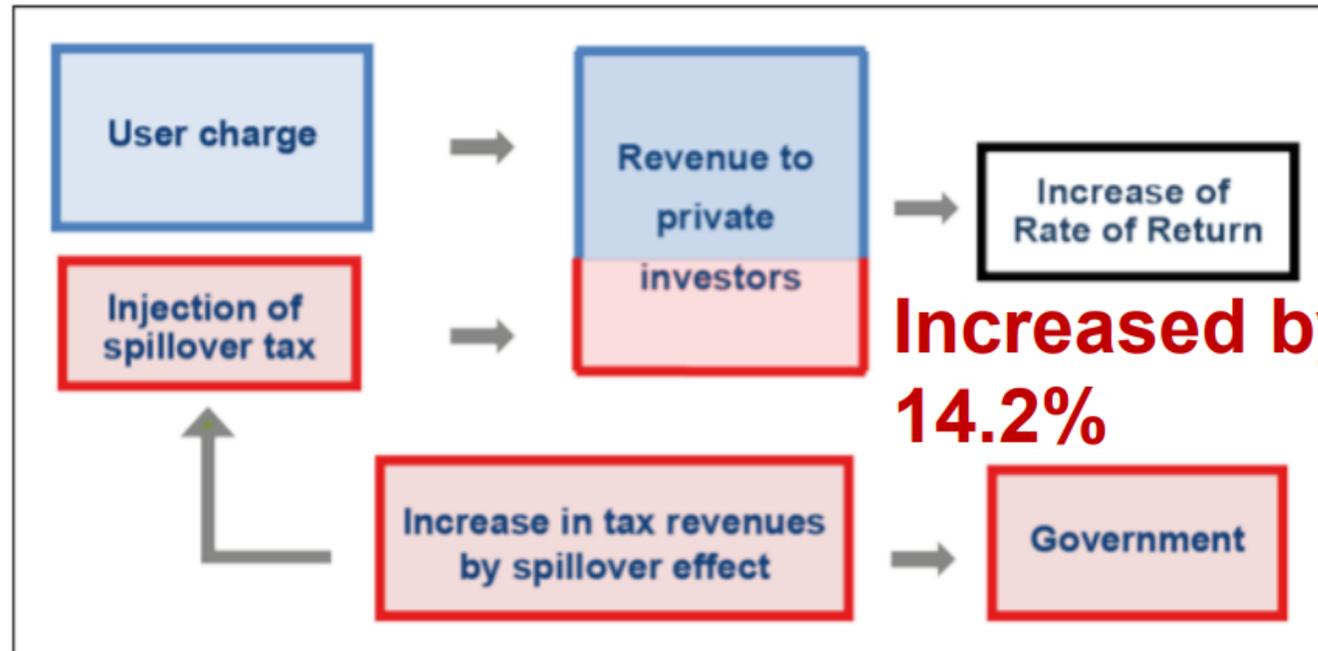
Pricing of Utilities -- Full Cost Recovery

Regarding the way to set up the user charges of the public utilities, the profit function of the public utility is written as follows: **Total Fee Revenue = PuGu = 2513843 (million US$)**

$$\pi = P_u G_u - C(G_u)$$

Total Costs = C(Gu) = 9708000 (million US$)

Where PuGu stands for the revenues. C(Gu) is the total costs of the public utility company. If the user price of the public utility is set to the full cost recovery, the price of the public utility will be set as follows:

$\pi = 0$ Full cost recovery, where the profit of the public utility is set to zero.

Current Price $P_u = \dfrac{C(G_u)}{G_u}$ **= (9708/2513)x3.86**

$$\widetilde{\pi} = P_u \, G_u - C(G_u) + SUB$$

where SUB is the subsidy from the general budget to the public utility company.

The government can provide subsidies to keep the user fees **at** a low level.

$$\widetilde{P_u} = \frac{C(G_u) - SUB}{G_u}$$

The user price of public utility after the injection of the subsidy
The user price of the public utility will become as follows
when part of the spillover tax revenues were returned.

$$P_u^{**} = \frac{C(G_u) - \theta\{t\,\Delta Y(K,L,K_G)\}}{G_u}$$

The user price of public utility by taking account of spillover tax return
If the spillover effects of the public utility would be large,
the user price P_u^{**} will be lower than the original price of the public utility.

$$P_u^{**} < P_u$$

Proposed Pricing

$$P_u^{**} < \widetilde{P_u}$$

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3, Recommended Fiscal Policy in Asia

Impact of Fiscal Policy: Keynesian Multiplier

Government Spending
→ New Job Creation
  → Reduction of unemployment
  → Increase in income
  → Rise in Consumption
  → Fiscal Multiplier Effects

$$\Delta Y = \frac{1}{1-c} \Delta G$$

Singapore Economic Review, 2024

INVITED PAPER
COMPARISON OF VARIOUS FISCAL POLICIES IN THE FACE OF DIFFERENT DEMOGRAPHIC STAGES

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Comparison of Various Fiscal Policies

1, Government Consumption

3, Public Investment

2, One-time Transfer

4, R&D Expenditure

	Period After Policy Implication	Government Consumption	One-Time Transfer	Public Investment	R&D Expenditure
Young population ($\phi = 0.85$)	Short term ($k = 5$)	0.366	0.024	0.203	0.979
	Long term ($k = 20$)	0.171	0.011	0.589	2.359
Old population ($\phi = 0.55$)	Short term ($k = 5$)	0.342	0.094	0.170	0.830
	Long term ($k = 20$)	0.247	0.068	0.509	2.149

Rethinking the Domar (r–g) Condition: Its Application to Greece, Japan, and China

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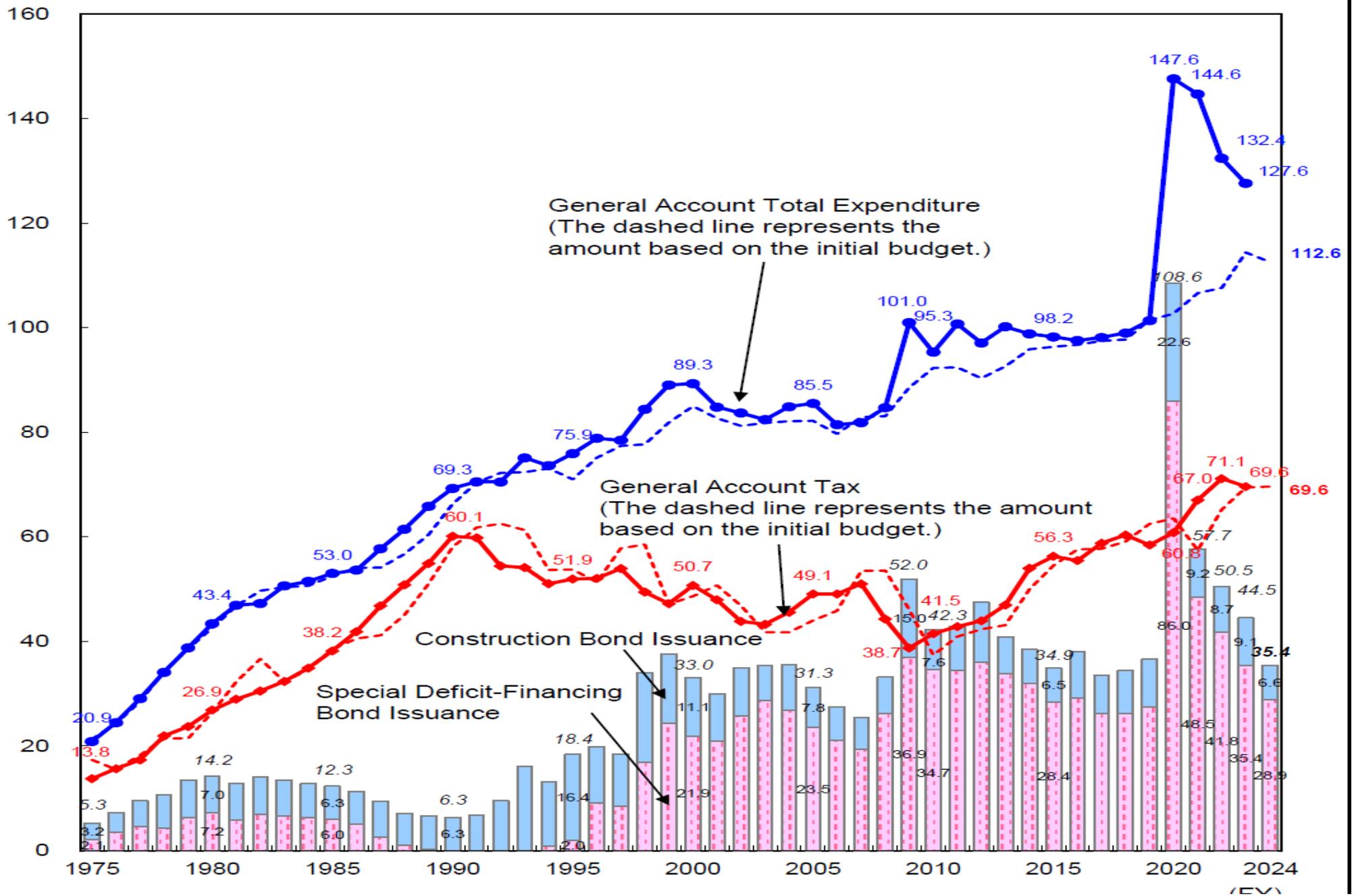Hitotsubashi University
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Table 3. Global Public Debt, 1950–2023[1]
(Percent of GDP, weighted averages)

	1950s	1960s	1968	1970s	1980s	1986	1990s	2000s	2004	2010s	2019	2020	2021	2022	2023
World	56.2	39.8	36.4	33.1	48.1	55.1	62.4	66.8	69.9	80.9	84.7	100.0	95.2	91.8	93.8
Advanced Economies	64.0	44.3	39.5	36.2	51.5	58.6	67.1	75.8	77.1	104.5	105.1	123.7	117.4	112.3	112.0
Euro Area	32.6	24.8	25.1	27.8	47.2	52.3	67.1	69.7	69.5	90.4	85.6	98.6	95.9	91.5	89.3
Japan	13.1	10.1	11.8	23.4	64.3	74.1	89.1	166.6	169.5	227.5	236.4	258.3	253.9	257.1	251.6
United Kingdom	134.0	81.6	71.0	56.4	41.3	42.9	39.0	42.7	39.8	84.9	85.7	105.8	105.2	100.4	101.1
United States	69.7	54.4	48.7	43.9	53.4	60.1	68.2	65.7	67.4	104.5	108.5	132.6	125.4	120.4	123.0
Emerging Market Economies	15.4	18.6	20.7	21.3	35.3	39.9	41.0	40.5	43.7	44.1	55.4	65.5	64.5	64.7	69.0
China 1/								21.2	26.9	26.4	44.3	60.4	70.1	71.8	77.1	84.3
Others	15.4	18.6	20.7	21.3	38.2	45.4	45.7	44.2	48.4	43.7	51.7	61.4	57.9	54.5	57.1
Low-Income Developing Countries				15.5	36.0	42.9	64.6	45.7	51.0	34.7	42.4	48.0	47.5	47.9	50.3

(trillion yen)

General Account Total Expenditure
(The dashed line represents the
amount based on the initial budget.)

General Account Tax
(The dashed line represents the amount
based on the initial budget.)

Construction Bond Issuance

Special Deficit-Financing
Bond Issuance

(Source: IMF)

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Comparison of the Fiscal Budget: 1990 and 2024

(Source: Ministry of Finance, Japan)

【FY1990 Initial Budget】

Revenue 66.2
- Tax Revenue 58.0
- Non-tax Revenue 2.6
- Construction Bonds 5.6

Expenditure 66.2

General Expenditure
- Public Works Projects 6.2
- Education and Science 5.1
- Others 9.6
- Defense 4.2
- Social Security 11.6 (17.5%)
- Local Allocation Tax Grants 15.3
- National Debt Service 14.3
  - Redemption of the National Debt 3.1
  - Interest Payments, etc. 11.2

+46.3   + 4.0   +26.1   +2.5   +12.7

Expenditure 112.6
- Public Works Projects 6.1
- Education and Science 5.5
- Others 9.6
- Defense 7.9
- Social Security 37.7 (33.5%)
- Local Allocation Tax Grants 17.8
- National Debt Service 27.0
  - Redemption of the National Debt 17.3
  - Interest Payments, etc. 9.7

Contingency Fund for the Measures to Address Soaring Crude Oil and Commodity Prices and to Set up the Environment for Promoting Wage Increases 1.0

Revenue 112.6
- Tax Revenue 69.6
- Non-tax Revenue 7.5
- Construction Bonds 6.6
- Special Deficit-financing Bonds 28.9

【FY2024 Budget】

(Note) Figures in parentheses represent the percentage of social security expenditure to general account total expenditure.

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Domar Condition: Fiscal Sustainability

The Domar condition is often used to judge whether the budget deficit is sustainable. The Domar condition is obtained from the government budget constraint:

$$G_t + r_t^B B_{t-1} = \Delta B_t + T_t,$$

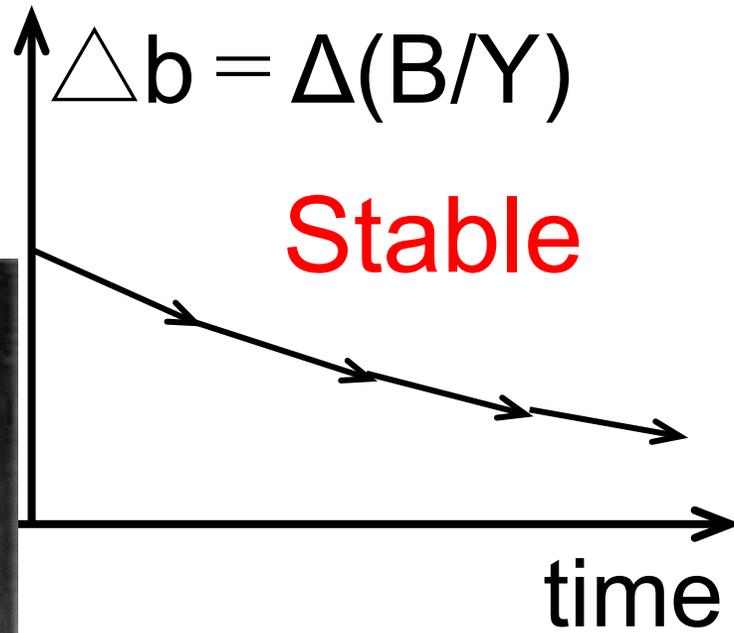where G_{t} is government spending, B_{t} is the revenues, and r_{t} is the interest rate for public can obtain
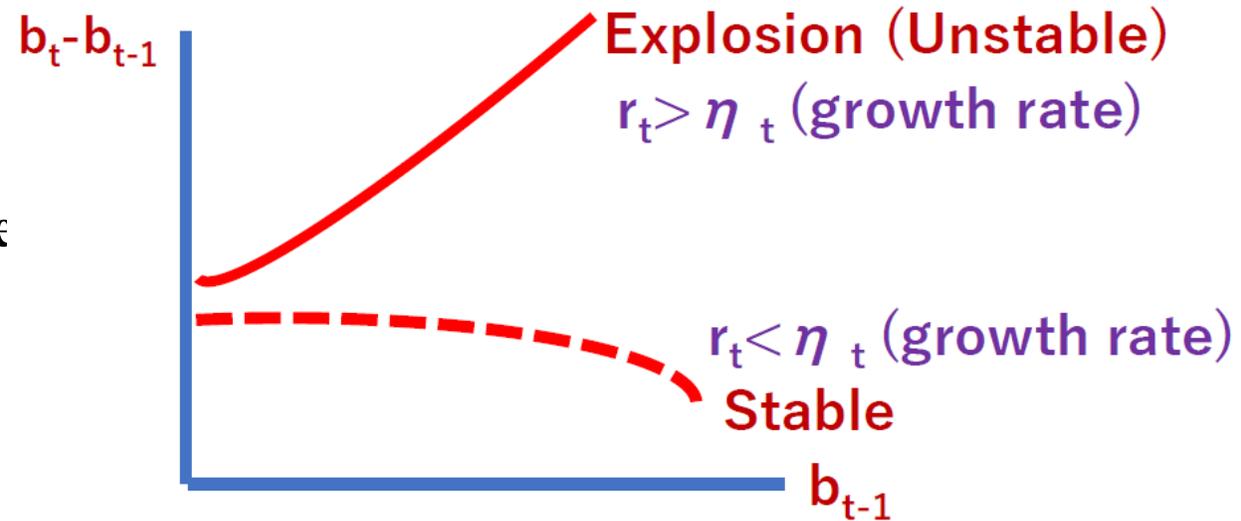
$$b_t - b_{t-1} = g_t - t_t + \frac{r_t - \eta_t}{1 + \eta_t} b_{t-1},$$

Interest Rate (r$_t$) > growth rate of the economy(η) → Unstable

Interest Rate (r$_t$)< growth rate of the economy(η) → Stable

Fiscal Sustainability: Domar condition

Interest rate (r) ⋚ Economic Growth (g)

$\triangle b = \Delta(B/Y)$

Stable

$\triangle b$

Debt Explosion

time

time

r<g
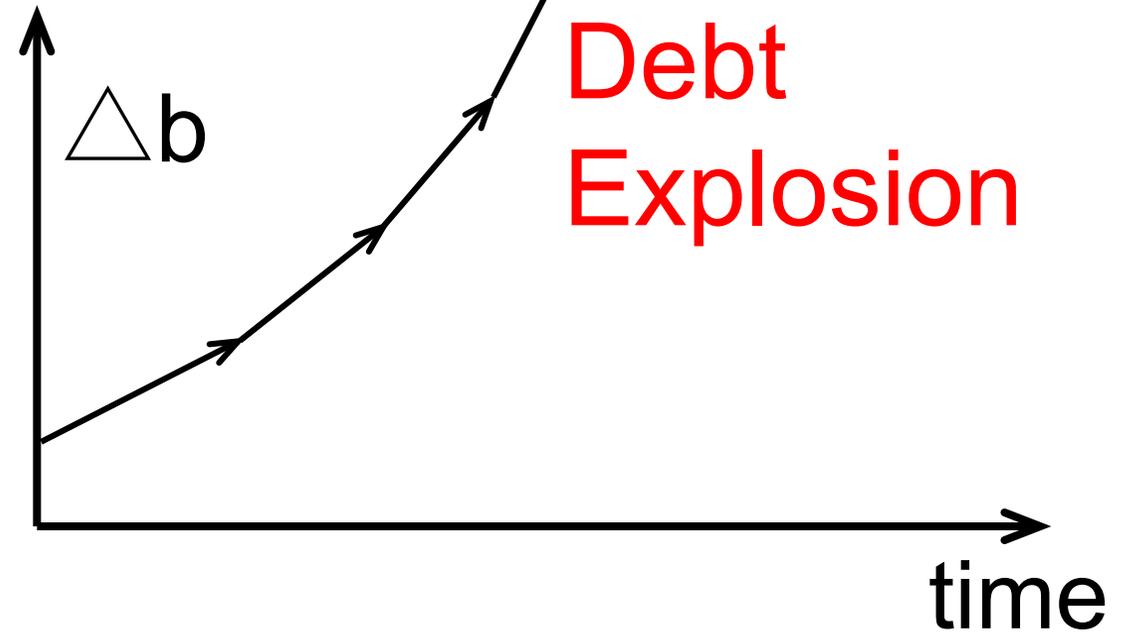
r>g

World Bank, Uneven Recovery, April 2021

Box II.B.5. The fiscal arithmetic of debt sustainability: How relevant is it for emerging markets and developing economies?

To understand the conditions for debt sustainability, the traditional accounting identity decomposes the changes in the government debt-to-GDP ratio into:[16]

$$d_t - d_{t-1} = \left(\frac{r_t}{1 + g_t}\right) d_{t-1} - \left(\frac{g_t}{1 + g_t}\right) d_{t-1} - P_t \qquad (1)$$

where d is the debt-to-GDP ratio, r is the real interest rate, g is the real growth rate, p is the primary surplus (the fiscal surplus excluding interest payments on the government's debt).[17] The first term on the right-hand side reflects the interest cost of financing the debt; the second term reflects the erosion of the debt ratio that stems from the growth of output (the denominator in the debt ratio). The difference between the interest rate and the rate of economic growth is a key determinant of changes in the debt-to-GDP ratio.

To avoid debt explosion:

$$d_t = d_{t-1} \rightarrow \left(\frac{r_t - g_t}{1 + g_t}\right) d_{t-1} = P_t \qquad (2)$$

meaning, the primary surplus must be sufficient to pay for debt service.

Figure 1 Government bond markets of Japan and Greece (see online version for colours)
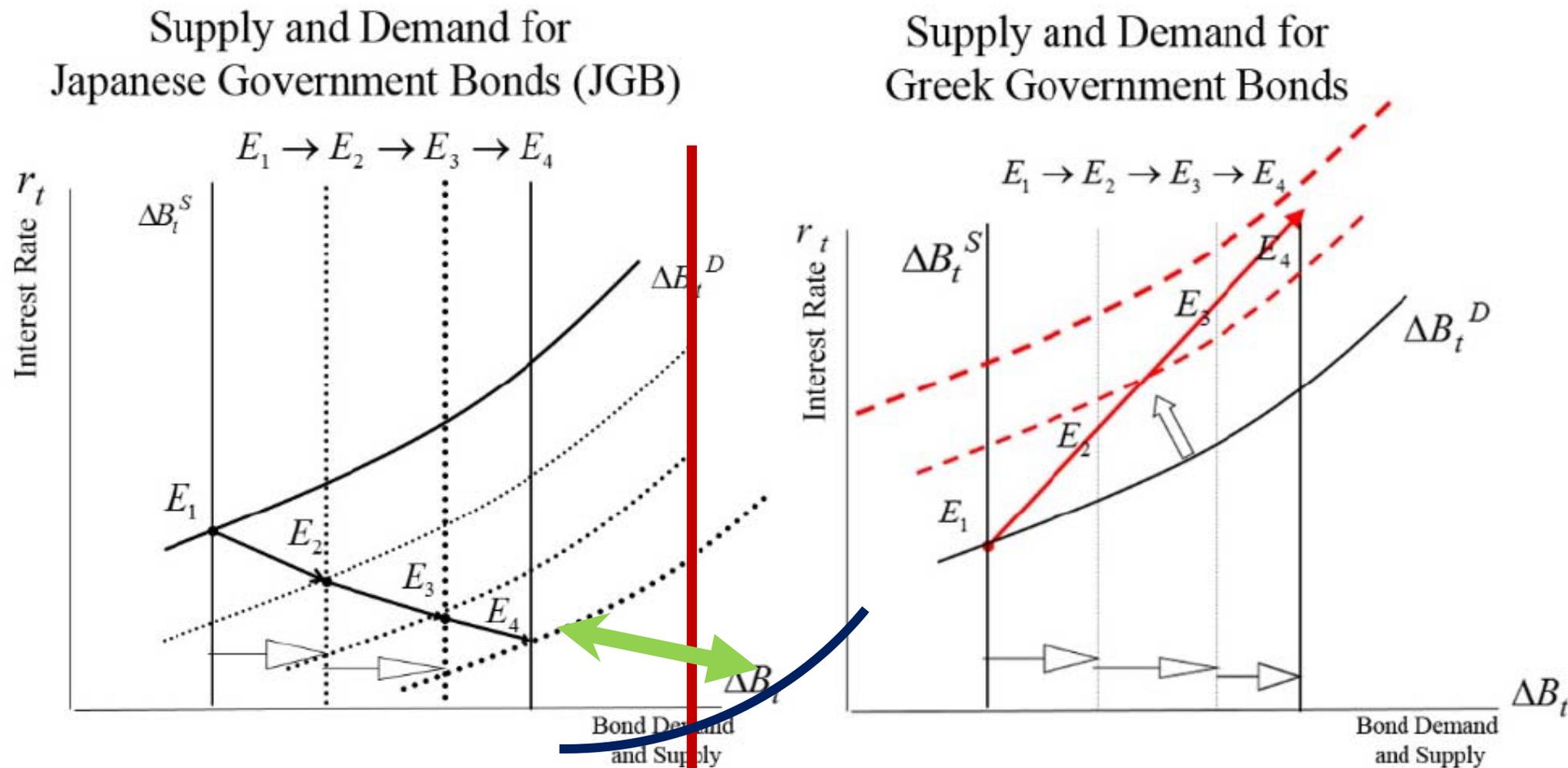
Supply and Demand for Japanese Government Bonds (JGB)

Supply and Demand for Greek Government Bonds

Optimal fiscal policy rule for achieving fiscal sustainability: *the Japanese case*
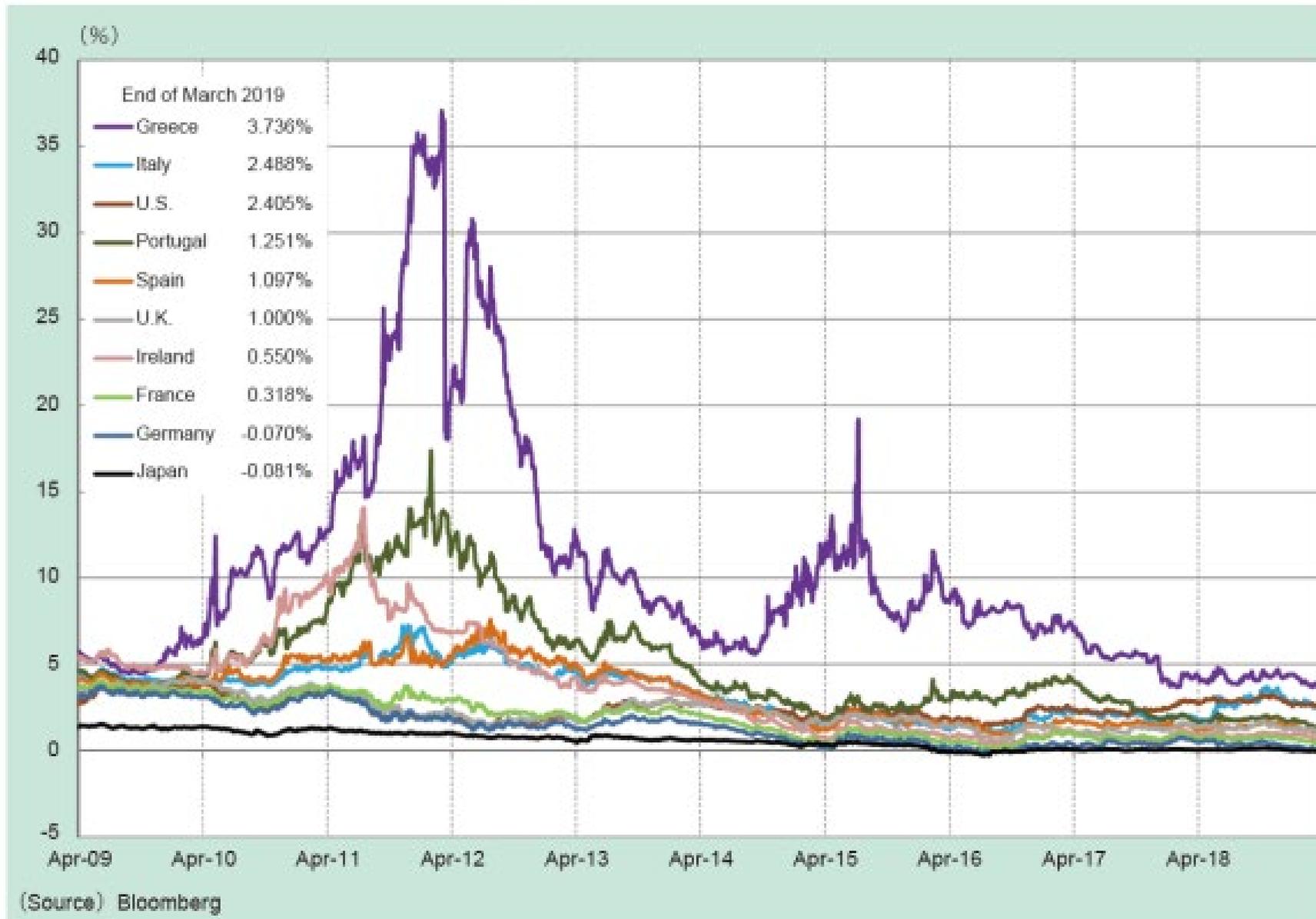
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10-Year Government Bond Yields

(%)

End of March 2019

Greece	3.736%
Italy	2.488%
U.S.	2.405%
Portugal	1.251%
Spain	1.097%
U.K.	1.000%
Ireland	0.550%
France	0.318%
Germany	-0.070%
Japan	-0.081%

(Source) Bloomberg

Table 1   Holders of Japanese and Greek Government bonds

Holders of Japanese Government bonds	% of total	Holders of Greek Government bonds	% of total
Bank and postal savings	45	Overseas investors	33
Life and non-life insurance	20	Domestic investors	21
Public pension funds	10	European Central Bank	18
Private pension funds	4	Bilateral loans	14
Bank of Japan	8	Social pension funds	6
Overseas investors	5	International Monetary Fund	5
Households	5	Greek domestic funds	3
Others	3		

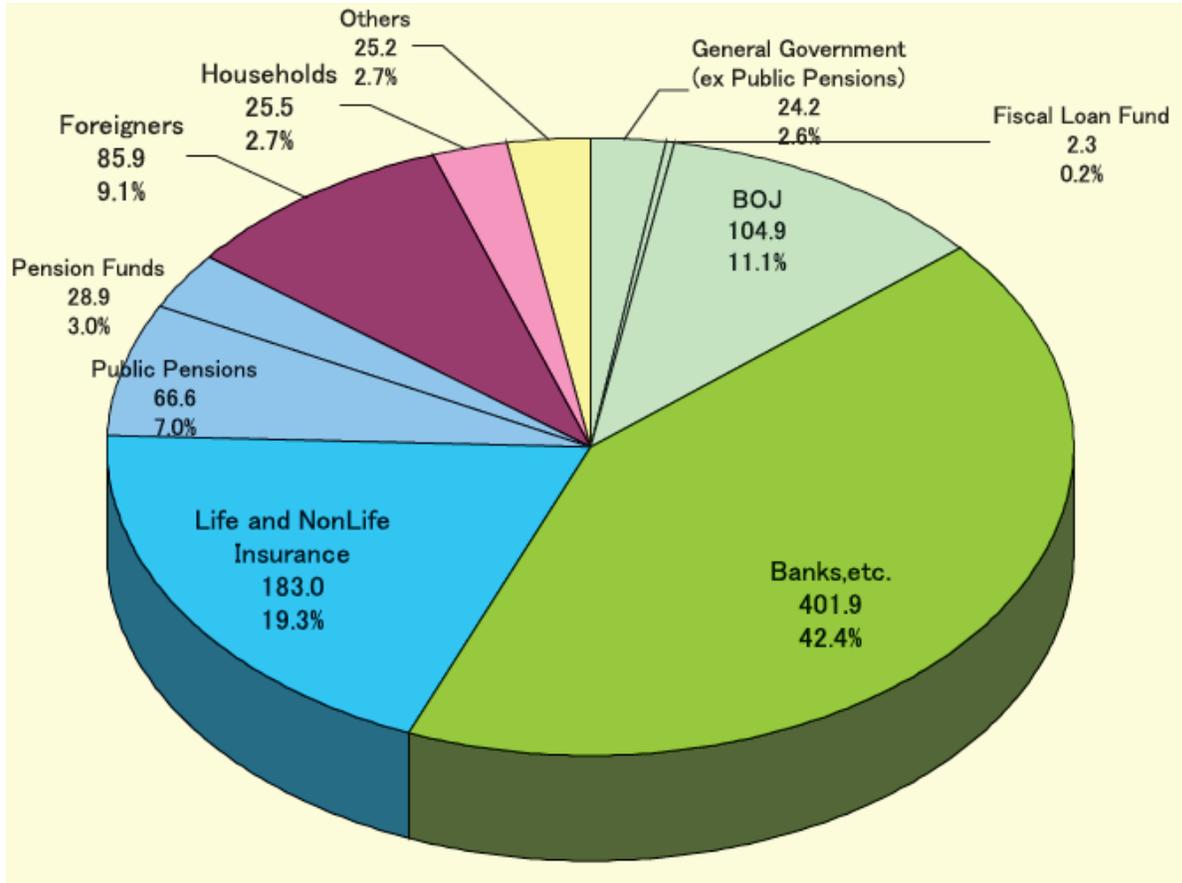Note: In Greece, 70% of debt is held by overseas investors, compared with 5% for Japan.
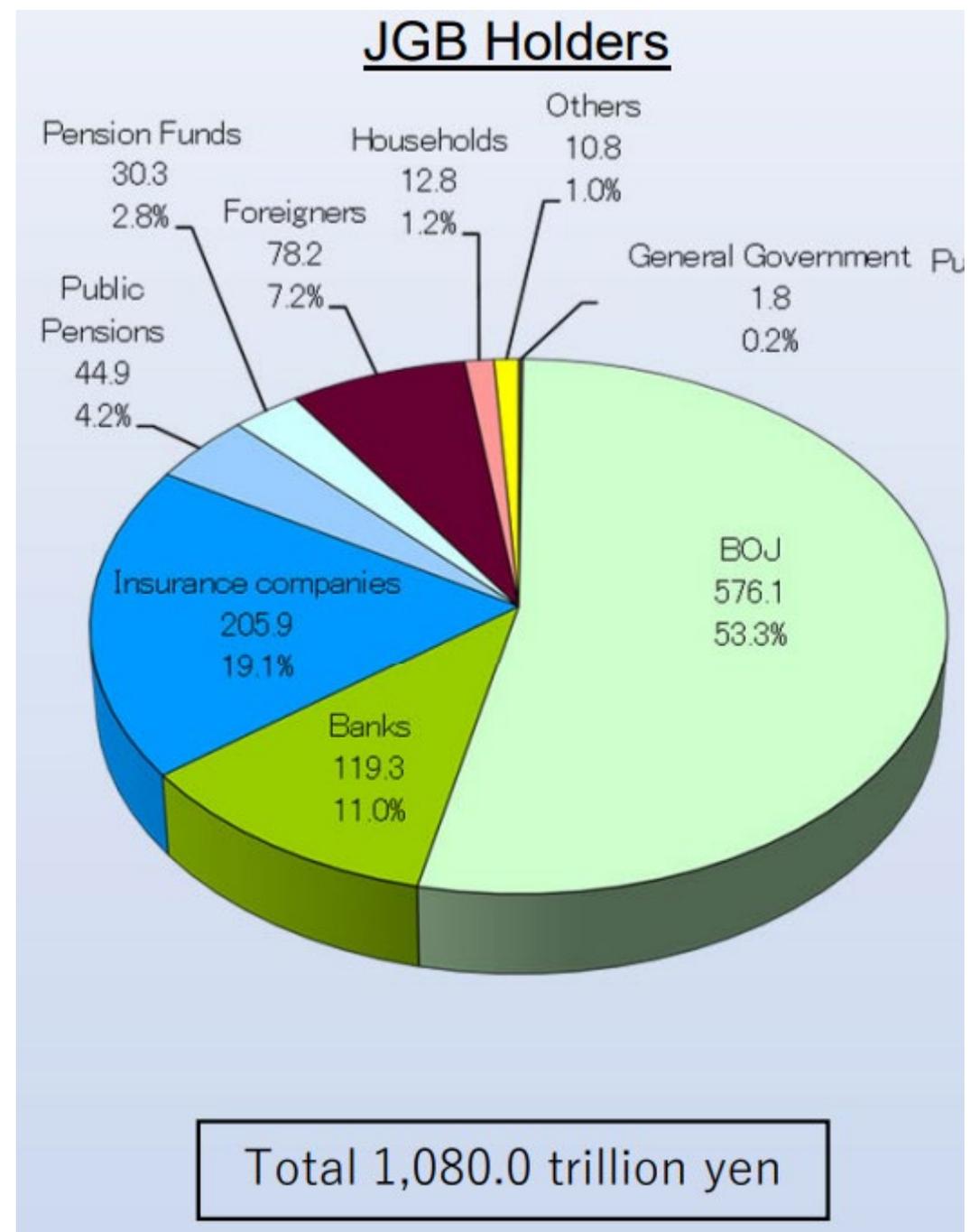Data are for 2011.

Optimal fiscal policy rule for achieving fiscal sustainability: *the Japanese case*
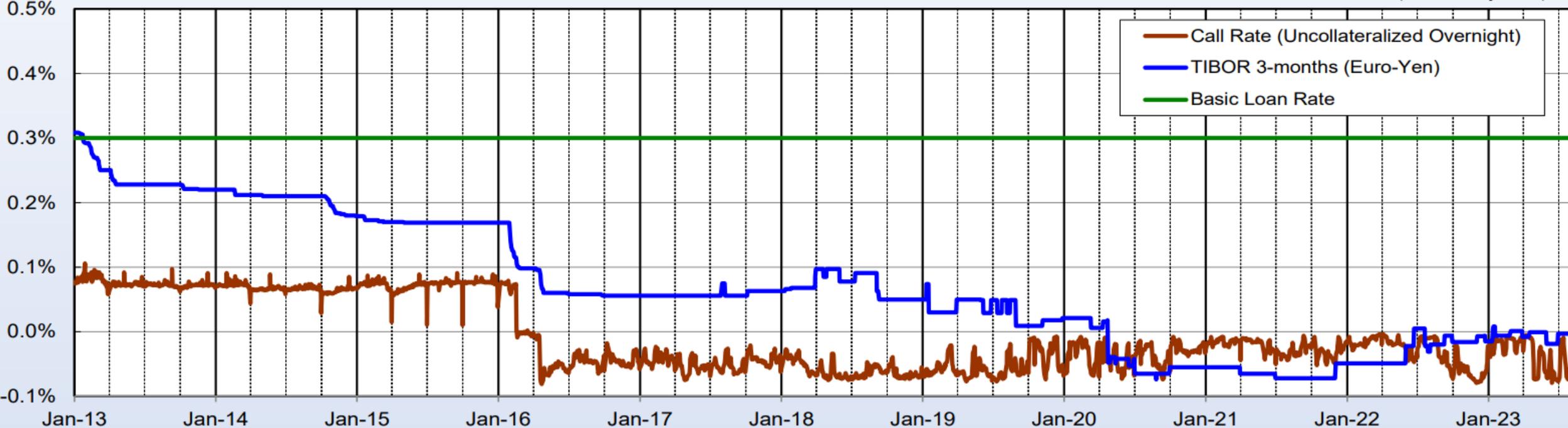
JGB Holders
2013 and   2024

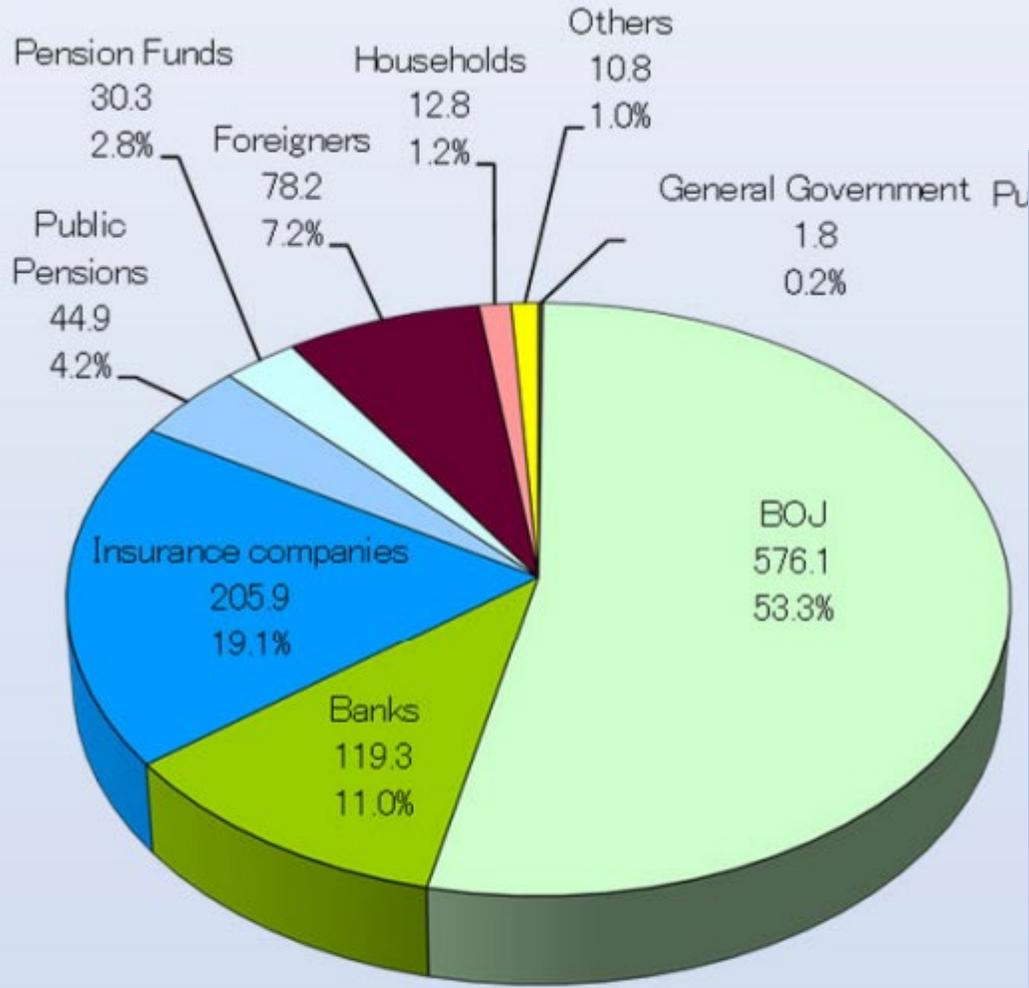
(Source: Ministry of Finance, Japan)

Short-Term Interest Rates

(Until 31 July 2023)

Legend:
- Call Rate (Uncollateralized Overnight)
- TIBOR 3-months (Euro-Yen)
- Basic Loan Rate

Sources: Bank of Japan, Tanshi Association, Bloomberg

（Source: Ministry of Finance, Japan）

JGB Holders

Pension Funds 30.3 — 2.8%
Foreigners 78.2 — 7.2%
Public Pensions 44.9 — 4.2%
Households 12.8 — 1.2%
Others 10.8 — 1.0%
General Government 1.8 — 0.2%

Insurance companies 205.9 — 19.1%
Banks 119.3 — 11.0%
BOJ 576.1 — 53.3%

Total 1,080.0 trillion yen
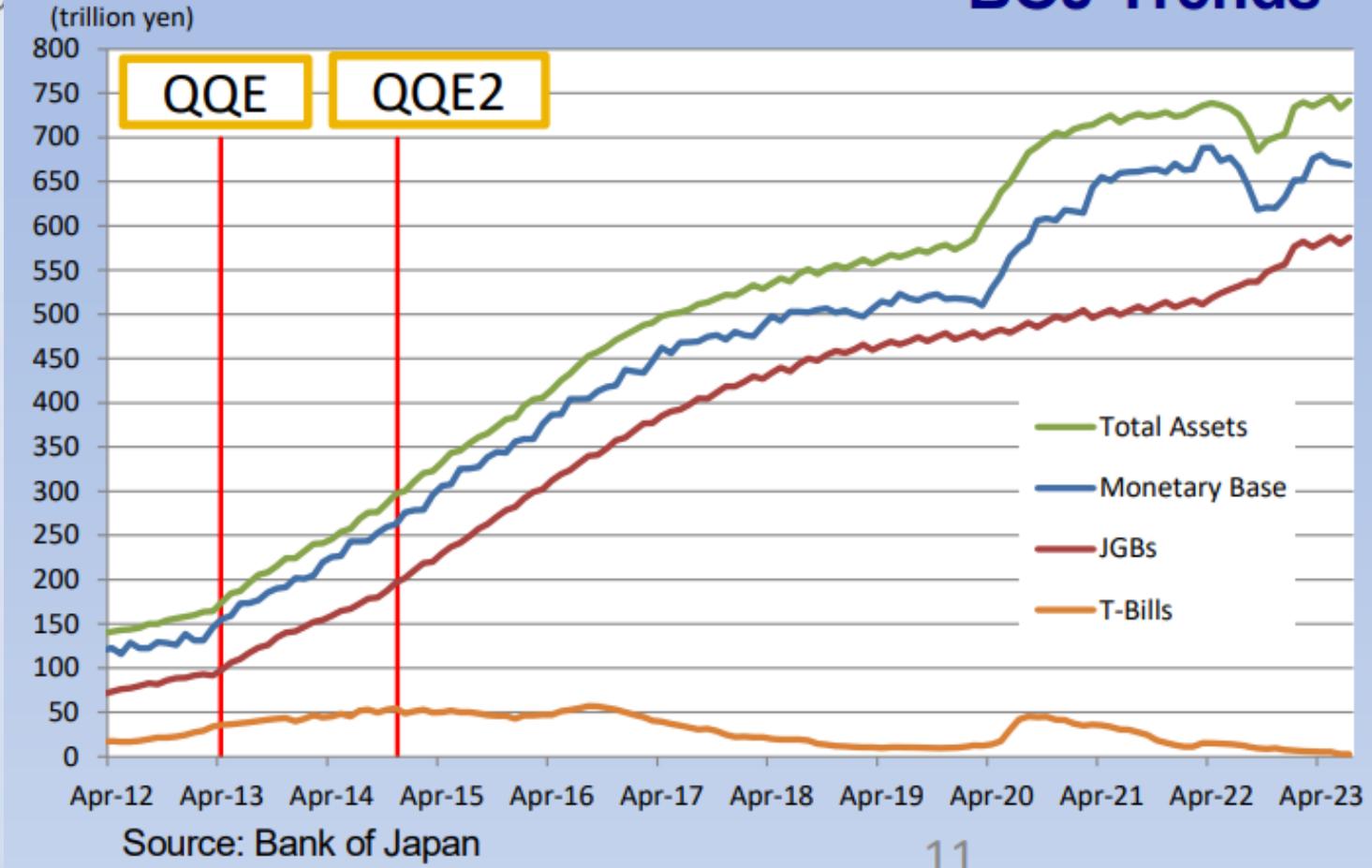
BOJ Trends

(trillion yen)

QQE   QQE2

- Total Assets
- Monetary Base
- JGBs
- T-Bills

Source: Bank of Japan

(Source: Ministry of Finance, Japan)

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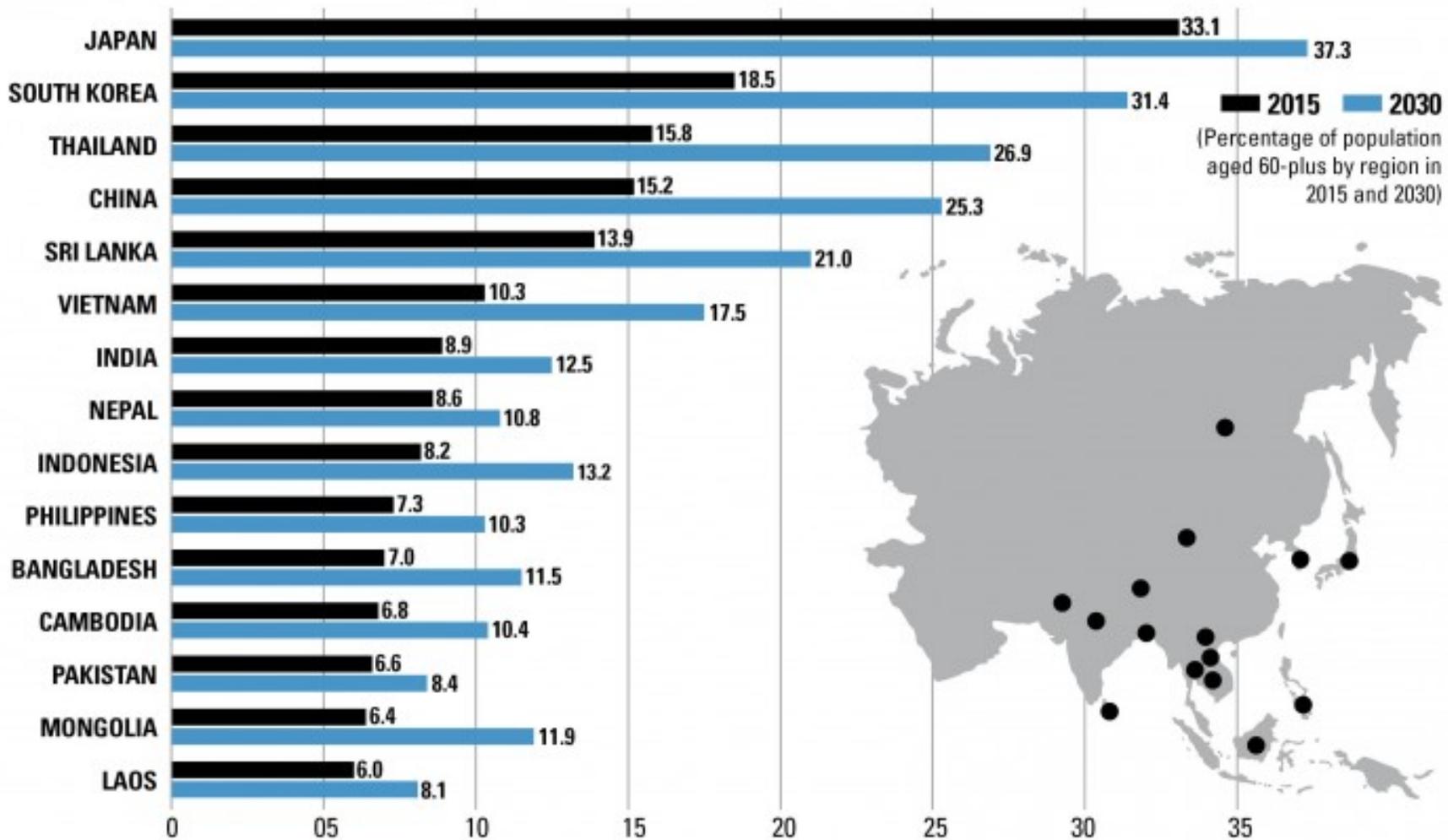# Declined effectiveness of fiscal and monetary policies faced with aging population in Japan

Naoyuki Yoshino[a], Hiroaki Miyamoto[b,*]

[a] Asian Development Bank Institute, Japan
[b] International Monetary Fund, United States
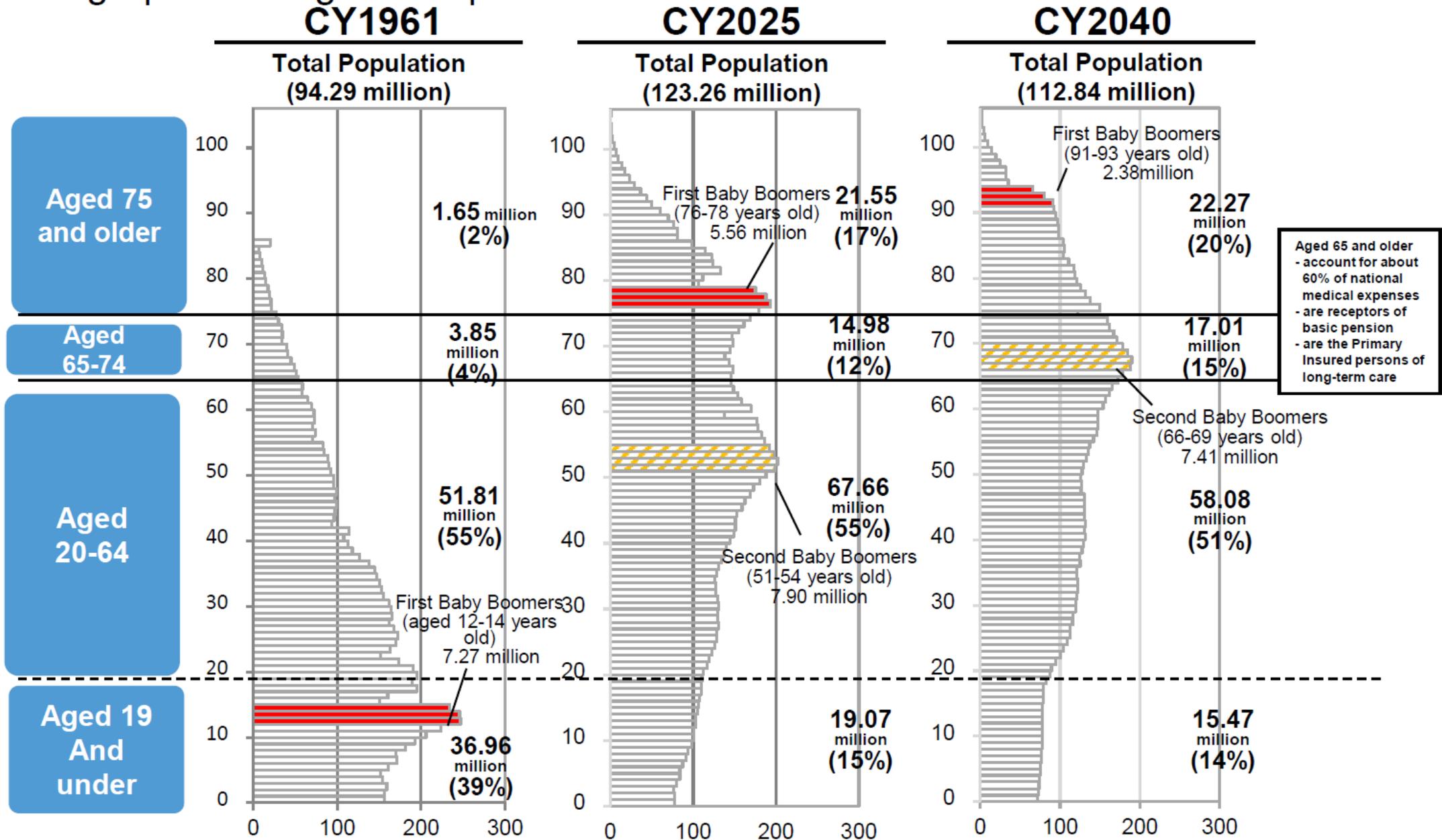
How Asia's Population is Ageing, 2015-2030 Scenario

The proportion of people aged 60 and over is projected to grow in all Asian countries with Japan and South Korea aging faster than their neighbours.

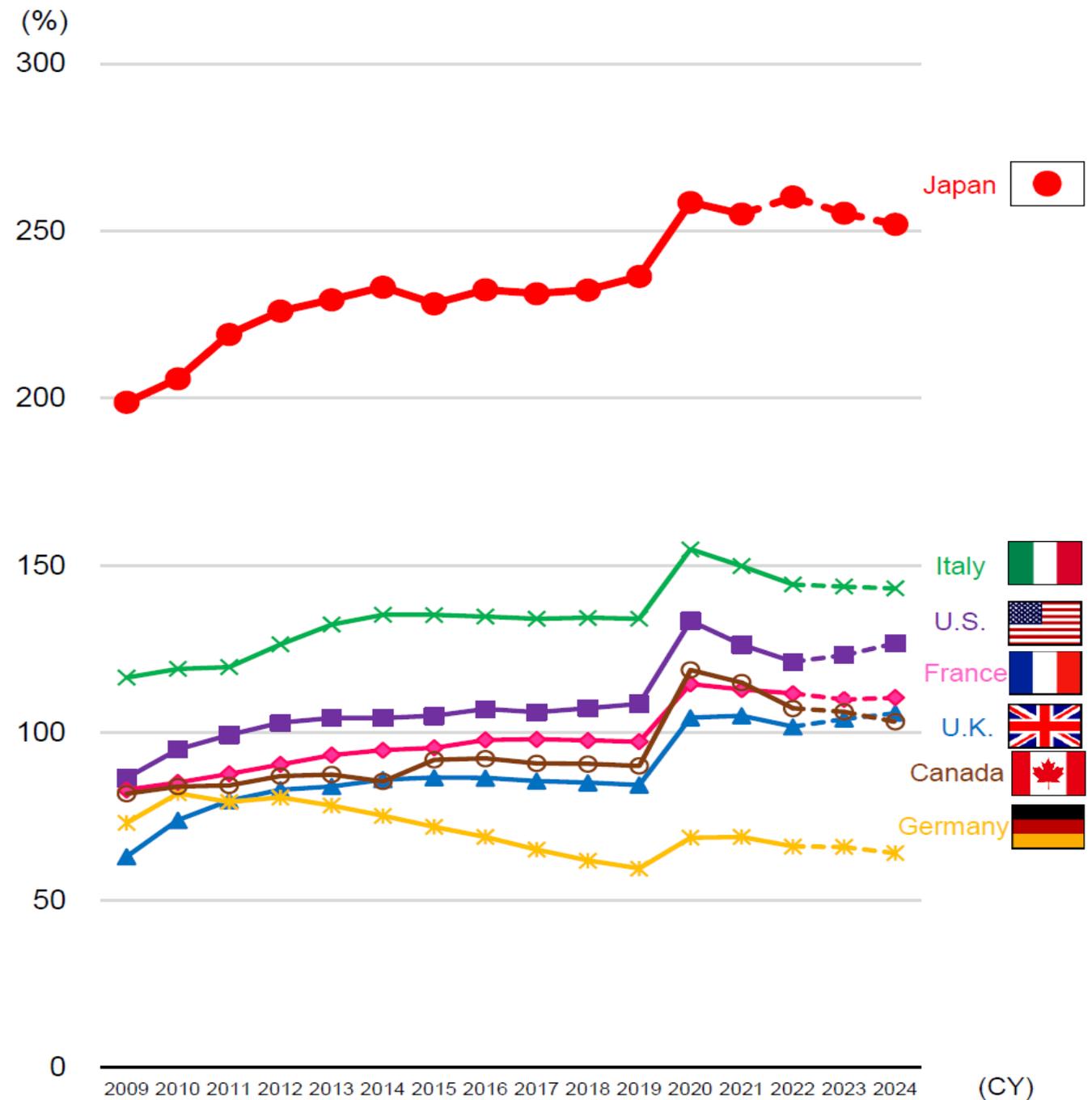| Country	2015	2030
JAPAN	33.1	37.3
SOUTH KOREA	18.5	31.4
THAILAND	15.8	26.9
CHINA	15.2	25.3
SRI LANKA	13.9	21.0
VIETNAM	10.3	17.5
INDIA	8.9	12.5
NEPAL	8.6	10.8
INDONESIA	8.2	13.2
PHILIPPINES	7.3	10.3
BANGLADESH	7.0	11.5
CAMBODIA	6.8	10.4
PAKISTAN	6.6	8.4
MONGOLIA	6.4	11.9
LAOS	6.0	8.1

■ 2015 ■ 2030

(Percentage of population aged 60-plus by region in 2015 and 2030)

Compiled by: ANN/DataLEADS

Source: Global Age Index, 2015

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Demographic Changes in Japan

CY1961 — Total Population (94.29 million)
CY2025 — Total Population (123.26 million)
CY2040 — Total Population (112.84 million)

Aged 75 and older
- CY1961: 1.65 million (2%)
- CY2025: First Baby Boomers (76-78 years old) 5.56 million — 21.55 million (17%)
- CY2040: First Baby Boomers (91-93 years old) 2.38million — 22.27 million (20%)

Aged 65-74
- CY1961: 3.85 million (4%)
- CY2025: 14.98 million (12%)
- CY2040: 17.01 million (15%)

Aged 20-64
- CY1961: 51.81 million (55%)
- CY2025: 67.66 million (55%) — Second Baby Boomers (51-54 years old) 7.90 million
- CY2040: 58.08 million (51%) — Second Baby Boomers (66-69 years old) 7.41 million

Aged 19 And under
- CY1961: First Baby Boomers (aged 12-14 years old) 7.27 million — 36.96 million (39%)
- CY2025: 19.07 million (15%)
- CY2040: 15.47 million (14%)

Aged 65 and older
- account for about 60% of national medical expenses
- are receptors of basic pension
- are the Primary Insured persons of long-term care

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Very High Debt /GDP

International Comparison

(Source: OECD)

Positive Impacts

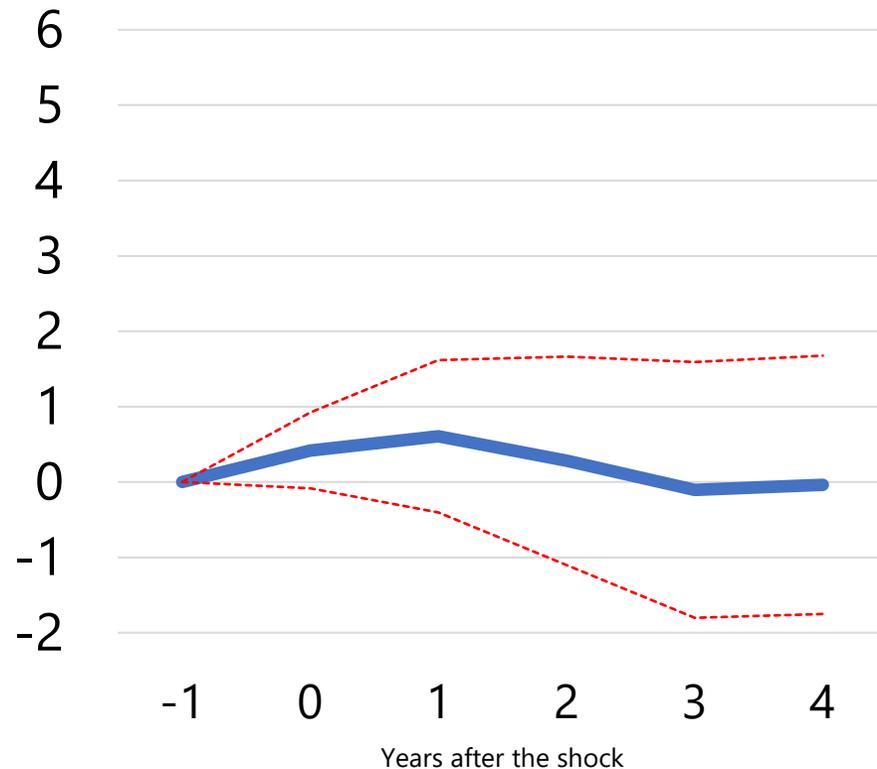Output
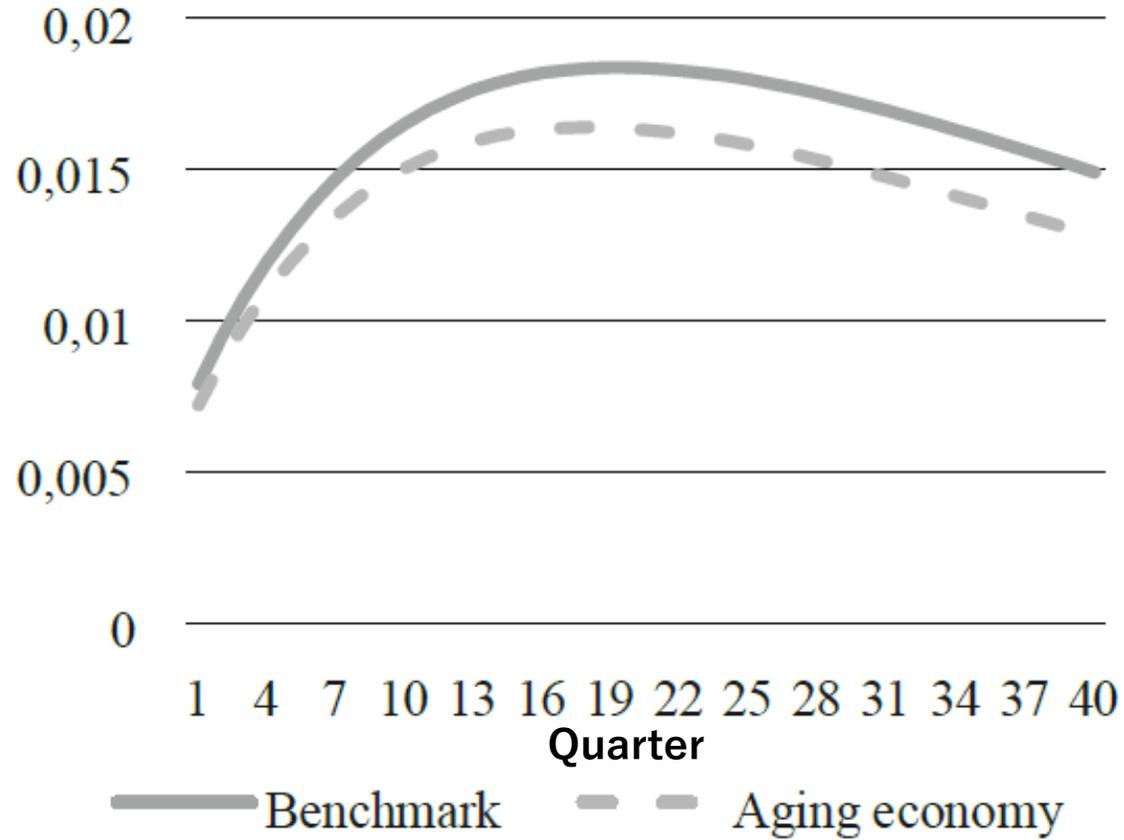
(a) Effects of an expansionary monetary policy

— Benchmark   - - Aging economy

Positive Impacts

Consumption
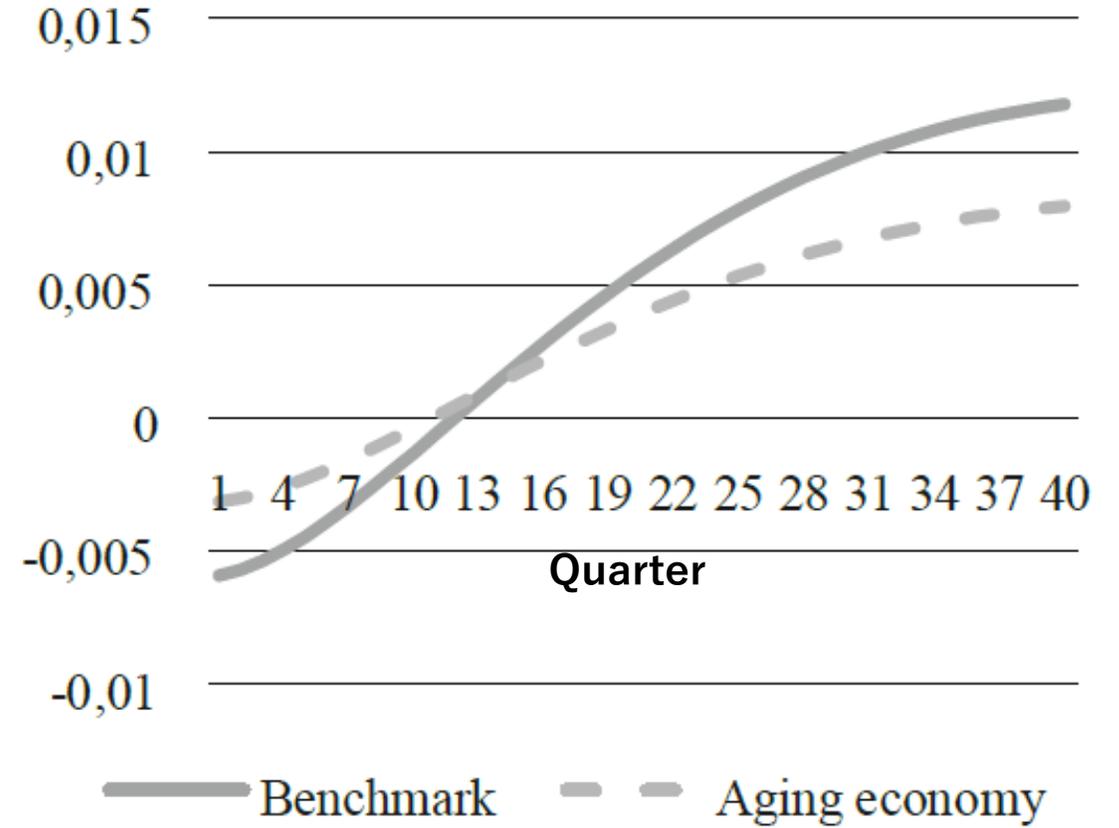
(b) Effects of a positive government investment shock

— Benchmark   - - Aging economy

Population aging weakens the impact of the government spending policy (Fiscal Policy).

Aging

Non-Aging
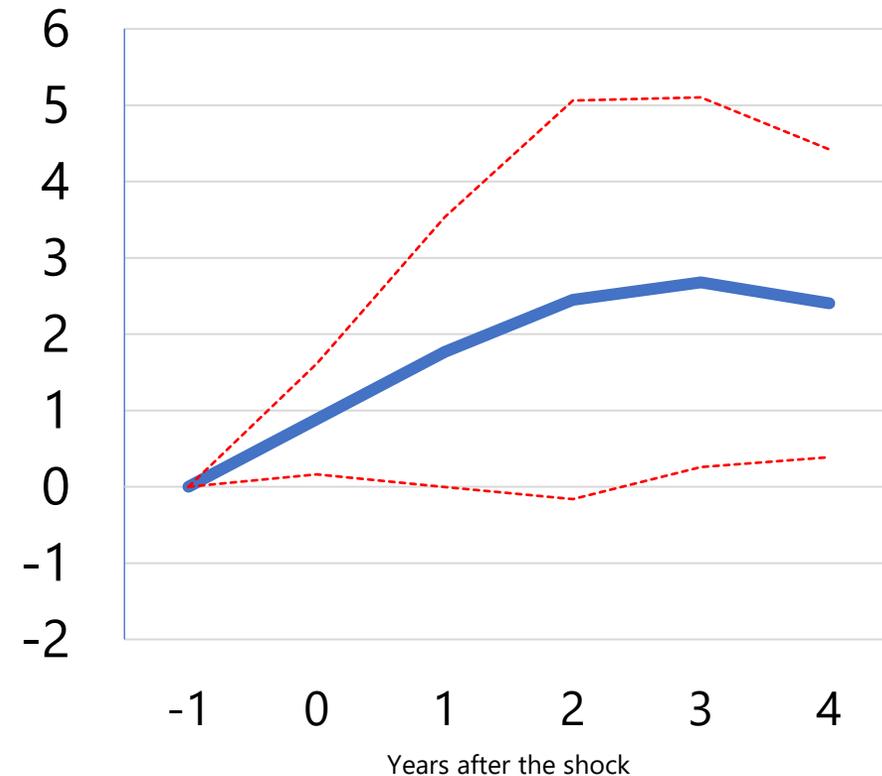
Note: t=0 is the year of the shock. Dashed lines denote 90 percent confidence bands. An economy is regarded as aging if its old age dependency ratio exceeds the mean of 23.5 percent.

38

Reduced Effectiveness of Fiscal Policy

Working Population:
→ Fiscal policy creates new jobs
→ Unemployment rate declines
→ Consumption will rise

Retired population:
→ Not affected by fiscal policy
→ Consumption remains the same

Effects of Expansionary Monetary Policy

Working Population

→ Monetary policy increases investment

→ Wages will rise
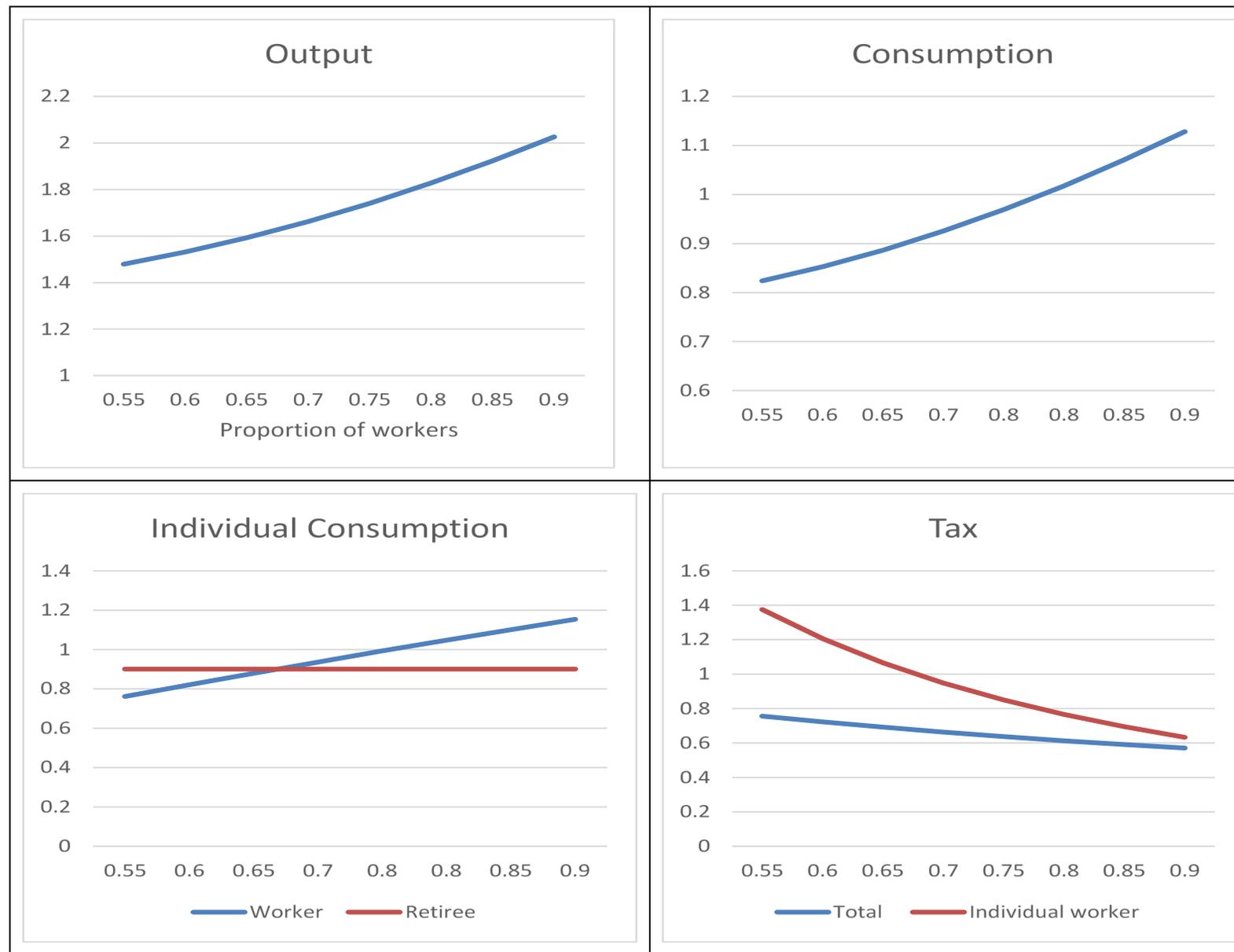
→ Consumption will rise

Retired Population

→ Relies on pensions and social welfare

→ Monetary policy does not affect retirees

Recommended Policy

Productivity based wage rate and postpone retirement age

Yoshino-Miyamoto (2017) Japan and the World Economy

Yoshino-Farhad-Miyamoto (2017) Credit and Capital Markets

Source: Yoshino and Miyamoto (2016).

Elderly Assistance by AI and Robots

70% of Japanese want to work

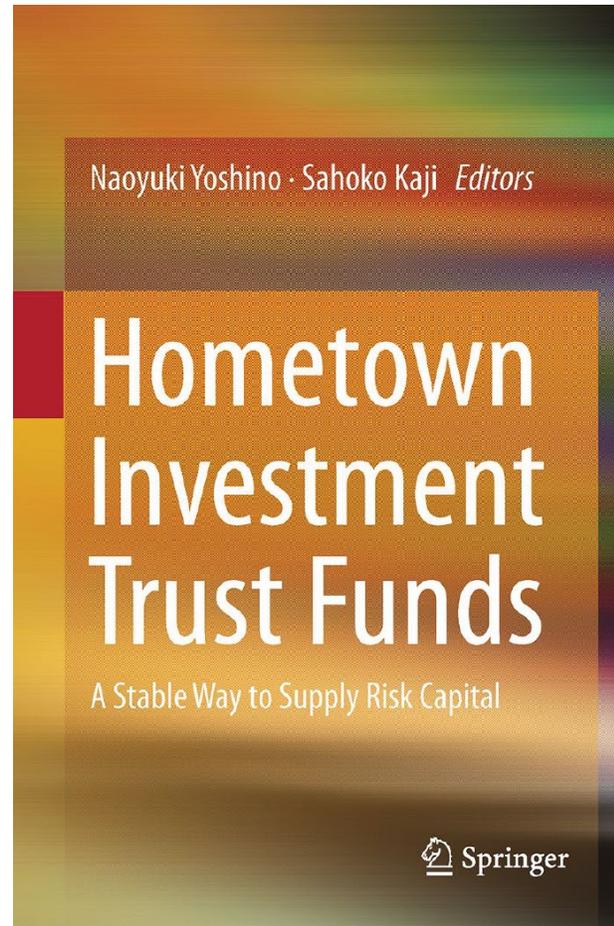Productivity based wage rate

Experiences can be transferred

Overall views by senior staff

Youngers views are important too

Elderly Care Facilities

Toilet, Bathing into Bath (new technology)

Springer

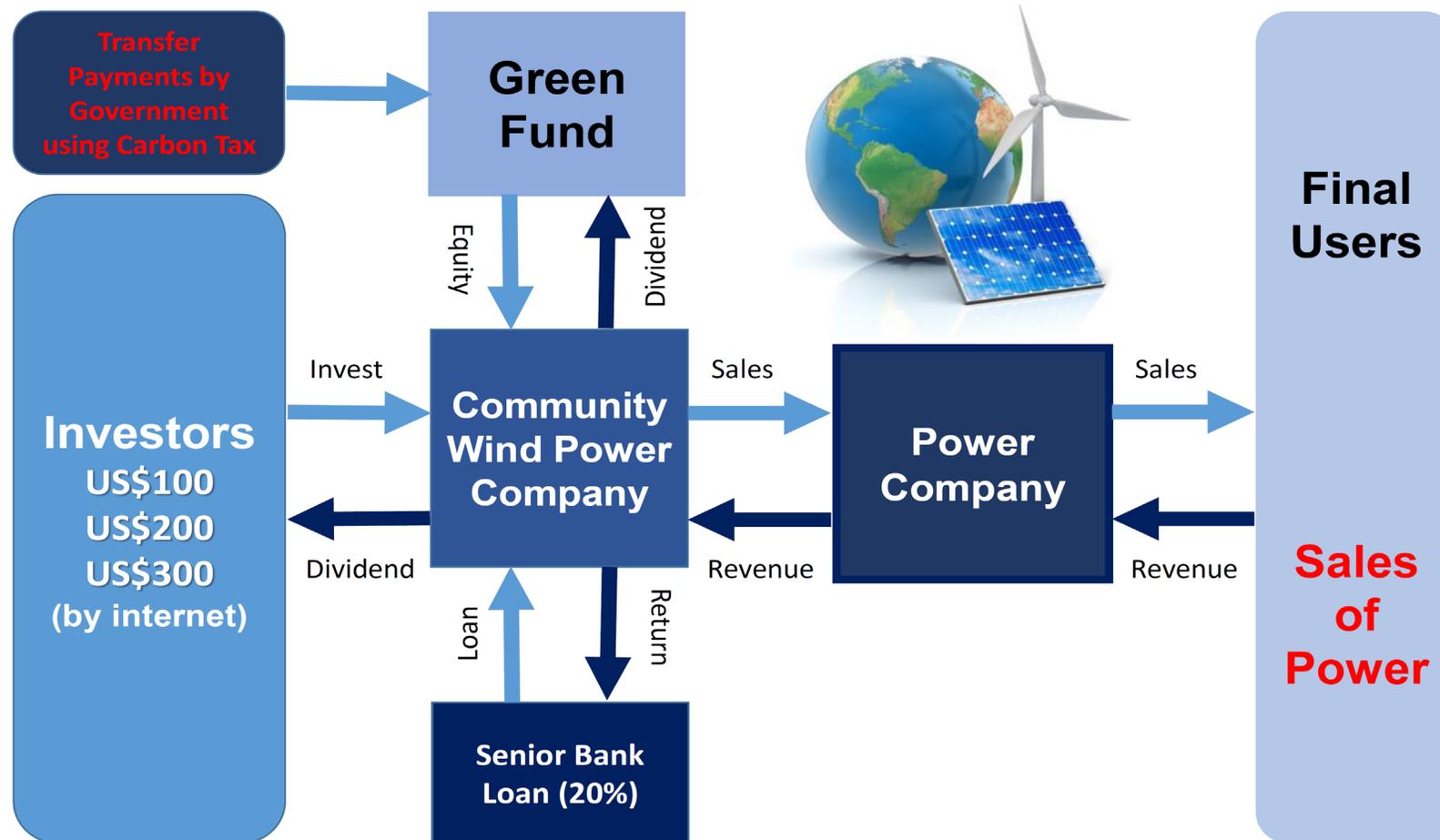## Possible Solutions
by use of community funds
For Risky businesses

Hometown Investment Trust Funds

A Stable Way to Supply Risk Capital
Yoshino, Naoyuki; Kaji Sahoko (Eds.), 2013,

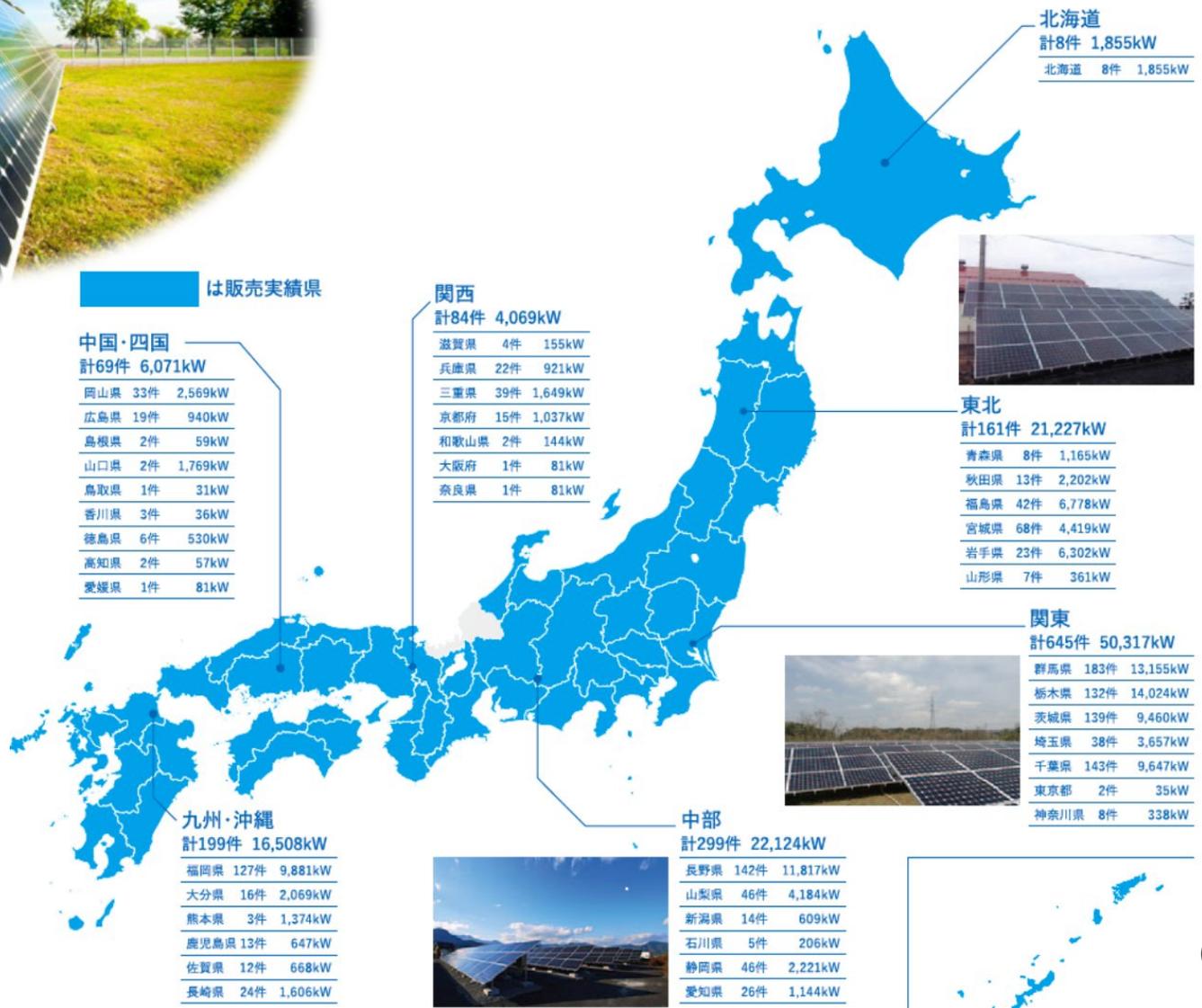**ADBI Working Paper Series**

Naoyuki Yoshino and
Farhad Taghizadeh-Hesary

Financing Scheme for Renewable Energy Projects Using HITs and Carbon Tax

Transfer Payments by Government using Carbon Tax

Green Fund

Final Users

Equity

Dividend

Investors
US$100
US$200
US$300
(by internet)

Invest

Community Wind Power Company

Sales

Power Company

Sales

Dividend

Revenue

Revenue

Sales of Power

Loan

Return

Senior Bank Loan (20%)
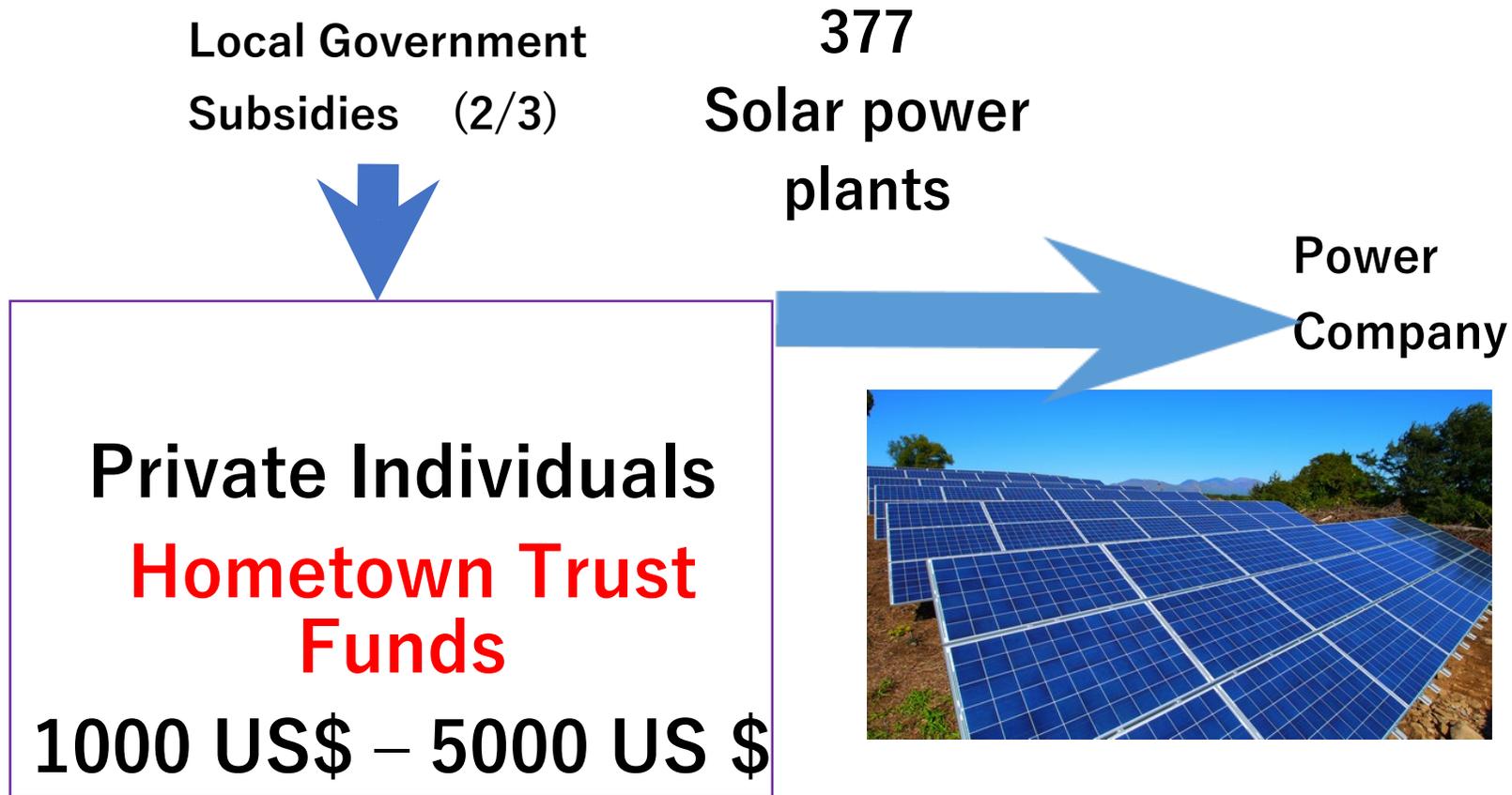
HIT = Hometown Investment Trust Fund.
Source: Authors.

Subsidies
From TAX on CO2
Spillover Tax revenues

44

Solar Power projects in Japan

(Source: Internet)

Scheme of Financing Solar Power Panels

Local Government
Subsidies   (2/3)

377
Solar power
plants

Power
Company

Private Individuals
Hometown Trust Funds
1000 US$ – 5000 US $
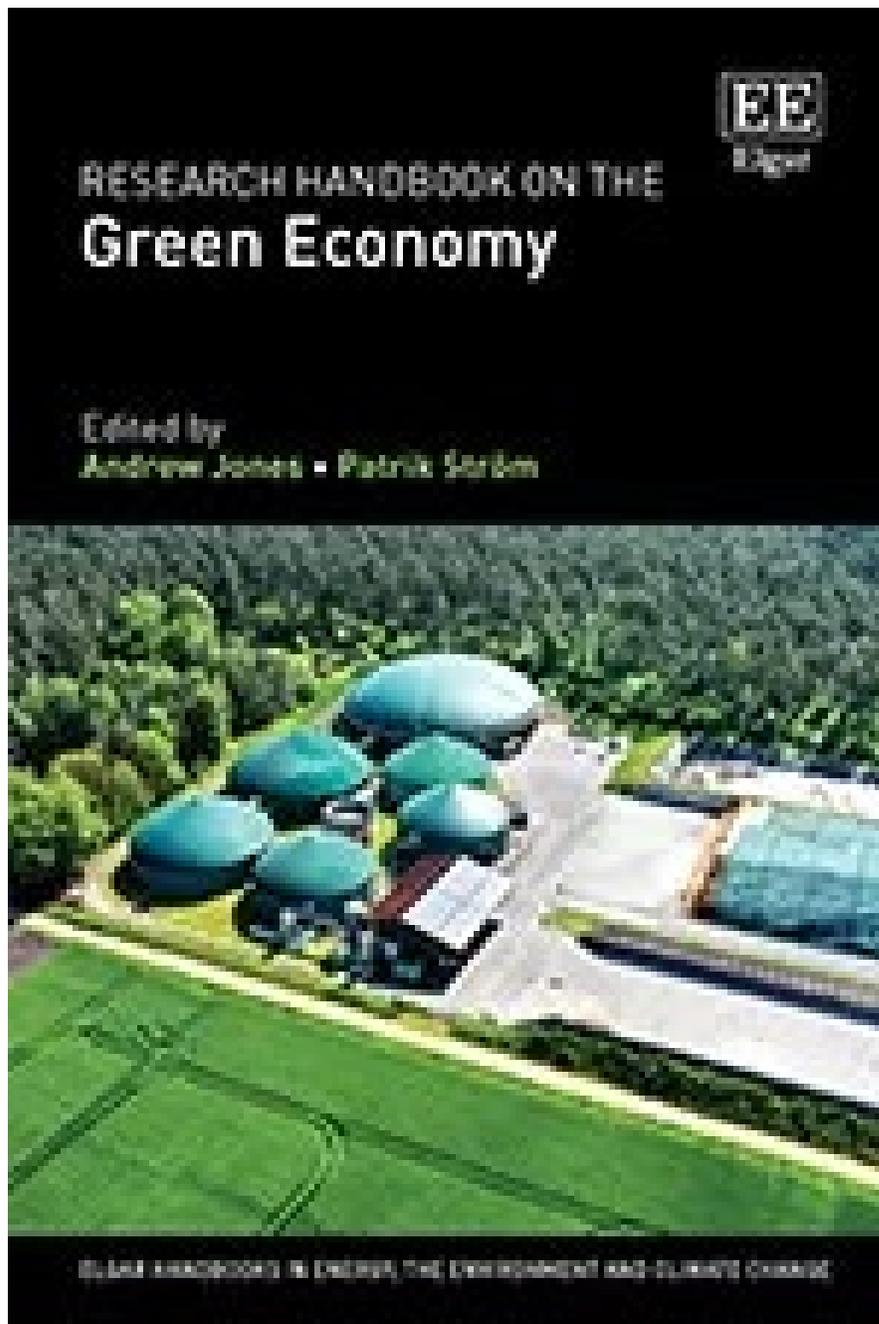
Asian Economic Papers, MIT Press, 2023

Diversified ESG Evaluation by Rating Agencies and Net Carbon Tax to Regain Optimal Portfolio Allocation*

Naoyuki Yoshino
Keio University and Japan Financial Services Agency
yoshino@econ.keio.ac.jp

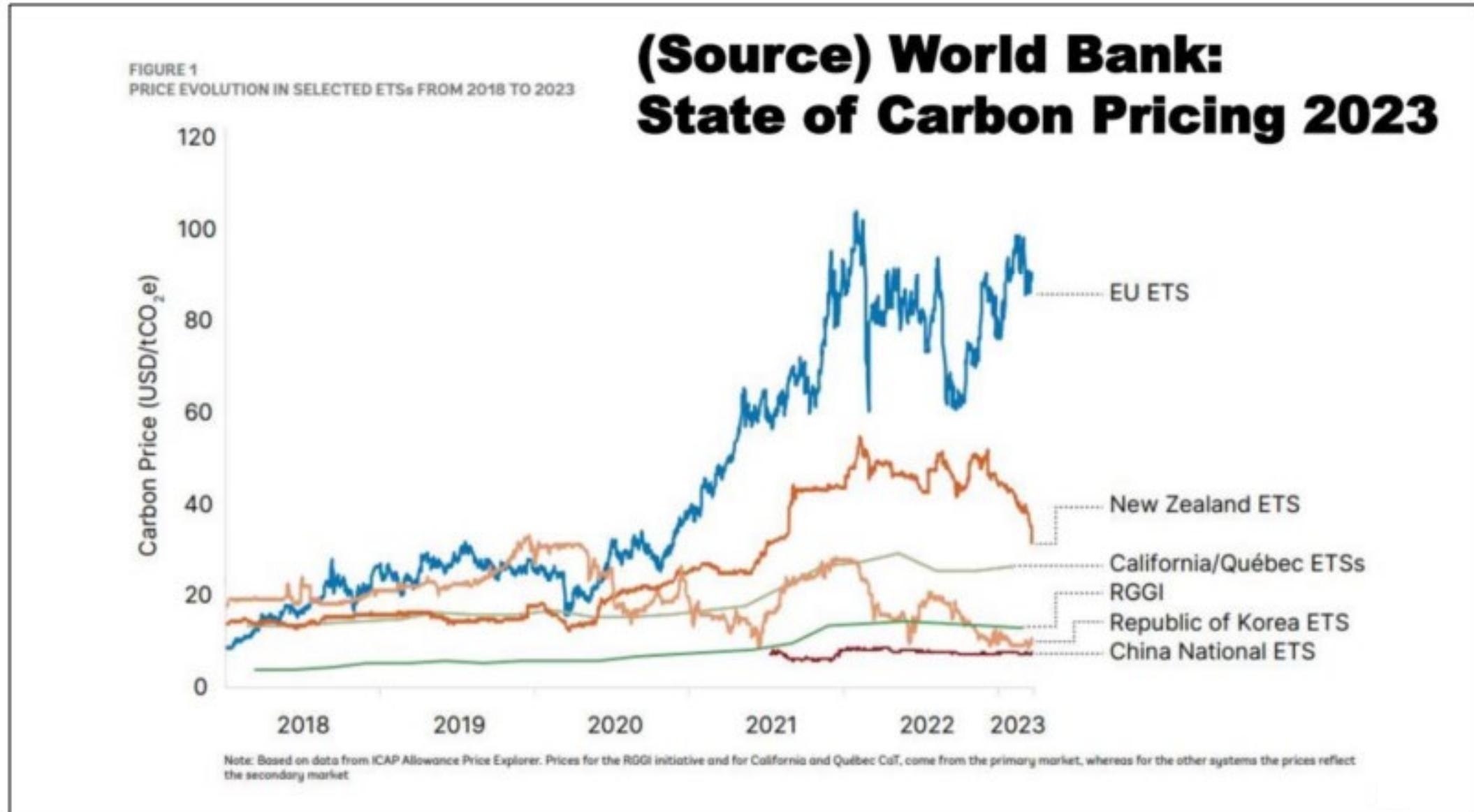**Tomonori Yuyama**
Japan Financial Services Agency
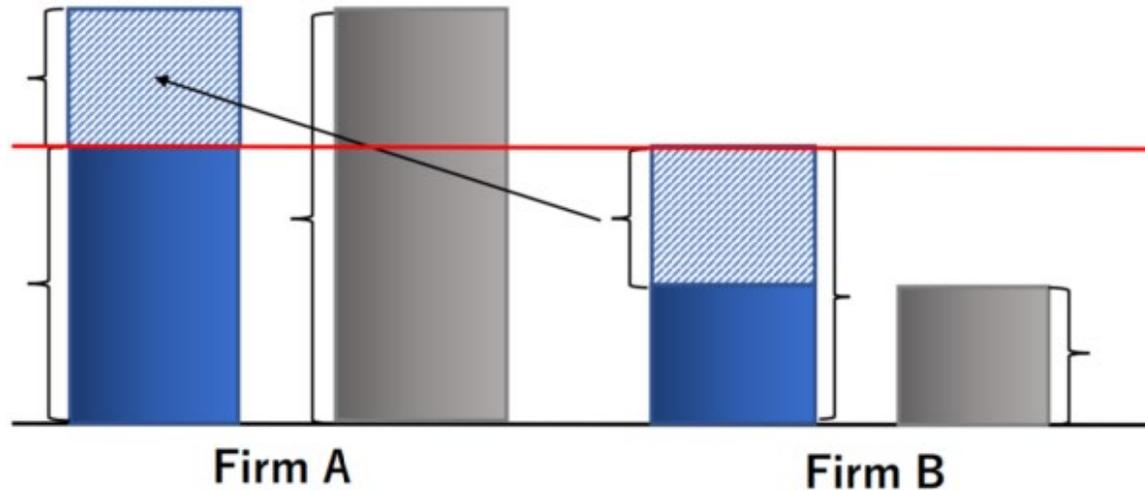
Farhad Taghizadeh-Hesary
Tokai University

Various Policy Tools
to Achieve Green Economy

1, Green Credit Rating （ESG Rating）
2, Carbon Pricing and Carbon Trading
3, Green Bonds
4, Carbon Tax

Figure 2: Price evolution in selected ETSs from 2018 to 2023

FIGURE 1
PRICE EVOLUTION IN SELECTED ETSs FROM 2018 TO 2023

(Source) World Bank:
State of Carbon Pricing 2023

EU ETS
New Zealand ETS
California/Québec ETSs
RGGI
Republic of Korea ETS
China National ETS

Note: Based on data from ICAP Allowance Price Explorer. Prices for the RGGI initiative and for California and Québec CaT, come from the primary market, whereas for the other systems the prices reflect the secondary market

Carbon Trading and Carbon Pricing

Firm A   Firm B

Carbon Supply & Demand

$$S = s_0 + s_1 P + \Delta X \text{ (Supply)}$$
$$D = d_0 + d_1 P - \Delta X \text{ (Demand)}$$
$$\Delta X = (\text{Cap-Actual emission})$$

Carbon Pricing
Carbon Trading

$$P^X = (d_0 - s_0)/(d_1 + s_1)$$
$$P^{\Delta X} = (d_0 - s_0 - 2\Delta X)/(d_1 + s_1)$$

$X + \Delta X$ $X + \Delta X$

CAP

X   X

FirmA   FirmB
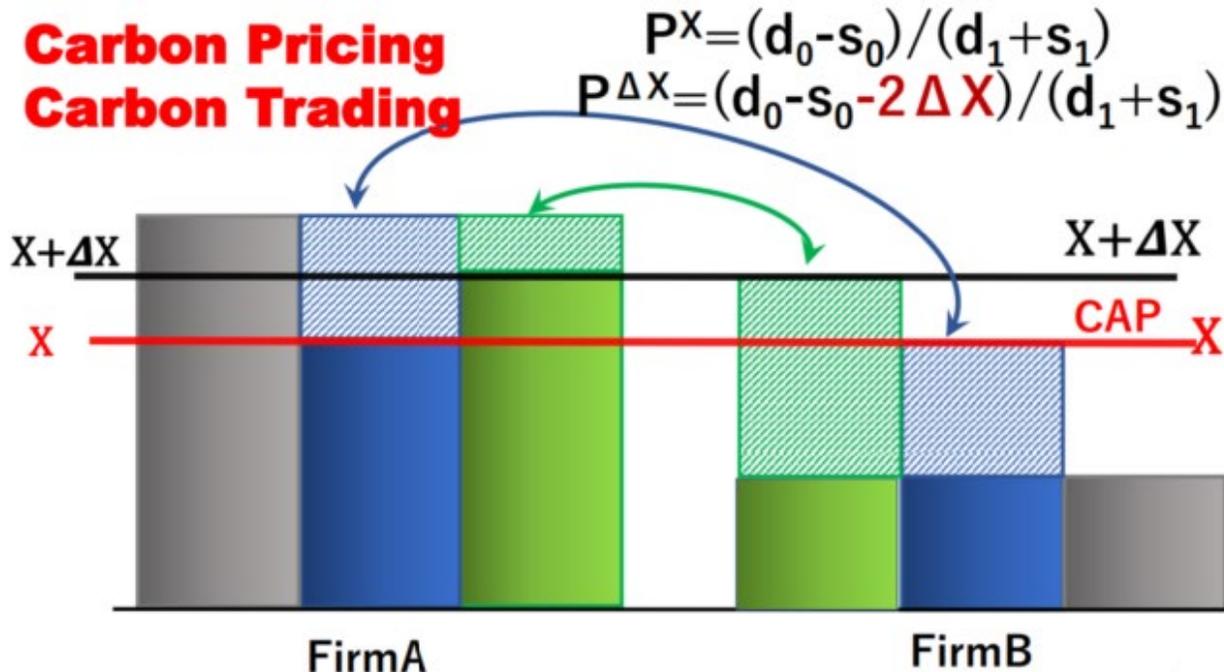
Equilibrium Carbon Price

$$P = \frac{(d_0 - s_0) - 2\Delta X}{(s_1 + d_1)}$$

International Capital Market Associations

Voluntary Process Guidelines for Issuing Green Bonds

Liquid H₂

- **Renewable energy** (including production, transmission, appliances and products);

- **Energy efficiency** (such as in new and refurbished buildings, energy storage, district heating, smart grids, appliances and products);

- **Pollution prevention and control** (including reduction of air emissions, greenhouse gas control, soil remediation, waste prevention, waste reduction, waste recycling and energy/emission-efficient waste to energy);

- **Environmentally sustainable management of living natural resources and land use** (including environmentally sustainable agriculture; environmentally sustainable animal husbandry; climate smart farm inputs such as biological crop protection or drip-irrigation; environmentally sustainable

fishery and aquaculture; environmentally sustainable forest including afforestation or reforestation, and preservation or restoration of natural landscapes);

- **Terrestrial and aquatic biodiversity** conservation (including the protection of coastal, marine and watershed environments);

- **Clean transportation** (such as electric, hybrid, public, rail non-motorised, multi-modal transportation, infrastructure f clean energy vehicles and reduction of harmful emissions);

- **Sustainable water and wastewater management** (including sustainable infrastructure for clean and/or drinkii water, wastewater treatment, sustainable urban drainage systems and river training and other forms of flooding mitigation);

- **Climate change adaptation** (including efforts to make infrastructure more resilient to impacts of climate change, as well as information support systems, such as climate observation and early warning systems);

- **Circular economy adapted products, production technologies and processes** (such as the design and introduction of reusable, recyclable and refurbished materials, components and products; circular tools and services); **and/or certified eco-efficient products**;

- **Green buildings** that meet regional, national or internationally recognised standards or certifications for environmental performance.

Example of Green Building in Japan

Several Buildings were constructed by issuing

Green Bonds

（1）How much CO2 to cut?

20% cut,   30% cut etc.

（2）Energy efficient elevators

（3）Better ventilation of air quality

Policies based on CO2 Emissions

1, Green Credit Rating: Based on CO2 emissions

$\qquad$ AAA, AA, A, BBB, BB,   B, CCC, CC, C $\quad = \theta$ x$(CO2)$

2, Carbon Tax

$\qquad$ **Tax rate x CO2** $= $ t x $(CO2)$

3, Green Bond Rating: Based on CO2 emissions

$\qquad$ AAA, AA, A, BBB, BB,   B, CCC, CC, C $\quad = \theta$ x$(CO2)$

4, Set up the ceiling of the amount of CO2 emissions

$\qquad$ **Carbon Trading and Carbon Pricing**

$\qquad$ **Carbon pricing will become identical to the Tax rate**

$\qquad$ P x $（CO2）$

Naoyuki YOSHINO

Green Credit Rating	Carbon Tax	Green Bond	Carbon Pricing
$\theta \times (CO_2)$	$t \times (CO_2)$	$\theta \times (CO_2)$	$P = \dfrac{(d_0 - S_0) - 2\Delta X}{(d_1 + S_1)}$ $P \times (CO_2)$

Measure of the Amount of CO_2 Emissions
α X (CO_2)

$Pr\,oductionFunction : g(Y, CO2) = F(K, L)$

$Pr\,ofit : \pi = PY - rK - wL$

$where : r = r^* + \sigma = \text{interest rate+risk factor}$

In the case of Environmental credit rating and green bonds, risks are added to the rate of intrest.

The profit of the company can be expressed as follows.

$\pi = P_Y Y - (r^* + \sigma)K - wL$

$where : r = r^* + \sigma$

$\pi = P_Y Y - r^* K - \sigma K - wL$

by setting the risk (σ) is measured

by the amount of CO2 emission per Capital (K),

$\sigma = \theta(\dfrac{CO2}{K})$

The profit of the company can be expressed as follows:

$\pi = P_Y Y - r^* K - \theta(\dfrac{CO2}{K})K - wL$

$\pi = P_Y Y - r^* K - wL - \theta(CO2)$

............$Carbon$ Credit Rating and Green bonds

$\pi = P_Y Y - r^* K - wL - P(CO2)$............Carbon

$$\pi = P_Y Y - r^* K - \sigma K - wL$$

by setting the risk (σ) is measured

by the amount of CO2 emission per Capital (K),

$$\sigma = \theta(\frac{CO2}{K})$$

The profit of the company can be expressed as follows:

$$\pi = P_Y Y - r^* K - \theta(\frac{CO2}{K})K - wL$$

$$\pi = P_Y Y - r^* K - wL - \theta(CO2)$$

.............*Carbon* Credit Rating and Green bonds

$$\pi = P_Y Y - r^* K - wL - P(CO2)$$.............Carbon Price

$$\pi = P_Y Y - r^* K - wL - t(CO2)$$...............*Carbon* Tax

These three equations show mathematically, the carbon credit rating,

green bonds, carbon pricing and carbon tax will lead to

 the identical cost to the firm.

Gains and Costs

Carbon Credit Rating	Carbon Tax	Carbon Pricing	Private Green Bonds	Public Green Bonds
Within private	Collected by government	Within private	Within private	Collected by government
Fund supply → recipients	Private → government	Excess supply → Lower supply	Private investor → private issuer	Private investor → government

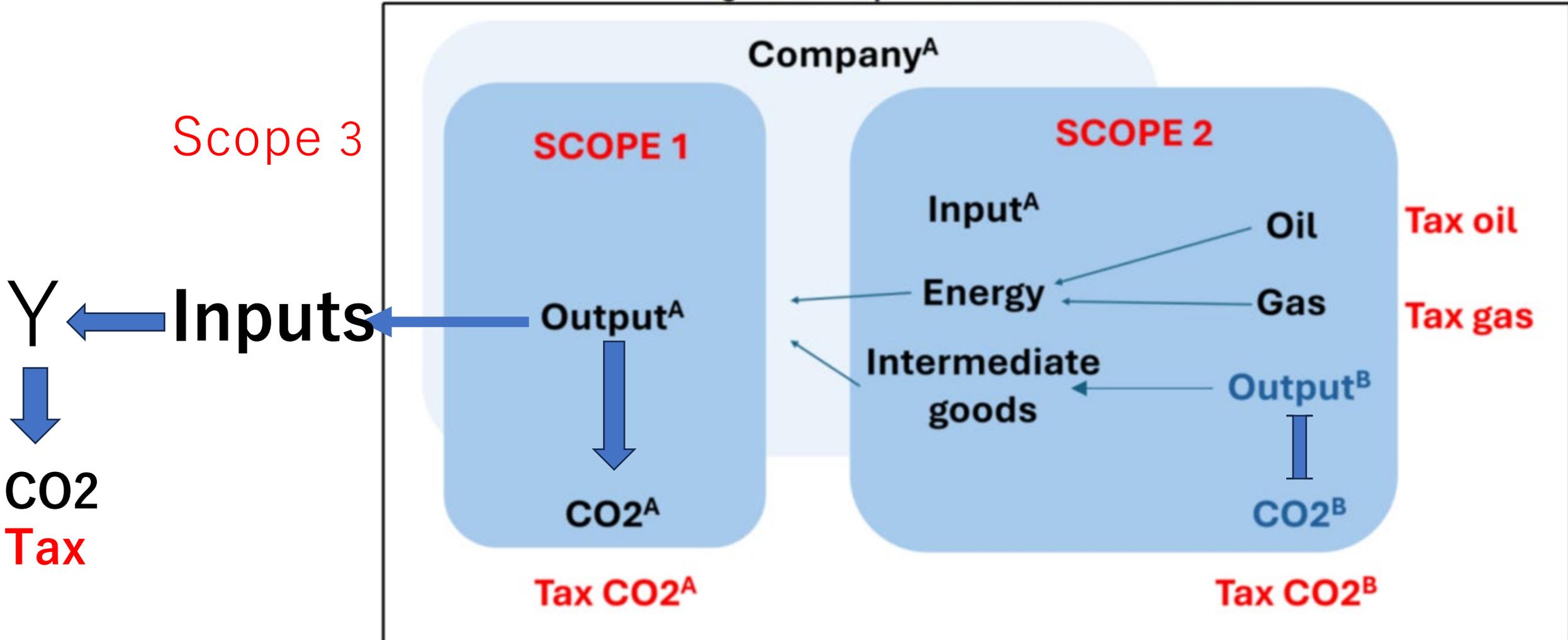# Equipment to Measure CO2 Emissions in Japan

70 US $

55 US $

40 US $

Scope1, Scope2 and Scope3: Value Chain

Figure 3: Proposed Taxation Mechanism

Global Value Chain--- Scope 1, 2 and 3

$$g_1(CO2, Y_1) = F_1(K, L, X) \quad \text{Scope 1}$$

$$g_2 (X, CO2) = F_2 (K, L)$$

Scope 2

$$g_3(CO2, Y_3) = F_3(Y_1, K, L)$$

Scope 3

Thank you for your attention

JOHNS HOPKINS
KRIEGER SCHOOL
of ARTS & SCIENCES

Department of
Economics

Prof. Naoyuki Yoshino (PhD'79) receives the International Green Finance Lifetime Achievement Scientific Award

Posted on: **December 12, 2021**

Planet Budapest EXPO-SUMMIT
2021
Central Bank of Hungary

DR. NAOYUKI YOSHINO

International Green Finance Lifetime
Achievement Scientific Award
Zöld Pénzügyi Tudományos Nagydíj