Macroeconomics Aspects of Infrastructure and Its Application to Specific Projects in Asia

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Infrastructure Investment and Disaster Management

1, Fiscal Multiplier is declining due to aging population

2, Need to bring Private sector finance into infrastructure

3, PPP failed in many regions

4, Increase the rate of return from infrastructure investment

5, Spillover tax revenues created by infrastructure

6, Land Trust to speed up infrastructure construction

7, Disclosure of Land Price

8, floating Interest rate Infrastructure bond

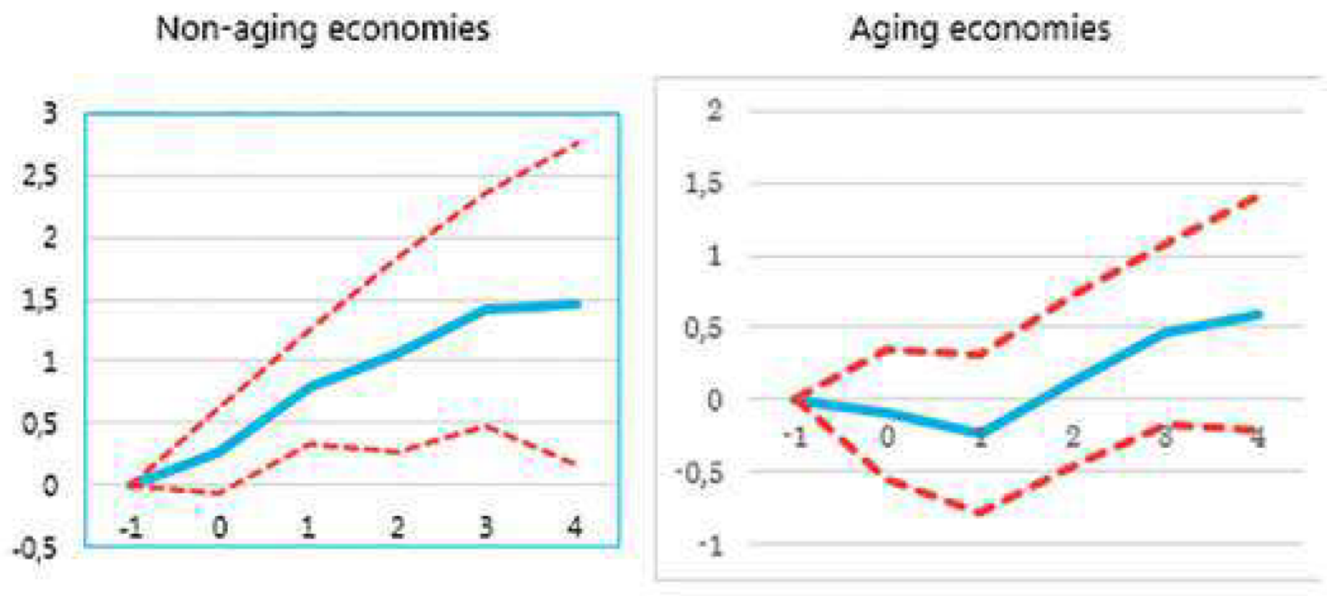
9, Decline in Tax caused by Disaster damage

10, Disaster bond

11, Environmental issues and Infrastructure investment

Long run Fiscal Multiplier

Figure 3: Population aging and output effects of government spending shocks



Note: t=0 is the year of the shock. Solid and dashed lines denote the point estimates and 90% confidence bands, respectively.

Miyamoto and Yoshino (2020) ***Macroeconomic Dynamics, 2020***
_*A Note on Population Aging and Effectiveness of Fiscal Policy*

Fiscal Multiplier in Macroeconomic Textbook

Keynesian Consumption

$$C = \widetilde{c_0} + \widetilde{c_1} Y$$

Aggregate Demand

$$Y = C + I + G$$

$$Y = \widetilde{c_0} + \widetilde{c_1} Y + I + G$$

$$Y(1 - \widetilde{c_1}) = \widetilde{C_0} + I + G$$

$$dY(1 - \widetilde{c_1}) = dG$$

$$\frac{dY}{dG} = \frac{1}{1 - \widetilde{c_1}}$$

$$\widetilde{c_1} = 0.666 = \frac{2}{3}$$

$$\frac{dY}{dG} = \frac{1}{1 - \frac{2}{3}} = 3$$

Fiscal Multiplier

Fiscal Multiplier In Aging Society

$$C_Y = c_0 + c_1 Y_{Young}$$

$$C_o = c_0' + c_1' Y_{old}$$

$$\frac{dY}{dG} = \frac{1}{1 - [c_1 \alpha + c_1'(1 - \alpha)]}$$

$$c_1 = \frac{2}{3} \text{ Young,} \qquad c_1' = \frac{1}{3} \text{ Old}$$

$$as \quad \alpha \quad \downarrow \qquad \frac{dY}{dG} \quad \downarrow$$

Population aging

Drop in Fiscal Multiplier

Economic Effects of infrastructure

(1) Effects on total GDP

L= Labor

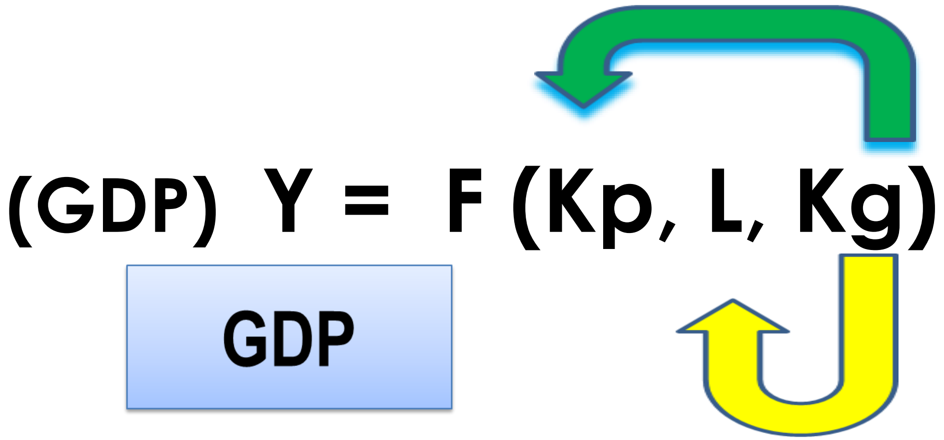
Kp = Private Capital

Kg = Infrastructure,

Agricultural sector

Manufacturing sector

the Services sector



Spillover Effects of infrastructure investment

Infrastructure

Business
e-commerce

↑ Employment

↑ Private investment

New Residents ↑

Spillover effect
→ Increase in Tax revenues

Cobb-Douglas Production Function

$$Y = F(K_p, L, K_g) \qquad K_g = K_g(t-1) + G$$

$$Y = K_p^{\alpha} L^{\beta} K_g^{(1-\alpha-\beta)}$$

$$\frac{dY}{dK_g} = (1 - \alpha - \beta)\frac{Y}{K_g}$$

no spillover effect

Trans-log Production Function

Whether or not infrastructure investment is effective for production activities is verified by estimating the productivity effect of infrastructure. Estimates can be made by using the following production function:

$$Y = F\left(K_P, L, K_G\right), \qquad (1)$$

where K_p denotes private capital, L stands for labor, and K_G represents stock of infrastructure investment. The production function is a trans-log production function written in the following manner:

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

To examine the productivity effect of infrastructure in greater detail, estimates are made by classifying direct effects and spillover effects based on

Table 3.2. Estimates of spillover effects on increased output in Japan

	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]).

Spillover Tax Revenues created by Infrastructure

Incremental tax revenues from spillover effects can be written as:

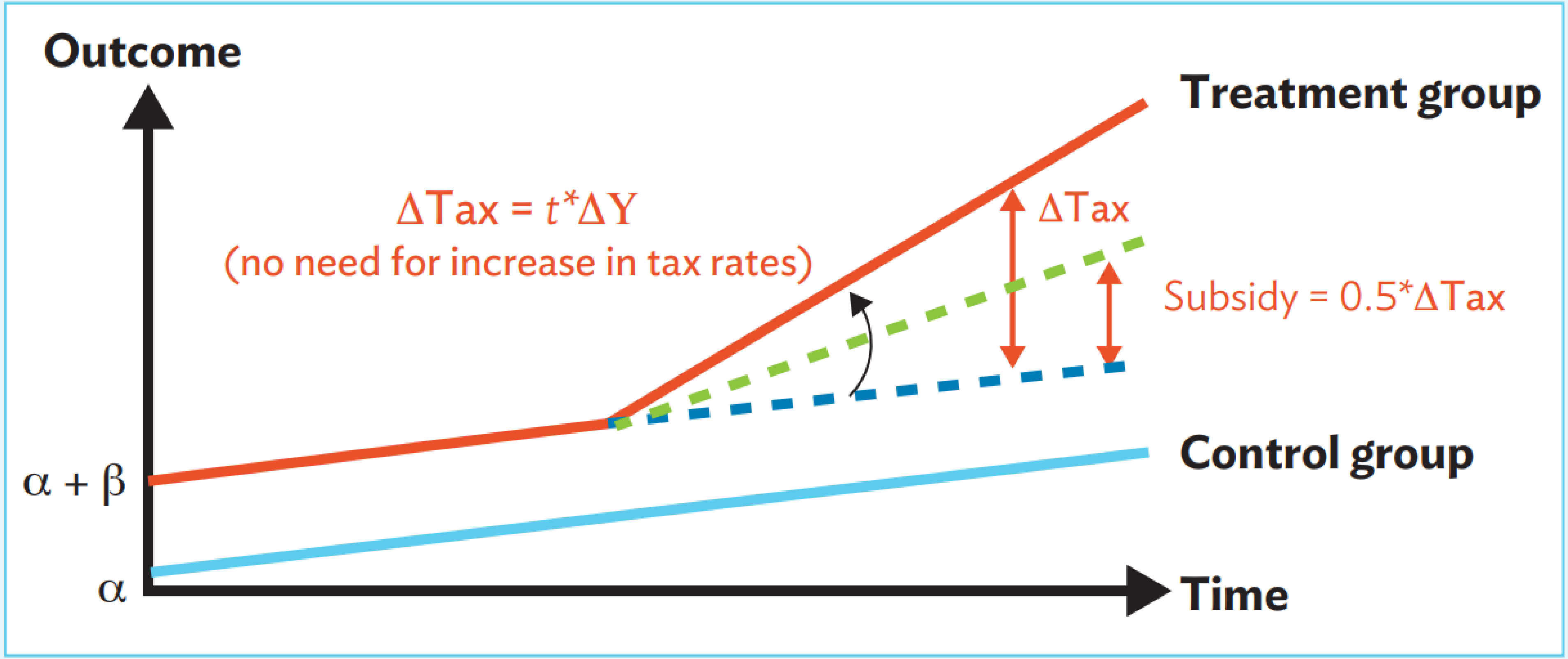
$$dT_{spill} = t\,x\,dY_{spill} = tX\left(\frac{\partial f(K_P, L, K_G)}{\partial K_P}\frac{\partial K_P}{\partial K_G} + \frac{\partial f(K_P, L, K_G)}{\partial L}\frac{\partial L}{\partial K_G}\right) x\,dKG. \qquad (4)$$

Spillover tax revenues can be decomposed into two parts. First comes from the contribution of private capital, while the second comes from the increase in employment.

Incremental tax revenues from the direct effect of infrastructure meanwhile can be expressed as:

$$dT_{direct} = t\,x\,dY_{direct} = t\,x\left(\frac{\partial f(K_P, L, K_G)}{\partial K_G}\right) x\,dKG. \qquad (5)$$

Diagram of Spillover Tax Revenues



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

The Difference in difference Method

Estimation

Following an econometric model (Equation 1), the difference in difference method is used to compare the differential impact of infrastructure investment in two different regions. One is the region which gained significantly from a transport infrastructure project. Another is the region located sufficiently far away so as not to be affected by the project. The difference between these two regions in either tax revenue or GDP can be obtained. Since monetary policy and fiscal policies affect all the countries, various economic variables will be used as explanatory variables to explain the fluctuations of tax revenue and gross domestic product (GDP). Then add the dummy variable which represents specific infrastructure investment. Periods before the construction, during the construction, and during operation are compared to examine the impact of transport infrastructure investment (Yoshino and Abidhadjaev 2017a, 2017b).

Equation 1: $$\Delta Y_{i,t} = \alpha_i + \phi_t + X'_{it}\beta + \delta(D_{gt\{2010:2009\}}) + \varepsilon_{it}$$

ΔY_{it} is the change in tax revenue or GDP of region i; X denotes time-varying covariates (vector of observed control variables); D is the dummy variable indicating whether the observation is in the affected group after the provision of the infrastructure services; g indexes groups of regions, affected and not affected; α_i is the sum of the autonomous and time-invariant unobserved region-specific rates of growth; ϕ_t is the year-specific growth effect; and ε_{it} is the error term, assumed to be independent over time.

Table 3.3. Estimated difference in gross domestic product before and after railway construction in Uzbekistan

Region group	Outcome	Pre-railway period 2005-08	Post-railway period 2009-12	Difference (percentage points)
Non-affected group	Average GDP growth rate (percentage)	8.3	8.5	0.2
Affected group	Average GDP growth rate (percentage)	7.2	9.4	2.2
		Difference	**2.0**	

Note: GDP = gross domestic product. Affected group includes the regions of Samarkand, Surkandharya, Tashkent and the Republic of Karakalpakstan.
Source: (Yoshino and Abidhadjaev, 2017[5]).

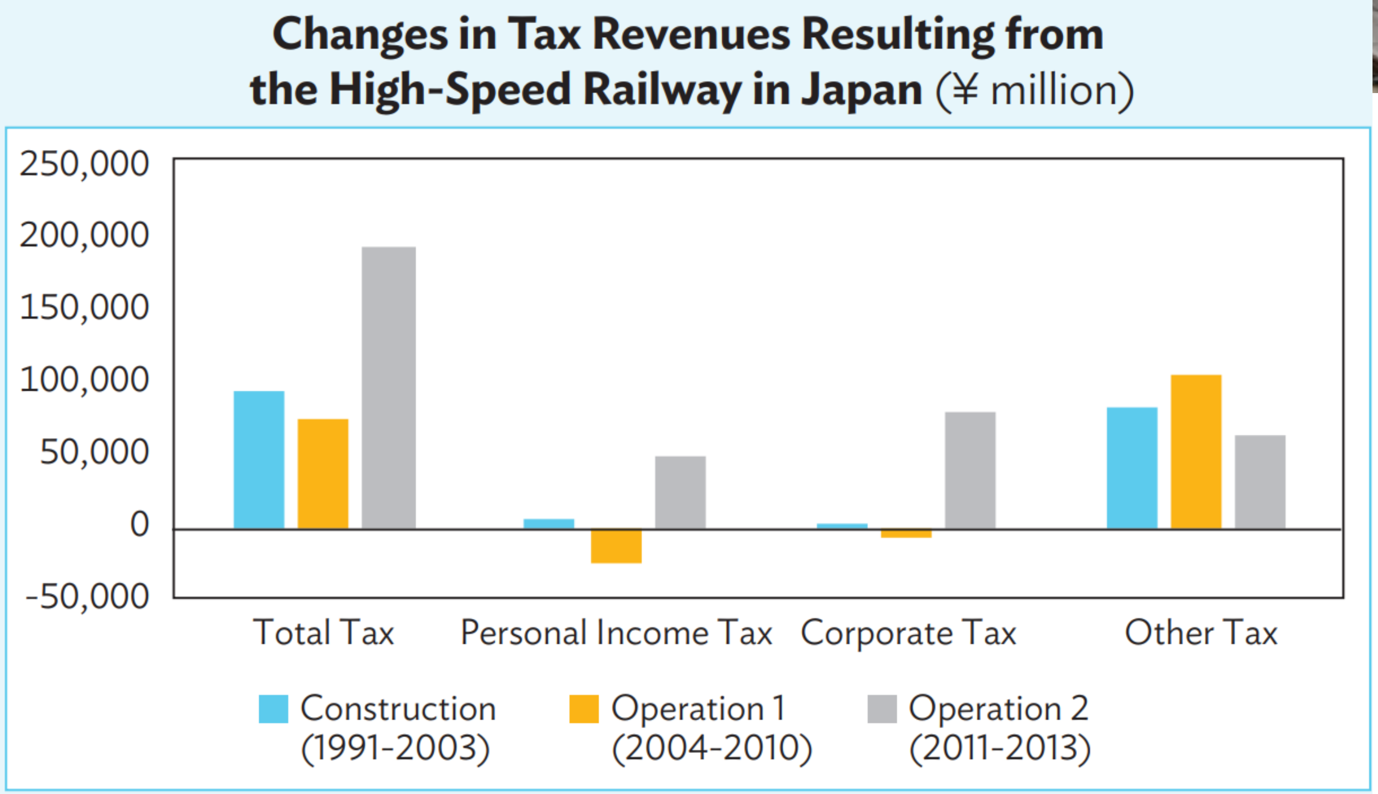
Table 3.4. Calculated increase in business tax revenues for the beneficiary group relative to non-beneficiary group

(PHP million)

Region	$t-2$	$t-1$	t	$t+1$	$t+2$	$t+3$	$t+4$
Lipa City	134.36	173.50	249.70	184.47	191.81	257.35	371.93
Ibaan City	5.84	7.04	7.97	6.80	5.46	10.05	12.94
Batangas City	490.90	622.65	652.83	637.83	599.49	742.28	1 209.61

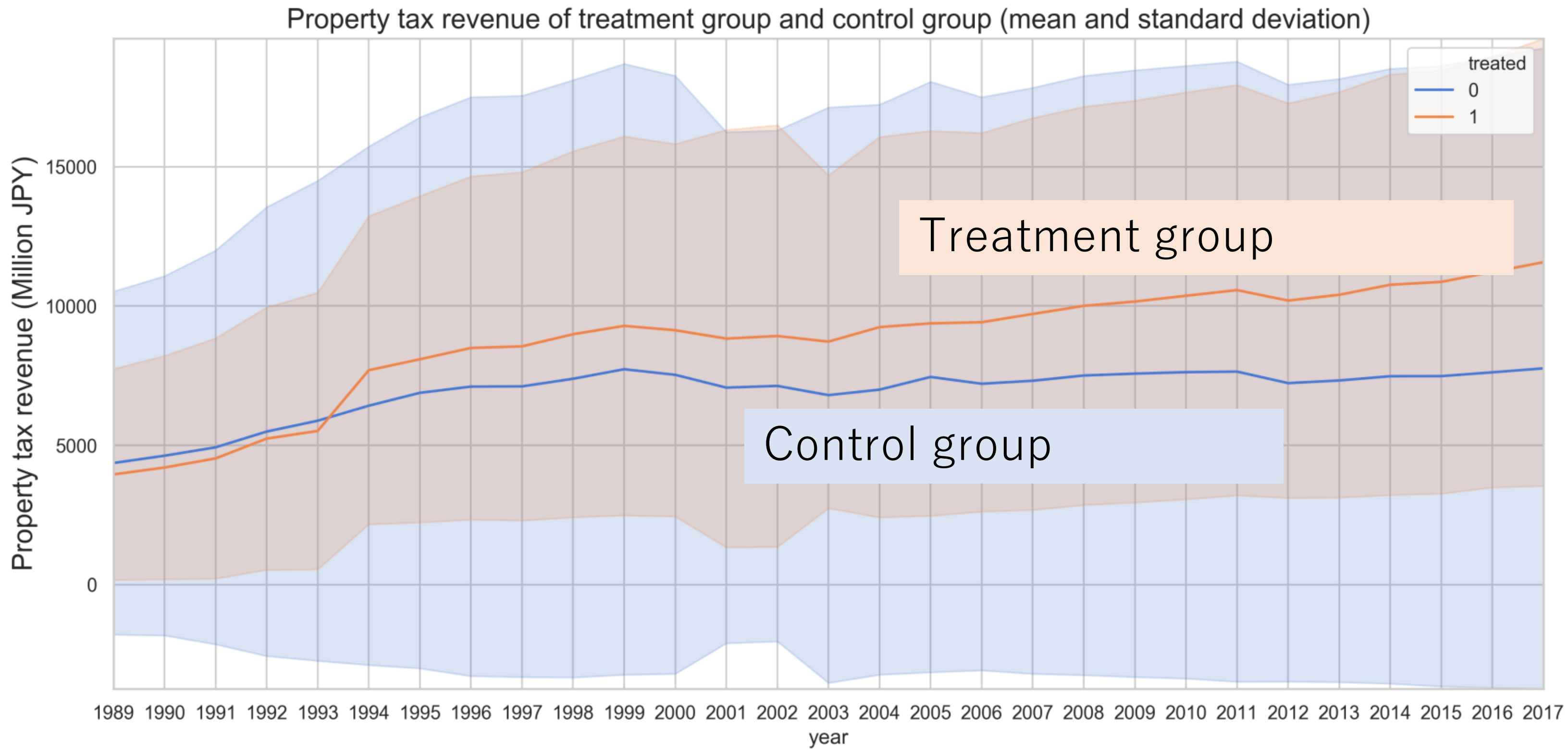
Source: (Yoshino and Pontines, 2018[4]).

Estimation results of Increased tax revenues



Note: The first bar is the period of construction, the second bar is the period after operation without connection to large cities, and the third bar is the period after the high-speed railway is connected to large cities such as Osaka and Tokyo.
Source: Yoshino and Abidhadjaev (2017b).

Case Study – Tsukuba Express (TX)
Property tax revenue



Yoshino, Kai and SeethaRam

Table 1.5: Net Present Value and Internal Rate of Return of High-Speed Rail Project in Taipei,China (NT$ billion)

	Original	With Land Trust	With Land Trust and Spillover Revenue
Total cost	–1,054	–1,134	–1,134
Net present value (NPV) cost	–620	–606	–606
Total revenue	1,890	1,890	2,524
NPV revenue	628	628	808
Net NPV	8	22	202
Internal rate of return	5.1%	5.4%	7.7%

Source: Authors.

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Positive Impact of Digital Infrastructure on Tax Revenues in India

Infrastructure & Education

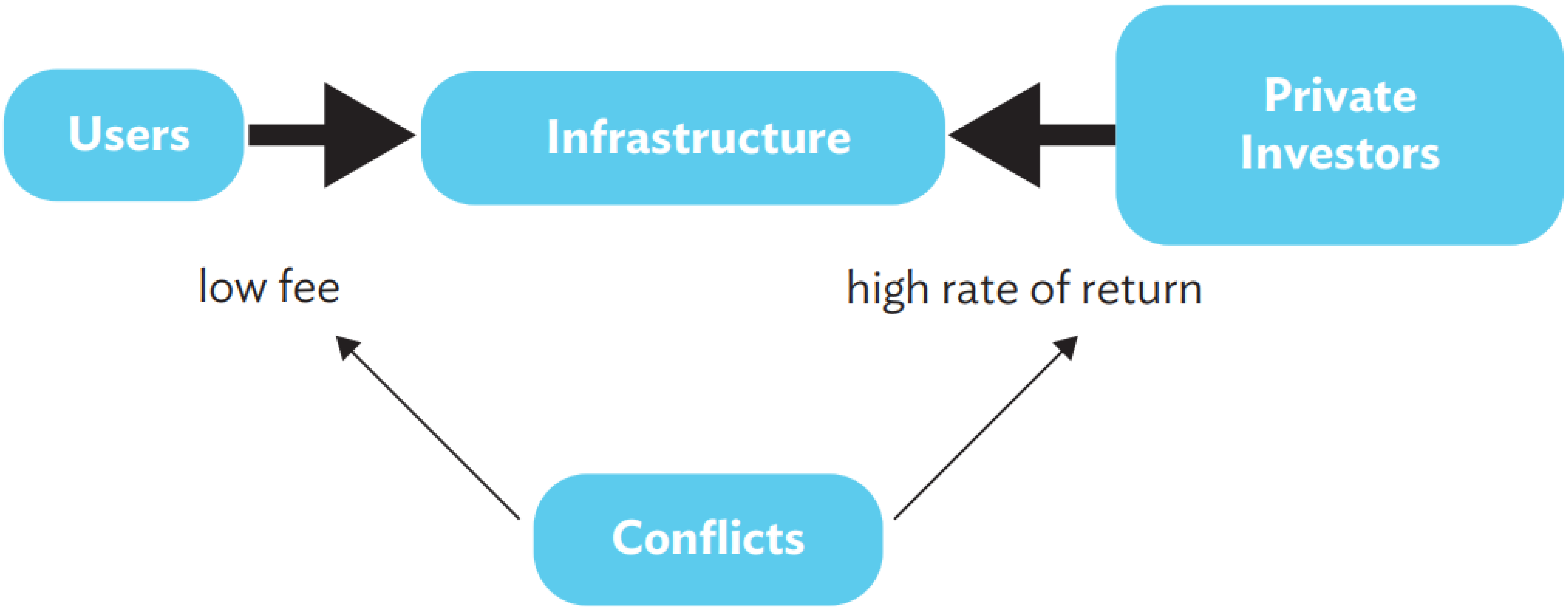
Yoshino and Umid Abidhadjaev (2016)

Education

In a study of 44 Countries Professor Yoshino found that education played a significant role in impacting the quantum of the spillover effect. Secondary schools provided basic skills for blue collar workers. Universities provided education for highly skilled workers. Workers' education level impacted businesses' productivity.

Dependent variable: log difference GDP per capita in 1991-2010			
Regression number	REG.1	REG.2	REG.3
Variables	Coef.	Coef.	Coef.
lnY_1991	-0.06	-0.14	-0.14
	(-0.54)	(-1.35)	(-1.38)
ln(n+g+d)	-3.09	-5.75	-4.36
	(-0.59)	(-1.23)	(-0.77)
ln(Kg)	0.23	0.31	0.53
	(1.17)	(2.00)	(3.30)
ln(Sec)			0.00
			(0.46)
ln(Kg)xln(Sec)	0.20		
	(1.59)		
ln(Uni)			0.21
			(2.07)
ln(Kg)xln(Uni)		0.24	
		(2.76)	
Constant	-0.28	0.56	0.48
	(-0.33)	(0.69)	(0.57)
Number of observations	44.00	44.00	44.00
R-squared	0.21	0.30	0.30
F-statistic	2.62	4.14	3.29

Conflict of Interest between Users and Investors



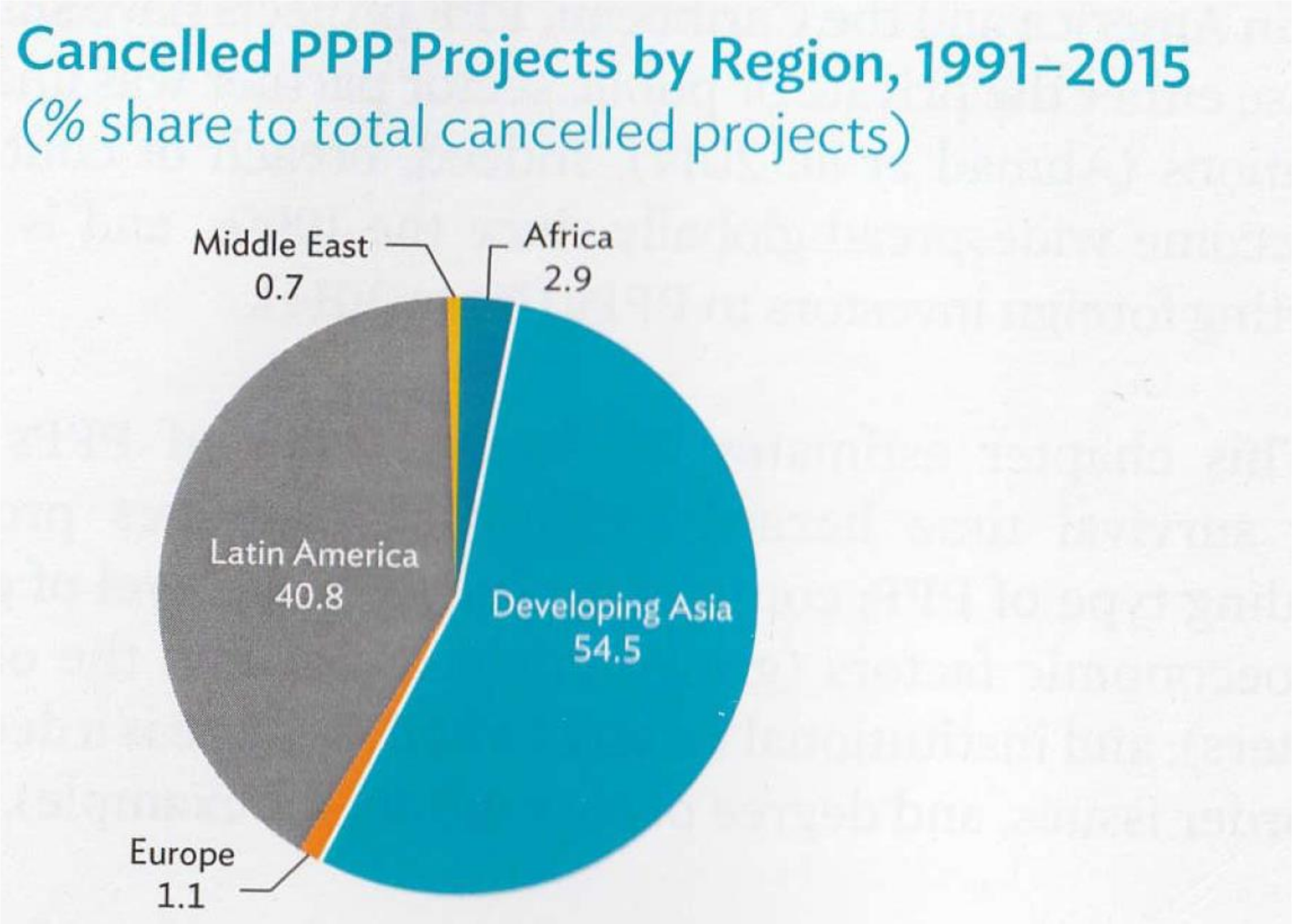
Yoshino, Lakhia and Yap (2021) ADB - Chapter 5

PPP = Public Private Partnerships

Realizing The Potential of Public Private Partnerships to Advance Asia's Infrastructure Development

Akash Deep
Jungwook Kim
Minsoo Lee

ADB (2019)



Public and Private Infrastructure Investment in Asia, 2010–2014
(% of GDP)

	Private	Public
25 ADB Developing Member Countries	0.4	5.1
East Asia	app. 0	6.3
South Asia	1.8	3.0
Central and West Asia	0.3	2.6
Pacific	0.3	2.5
Southeast Asia	0.5	2.1
People's Republic of China	app. 0	6.3
Indonesia	0.3	2.3

ADB = Asian Development Bank, GDP = gross domestic product.
Note: The numbers are based on 25 selected countries listed in Appendix 3.1 of ADB (2017).
Source: ADB (2017).

Figure 5.4: Debt Service in Selected Developing Asian Economies, 2019 and 2020

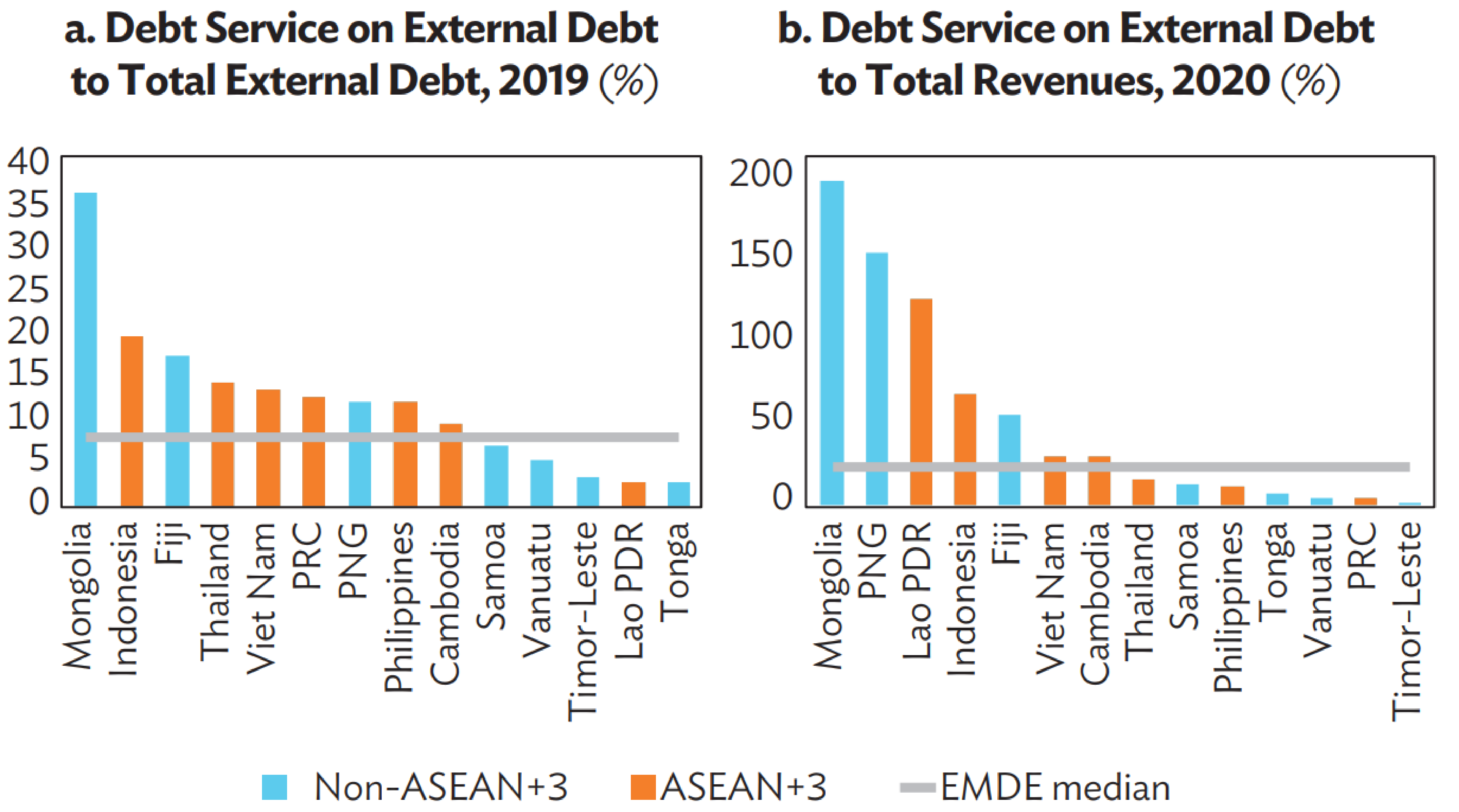
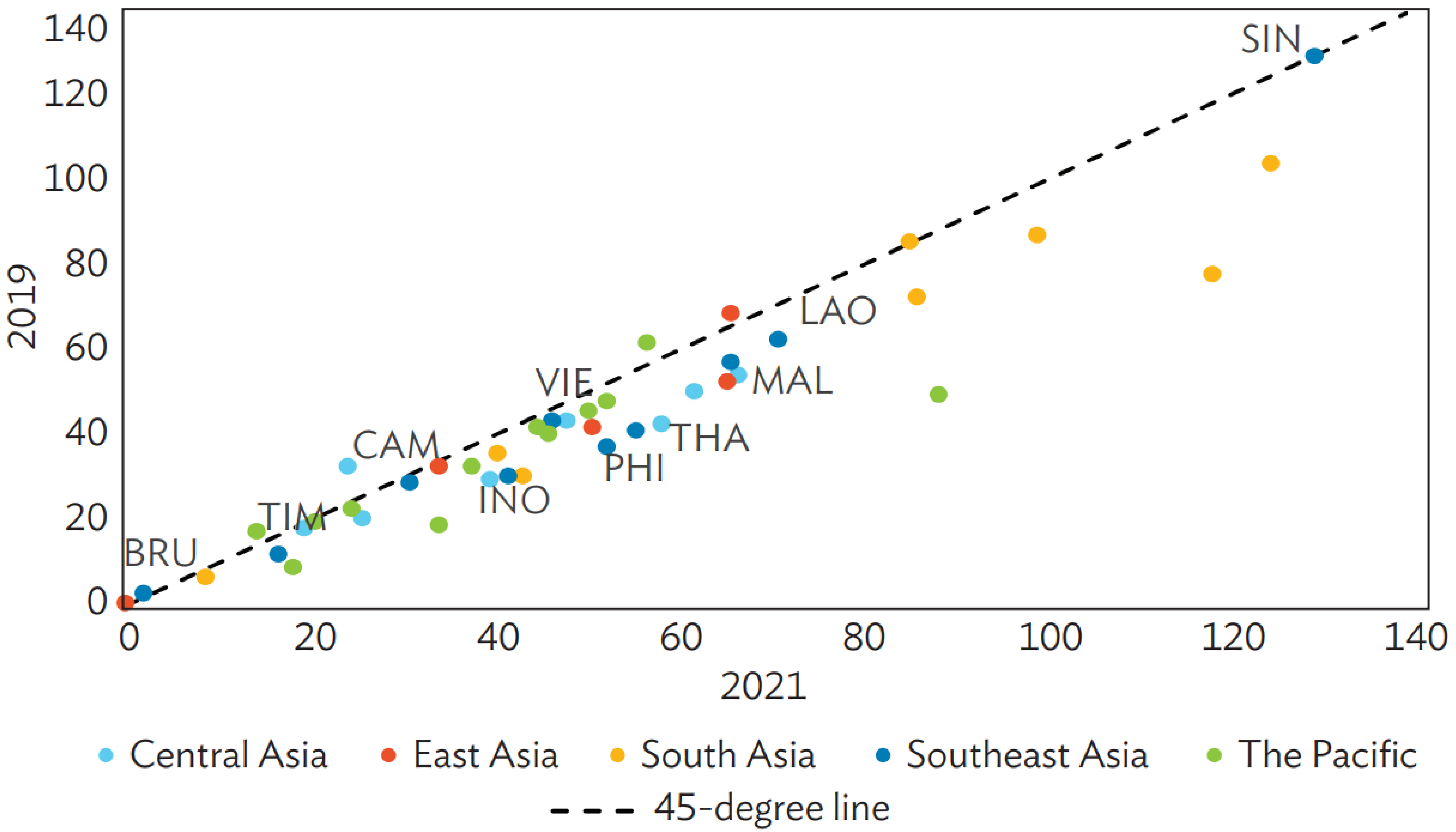
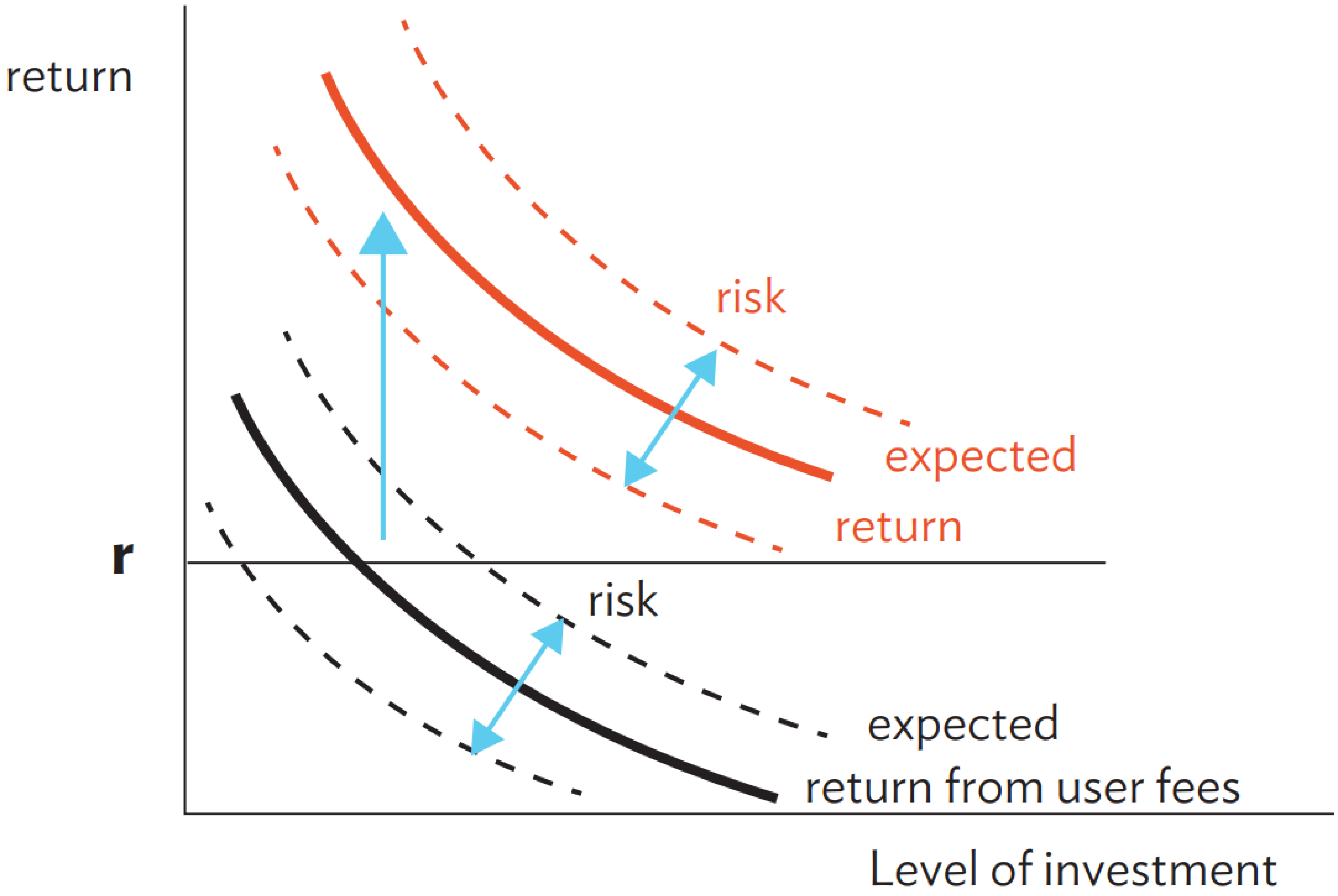


Figure 5.10: Comparing Public Debt in 2019 and 2021

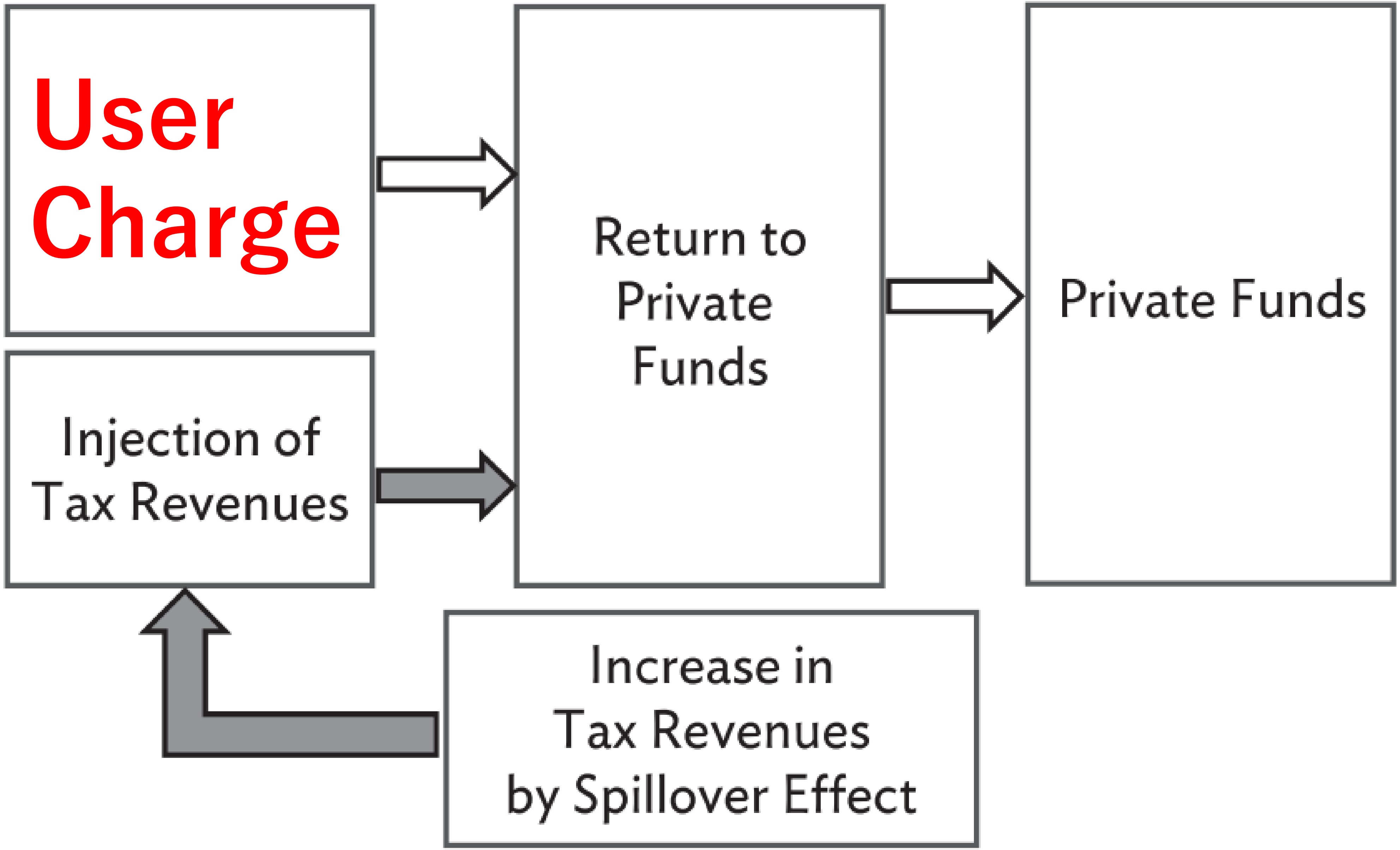


BRU = Brunei Darussalam, CAM = Cambodia, INO = Indonesia, LAO = Lao PDR, MAL = Malaysia,

Figure 5.2: Expected Rate of Return and Risk Profile of Project Bonds versus Benchmark Yield



Injection of a Fraction of Tax Revenues as a Subsidy



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ORIGINAL ARTICLE

Financing infrastructure using floating-interest-rate infrastructure bond†

Naoyuki Yoshino[1], Dina Azhgaliyeva[2] and Ranjeeta Mishra[2]*

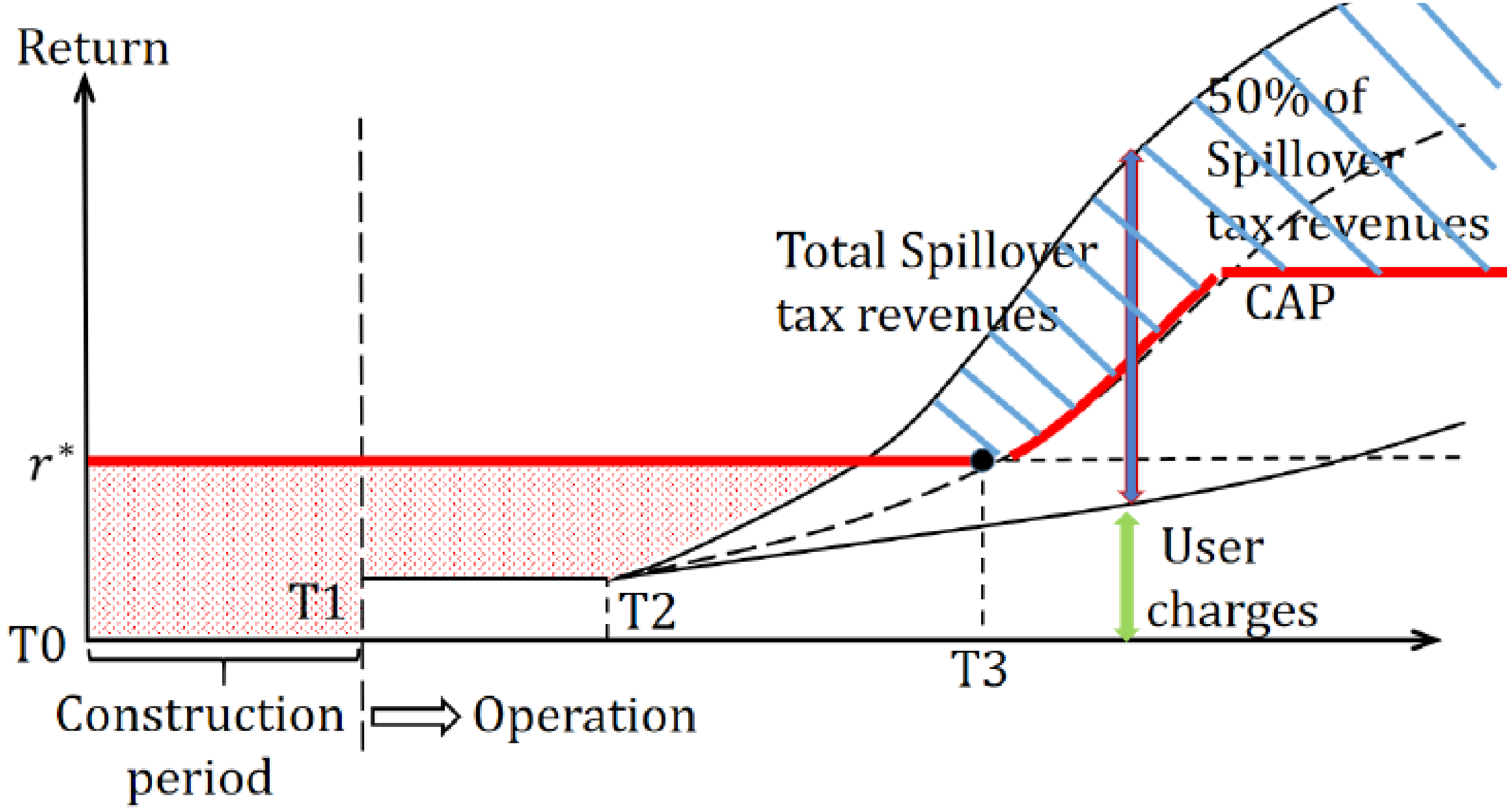
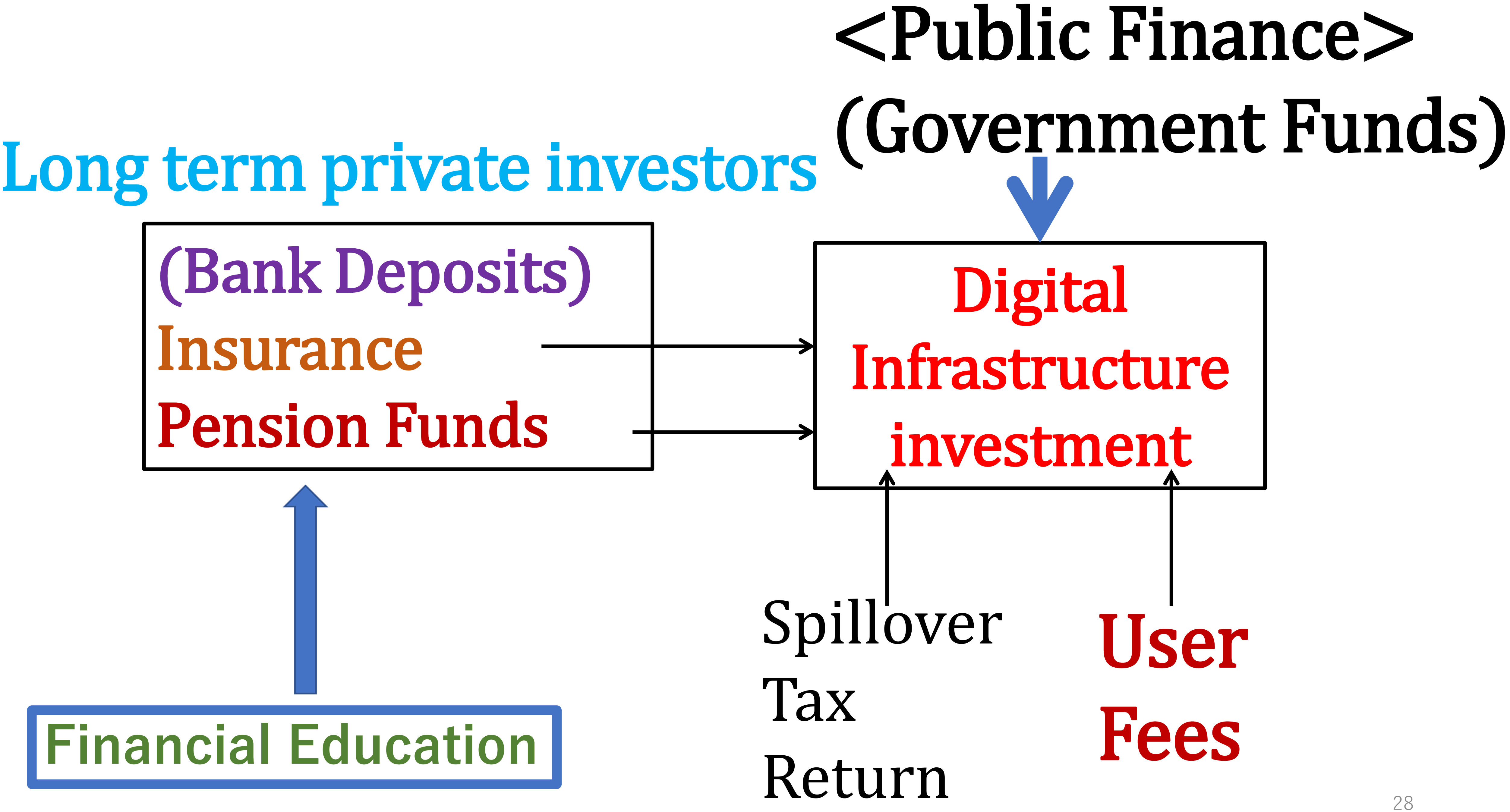
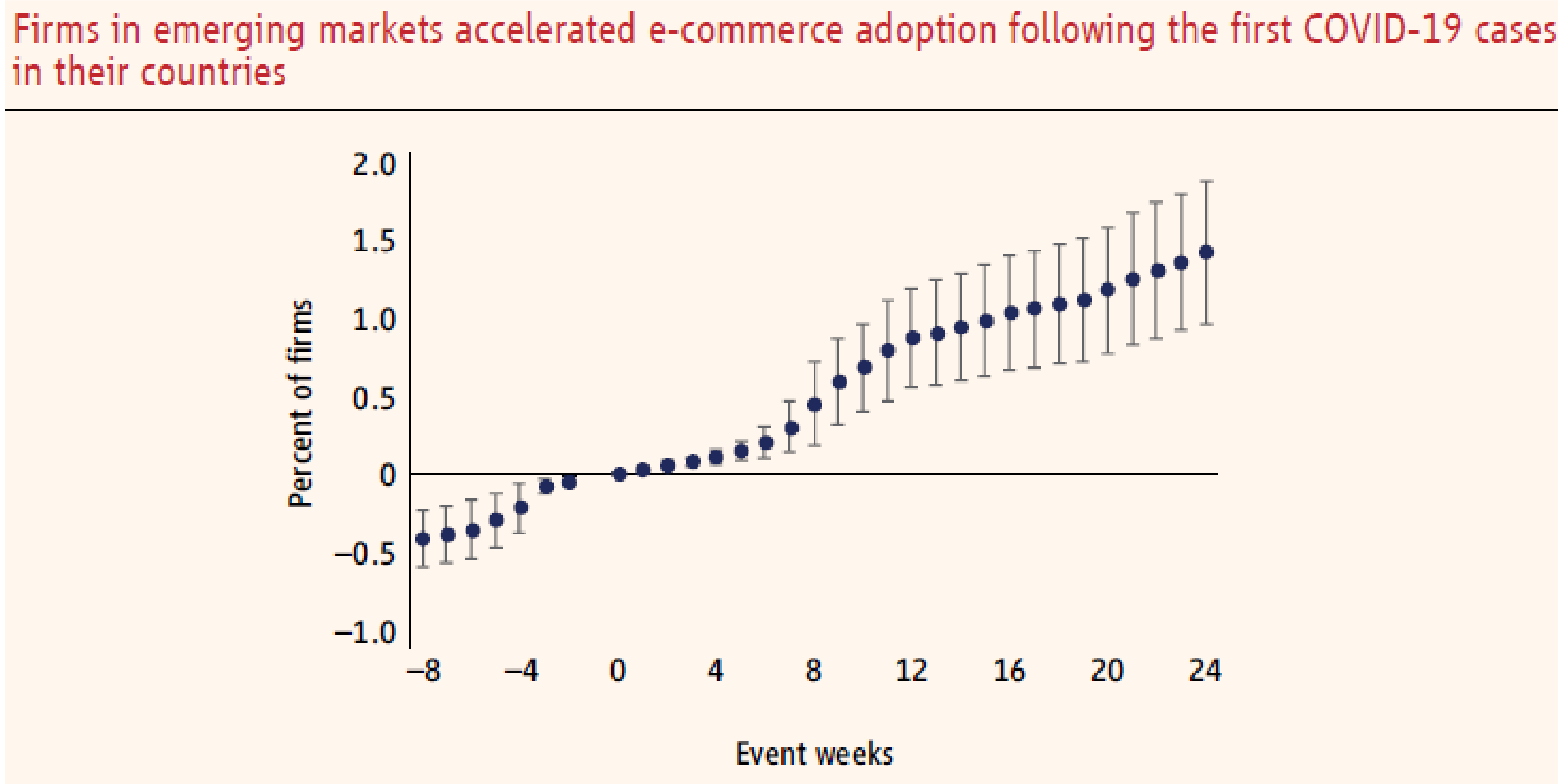


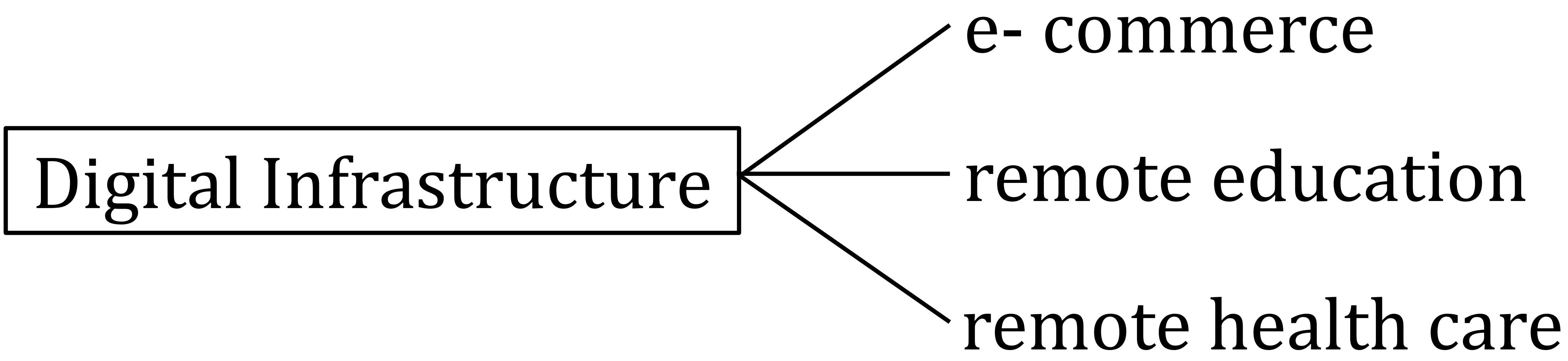
Figure 4. The proposed floating-rate infrastructure bonds to make spillover tax return in practice.


<Public Finance>
(Government Funds)
Long term private investors
(Bank Deposits)
Insurance
Pension Funds
Digital Infrastructure investment
Spillover Tax Return
User Fees
Financial Education

Digital Infrastructure + Transport Infrastructure



Ex. Small Business: Tatami mat of Japan


Digital Infrastructure
e- commerce
remote education
remote health care

Sustainable Development
Series Editors:
Parkash Chander · Euston Quah

SPRINGER REFERENCE

Jeffrey D. Sachs · Wing Thye Woo
Naoyuki Yoshino
Farhad Taghizadeh-Hesary *Editors*

Handbook of Green Finance

Environmental Issues associated with Infrastructure

$Y = F(L \ K_P \ K_g)$ (1)

Traditional Production Function

$F(Y, CO_2) = F(L \ K_P \ K_g)$ (2)

Y= Output CO_2 emission

L= labor K_P= Private capital,

K_g =infrastructure

Optimal portfolio allocation can be achieved by taxing GHG (Green House Gas)

1, By taxing wastes such as CO2, NOX, Plastics, etc. by identical international taxation, the investors can only look for the rate of return and risks as they were conventionally focused on.

2, International taxation will lead to optimal asset allocation and achieve sustainable growth

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Covid-19 and Optimal Portfolio Selection for Investment in Sustainable Development Goals

Naoyuki Yoshino[a], Farhad Taghizadeh-Hesary[b,*], Miyu Otsuka[c]

Global Taxation on GHG

Tax levied on Asset A

$T_A = t_1 x a_1(CO_2) + t_2 x a_2(NOX)$

Tax levied on Asset B

$T_B = t_1 x b_1(CO2) + t_2 x b_2(NOX)$

Revised rate of return on asset A

$RA = R_A - t_1 x a_1(CO_2) - t_2 x a_2(NOX)$

Revised rate of return on asset B

$RB = R_B - t_1 x b_1(CO2) - t_2 x b_2(NOX)$

Investors look RA and RB instead of R_A and R_B

Environmental Issues can be solved by Carbon tax and other tax policies

Rate of return will be lowered if CO2 emission is large

$$\tilde{R}_t^A = R_t - T_A \qquad (16)$$

$$\tilde{R}_t^B = R_t - T_B \qquad (17)$$

Equations (16) and (17) show the after-tax rate of return of company A and company B. We can compute the optimal allocation of assets between company A and company B as in equations (18) and (19), which show the optimal rate of return and risks, respectively:

$$\tilde{R}_t = \tilde{\alpha}_t \tilde{R}_t^A + (1 - \tilde{\alpha}_t)\tilde{R}_t^B \qquad (18)$$

$$\tilde{\sigma}_t^2 = \tilde{\alpha}_t^2 (\tilde{\sigma}_t^A)^2 + (1 - \tilde{\alpha}_t)^2 (\tilde{\sigma}_t^B)^2 + 2\tilde{\alpha}_t (1 - \tilde{\alpha}_t) \tilde{\sigma}_t^{AB} \qquad (19)$$

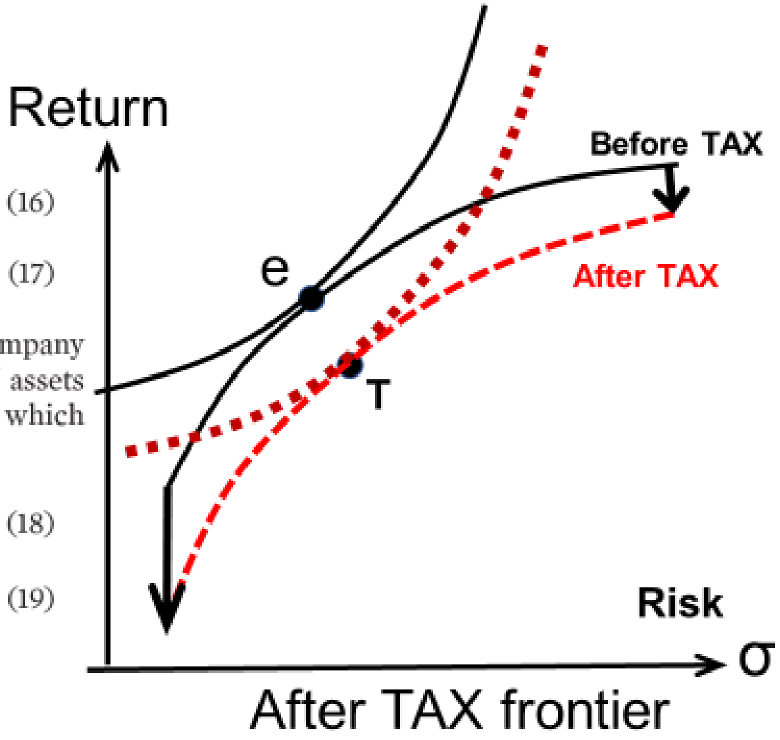
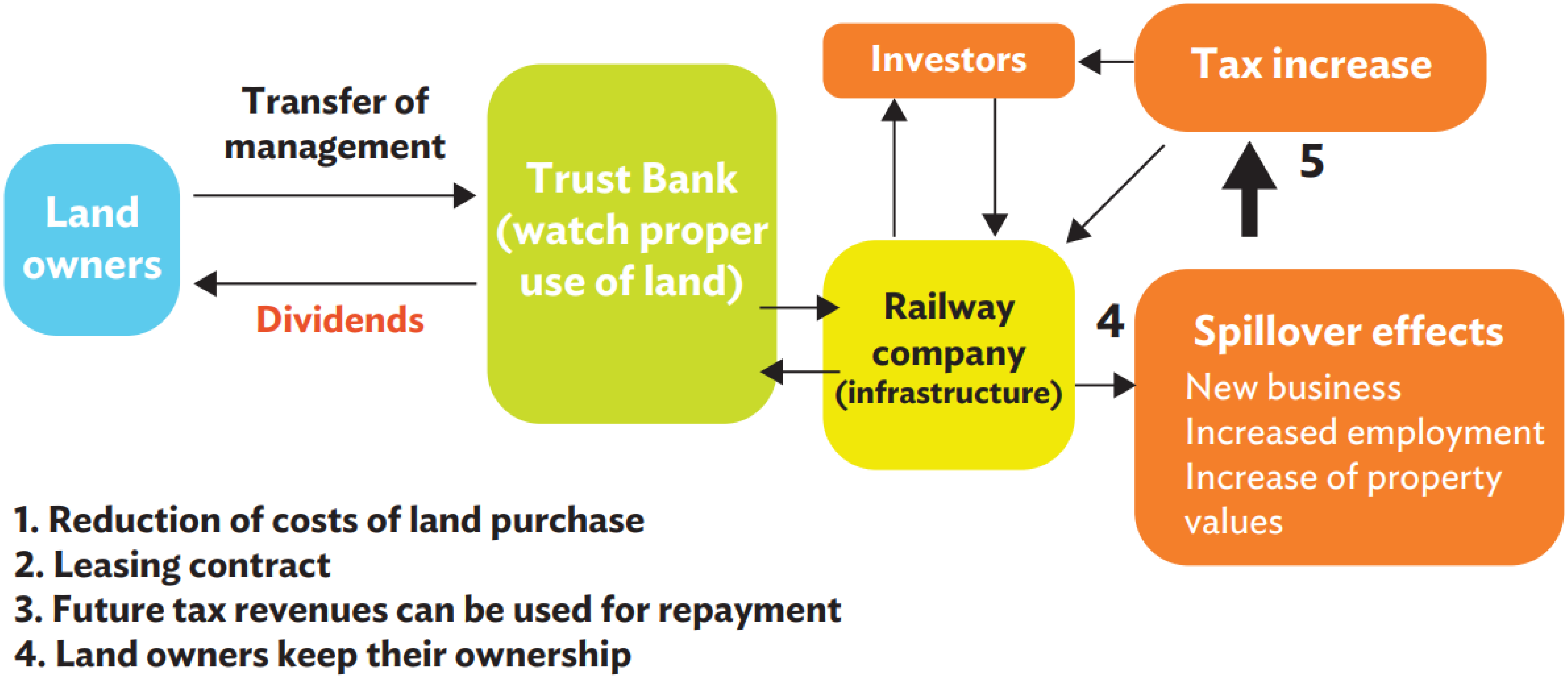


Figure 5.9: Land Trust for Infrastructure Investment



Source: Yoshino and Lakhia (2020).

Thank you for your attention

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