CBA of Spillover Tax Revenues of Infrastructure: Case Study of High-Speed Railway in Asia

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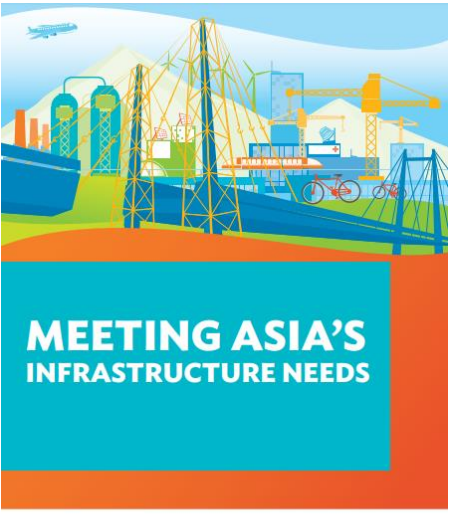


Big Infrastructure Needs in Asia: Resilient and Sustainable Infrastructures needed

ASIAN DEVELOPMENT BANK

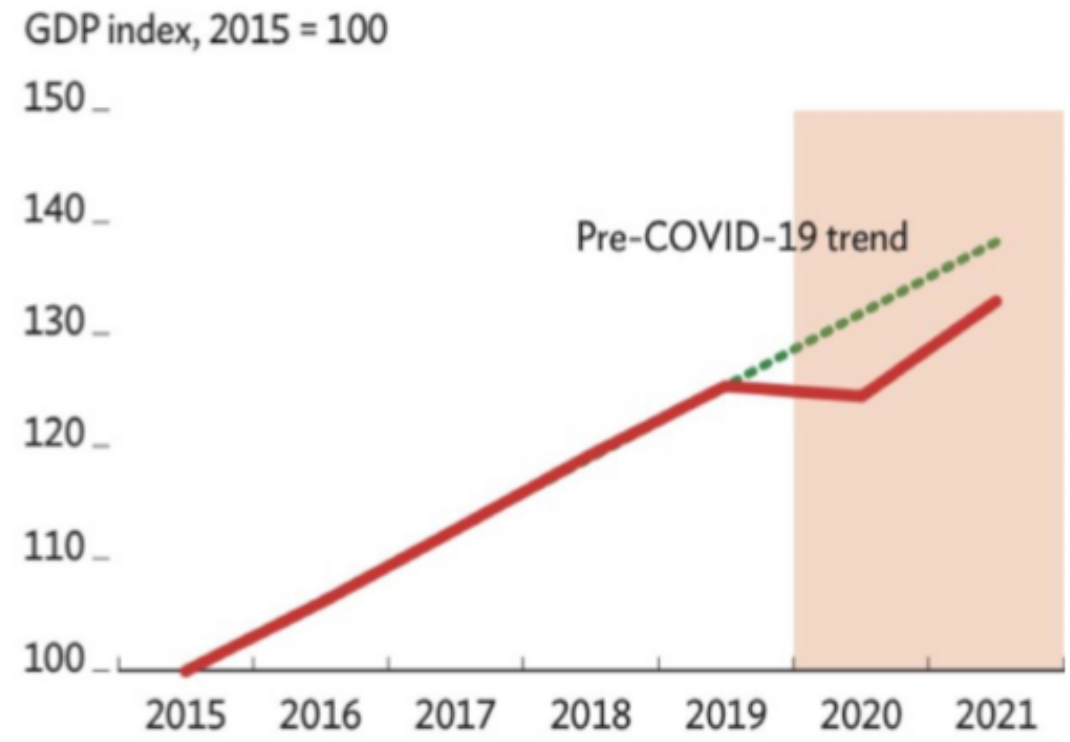
Estimated infrastructure needs in Asia

	Baseline total (US$ billion)	Percent of GDP	Climate-adjusted (US$ billion)	Percent of GDP
Central Asia	33	6.8	38	7.8
East Asia	919	4.5	1071	5.2
South Asia	365	7.6	423	8.8
Southeast Asia	184	5.0	210	5.7

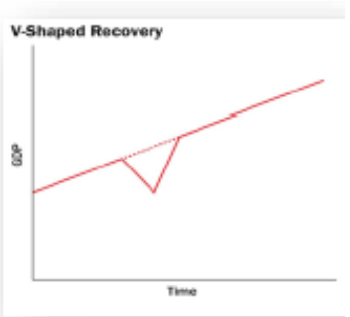
Source: Asian Development Bank (2017).

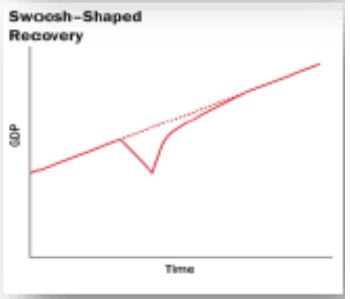
Low rate of return & high risks in infrastructure investments

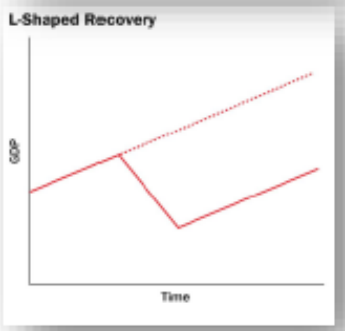
	2021	2022	2023
Developing Asia	**6.9**	**5.2**	**5.3**
East Asia	**7.6**	**4.7**	**4.5**
Hong Kong, China	6.4	2.0	3.7
People's Republic of China	8.1	5.0	4.8
Republic of Korea	4.0	3.0	2.6
Taipei,China	6.4	3.8	3.0
Southeast Asia	**2.9**	**4.9**	**5.2**
Indonesia	3.7	5.0	5.2
Malaysia	3.1	6.0	5.4
Philippines	5.6	6.0	6.3
Singapore	7.6	4.3	3.2
Thailand	1.6	3.0	4.5
Viet Nam	2.6	6.5	6.7
South Asia	**8.3**	**7.0**	**7.4**
Bangladesh	6.9	6.9	7.1
India	8.9	7.5	8.0
Pakistan	5.6	4.0	4.5
Caucasus and Central Asia	**5.6**	**3.6**	**4.0**
Azerbaijan	5.6	3.7	2.8
Kazakhstan	4.0	3.2	3.9
Uzbekistan	7.4	4.0	4.5



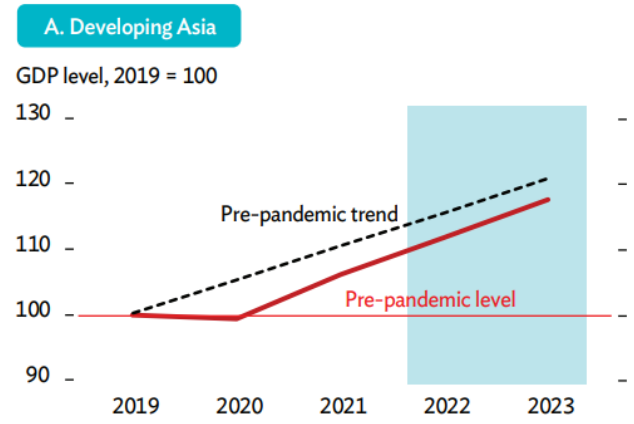
The recovery in Developing Asia will be gradual, with GDP growth below its pre-COVID-19 trend in 2021 and possibly beyond.

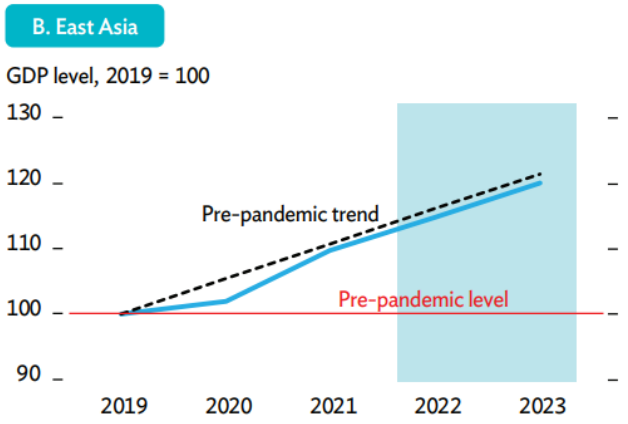


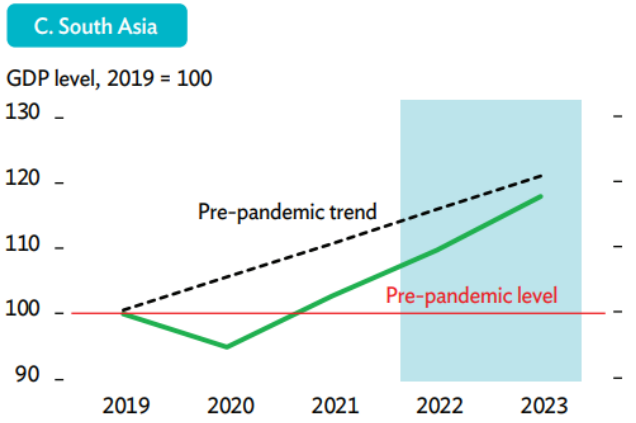


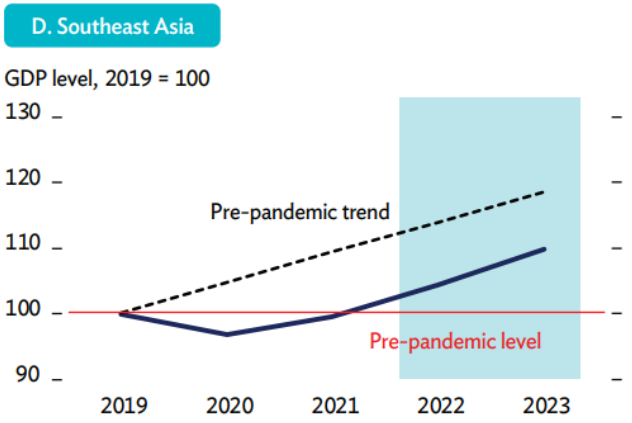


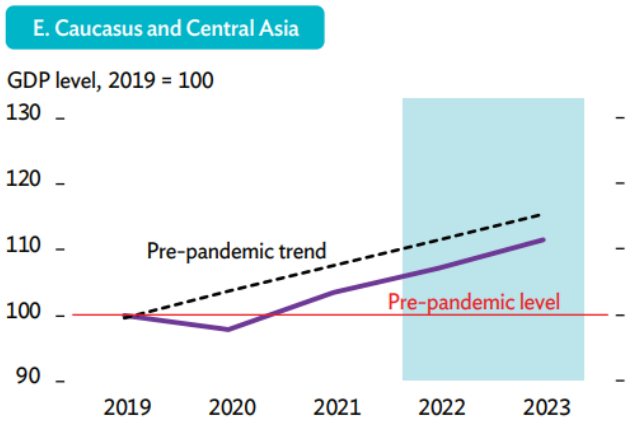
Source: (Figure 3) Asian Development Bank. 2020. *Asia's Journey to Prosperity Policy, Market and Technology over 50 years.* Manila; ADB. 2020. Asian Development Outlook Update. Manila; (Figure 4) United Economic and Social Commissions for Asia and the Pacific 2020. Asia and the Pacific SDG Progress Report 2020. Bangkok.

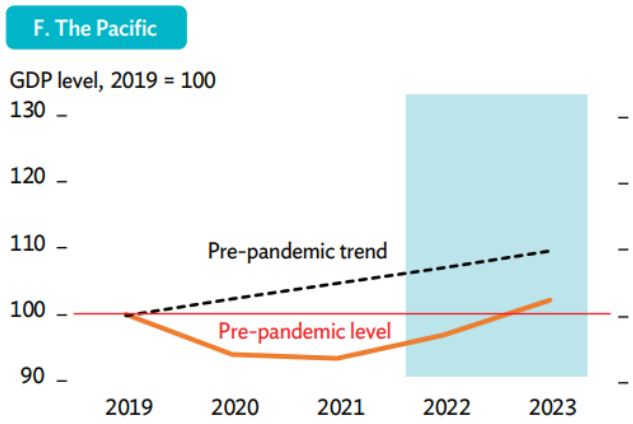












COVID-19 impact on GDP

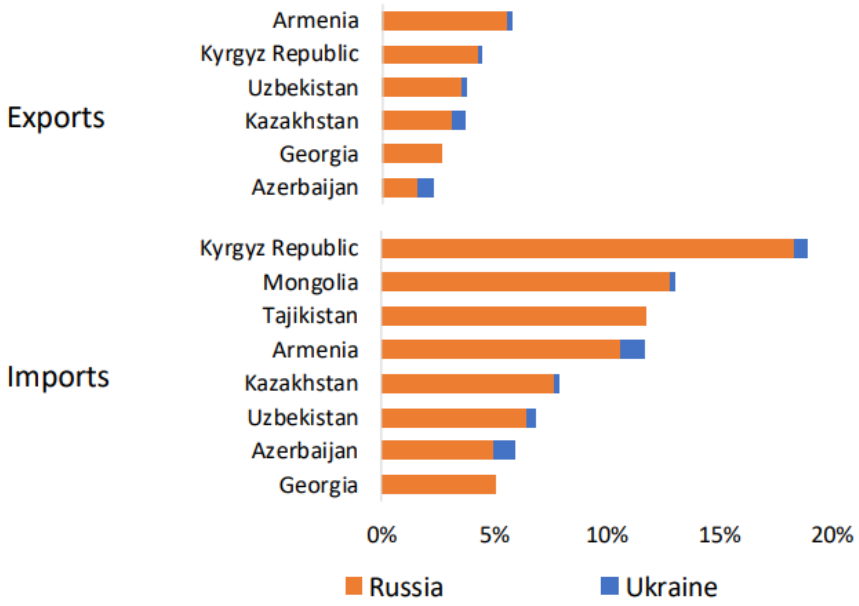
Persistent threat, Omicron variant and others

PRC's current outbreaks and the lockdowns

The Caucasus and Central Asia are exposed to Russia's economic downturn

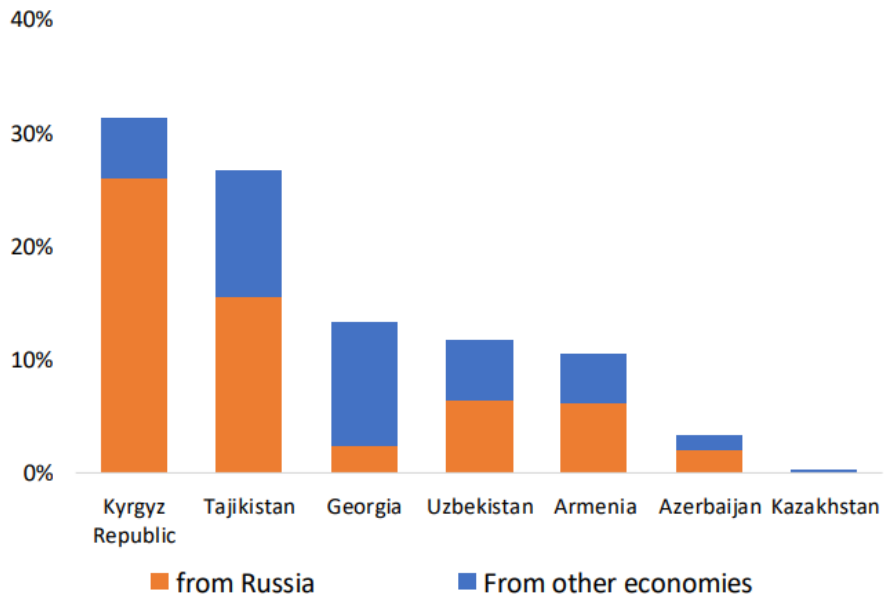
Economies in the Caucasus and Central Asia have close trade links with Russia.

Trade with Russia and Ukraine (% of GDP)

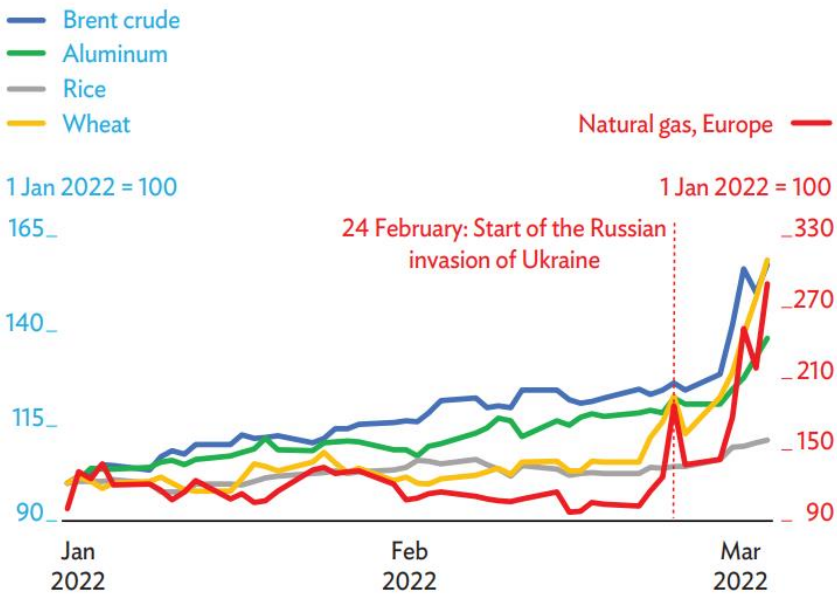


Remittances from Russia exceed 15% of GDP in the Kyrgyz Republic and Tajikistan.

Remittances (% of GDP)

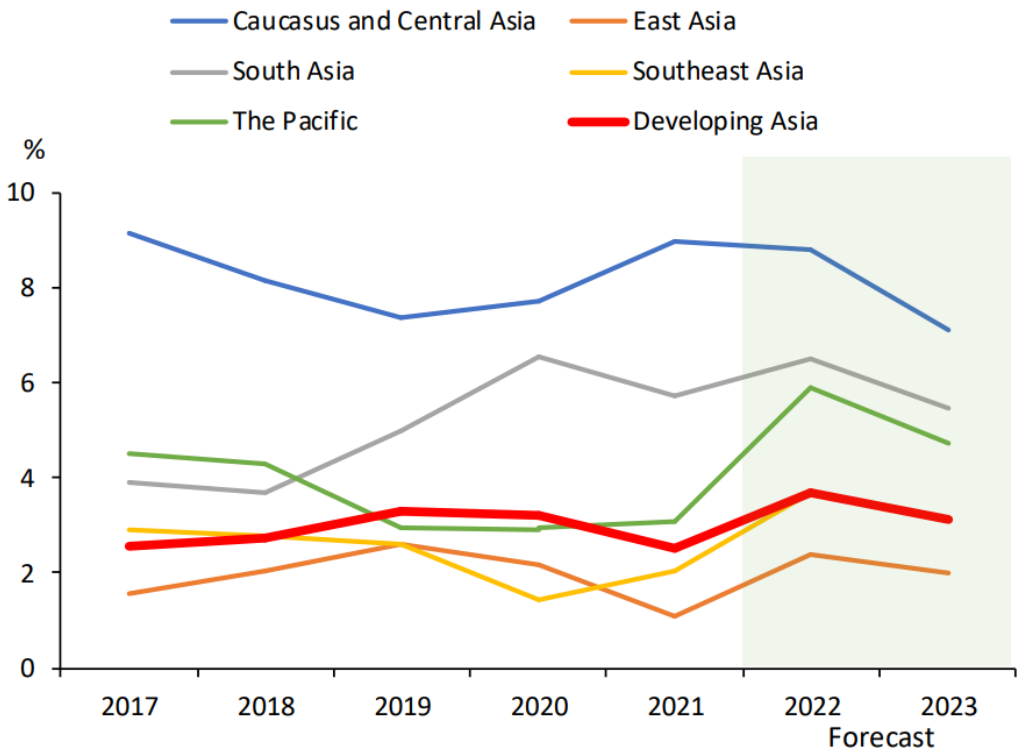


Commodity prices



Source: Bloomberg (accessed 6 March 2022).

Inflation forecast in developing Asia



Source: *Asian Development Outlook* database.

Risks include escalation of Russia Ukraine conflict, financial instability triggered by the Fed's aggressive tightening, emergence of more COVID-19 variants, and disruptions associated with the PRC's current outbreaks.

Spillover Tax Revenues for Infrastructure Investment

1, Infrastructure investment is a crucial driver of economic development and Public sector efforts alone will not be enough to finance infrastructure needs

2, Significant private sector contributions are required for long-term

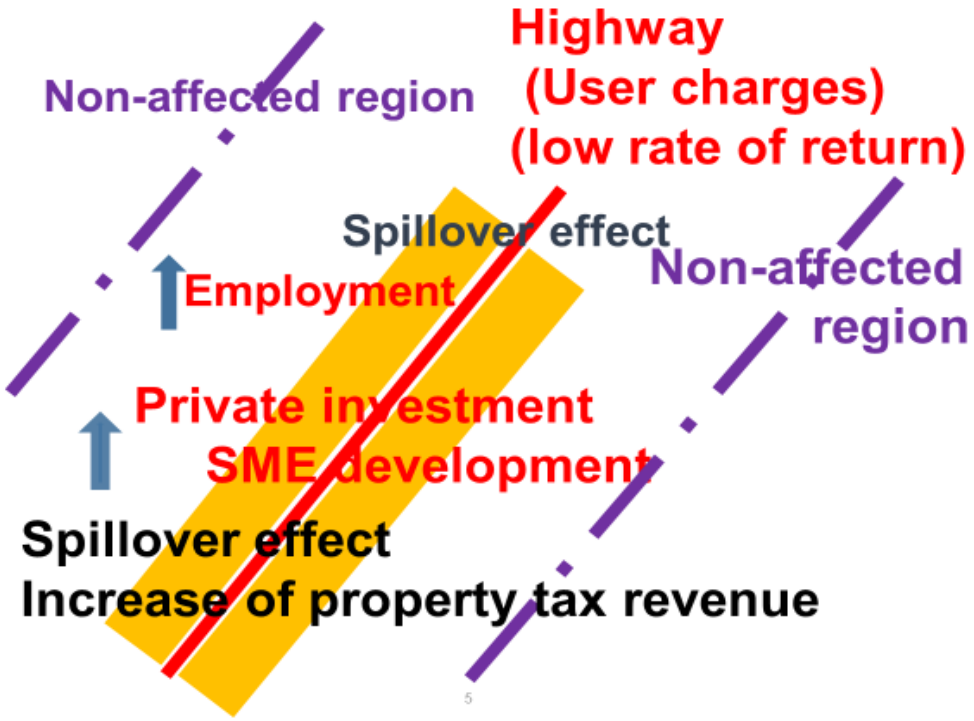
3, Quantifying positive spillover effects of infrastructure

Floating-Rate Infrastructure Bond Combined with Spillover Tax Revenues

Mitigating bottlenecks in the land acquisition process (Land Trust)

Spillover Effects of Infrastructure

Railway, Road, Water, Digital Infrastructure



Quality Infrastructure
Economic Effect of Infrastructure Investment

(1) Effects on total GDP

L= Labor

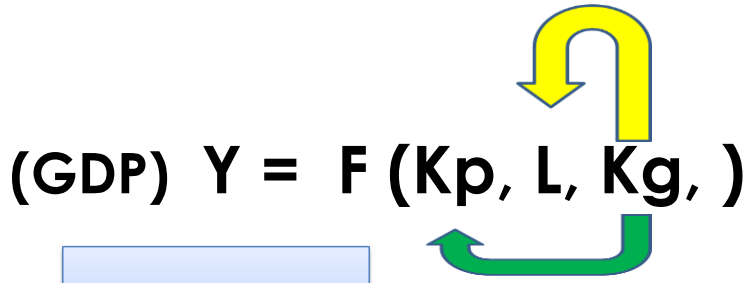
Kp = Private Capital

Kg = Infrastructure

Agricultural sector

Manufacturing sector

Services' sector



Using the following form of the production function, we derive the direct and indirect effects, or externality effects, thus:

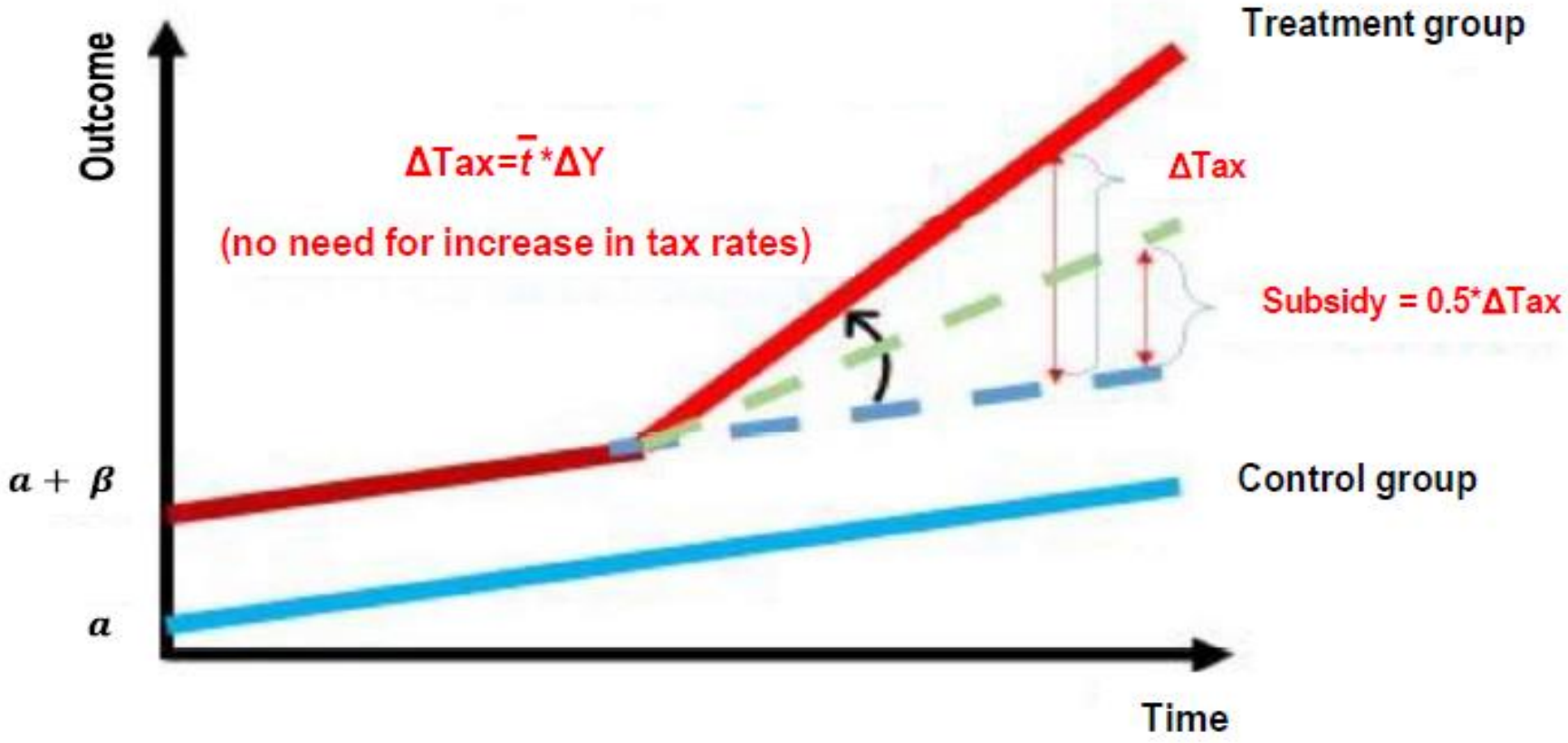
$$Y = F(K_P(K_G), L(K_G), K_G) \tag{3}$$

$$\frac{dY}{dK_G} = \underbrace{\frac{\partial F(K_P, L, K_G)}{\partial K_G}}_{\text{Direct effects}} + \underbrace{\frac{\partial F(K_P, L, K_G)}{\partial K_P}\frac{\partial K_P}{\partial K_G} + \frac{\partial F(K_P, L, K_G)}{\partial L}\frac{\partial L}{\partial K_G}}_{\text{Externality effects}} \tag{4}$$

Incremental tax revenues from externality effects can be written in the equation (5) as follows:

$$dT_{spill} = t \times dY_{spill} = t \times \left(\frac{\partial F(K_P, L, K_G)}{\partial K_P}\frac{\partial K_P}{\partial K_G} + \frac{\partial F(K_P, L, K_G)}{\partial L}\frac{\partial L}{\partial K_G}\right) \times dK_G \tag{5}$$

Spillover tax revenues of affected region vs. national average tax revenues



Difference in Difference (DID) Method

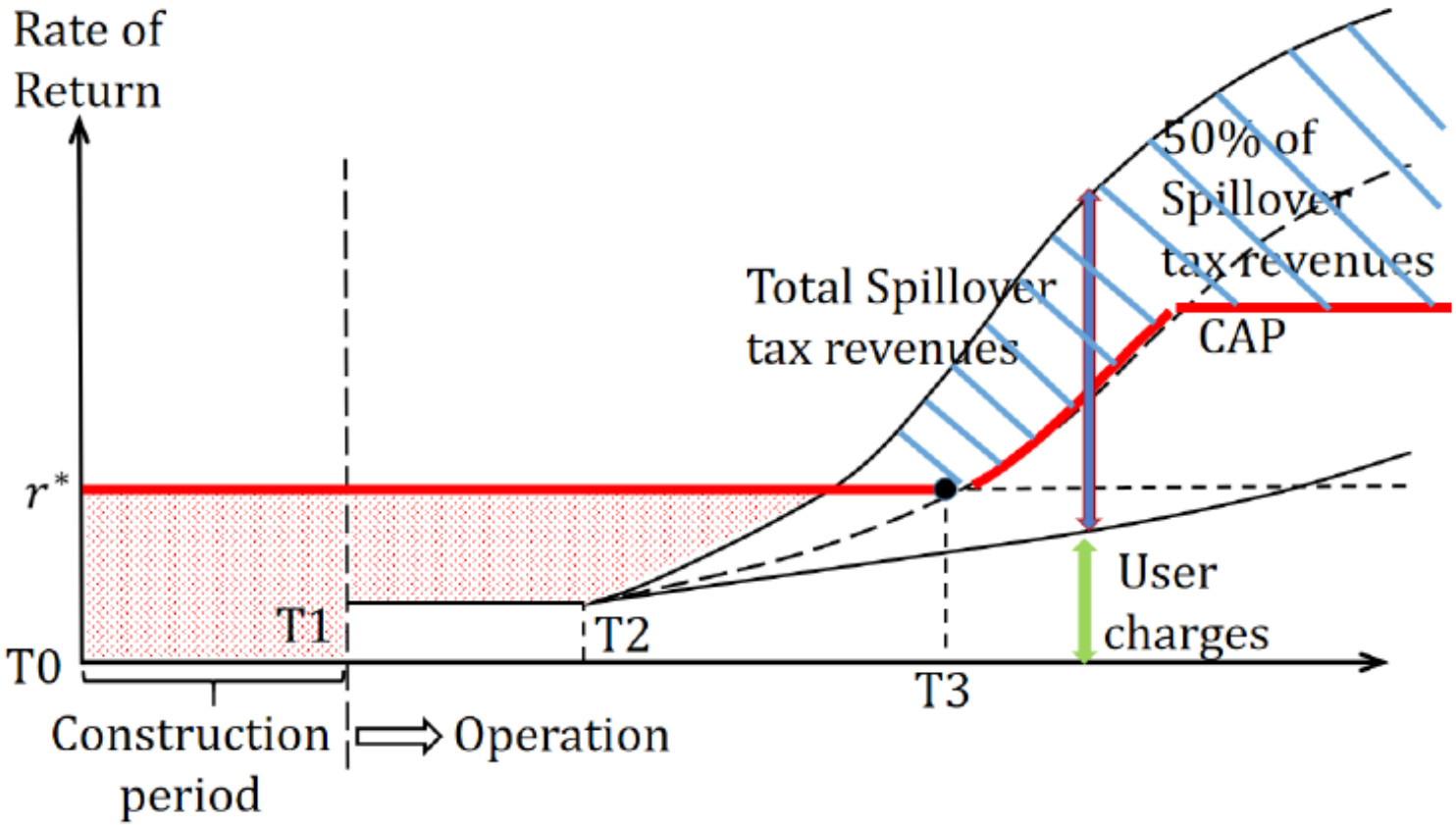
To address this issue, we need to acknowledge the factor inputs, which might affect the performance of tax revenue in the prefecture and control for time-varying covariates. Incorporating the number of taxpayers in the estimation framework and obtaining a linear projection of the tax revenues onto the number of taxpayers, accounting for time-invariant region-specific effects and year-specific effects, provide us with the following baseline estimation strategy of the DID specification:

$$\Delta T_{it} = \alpha_i + \phi_t + \beta X_{it} + \delta D_{gt} + \epsilon_{it} \qquad (1)$$

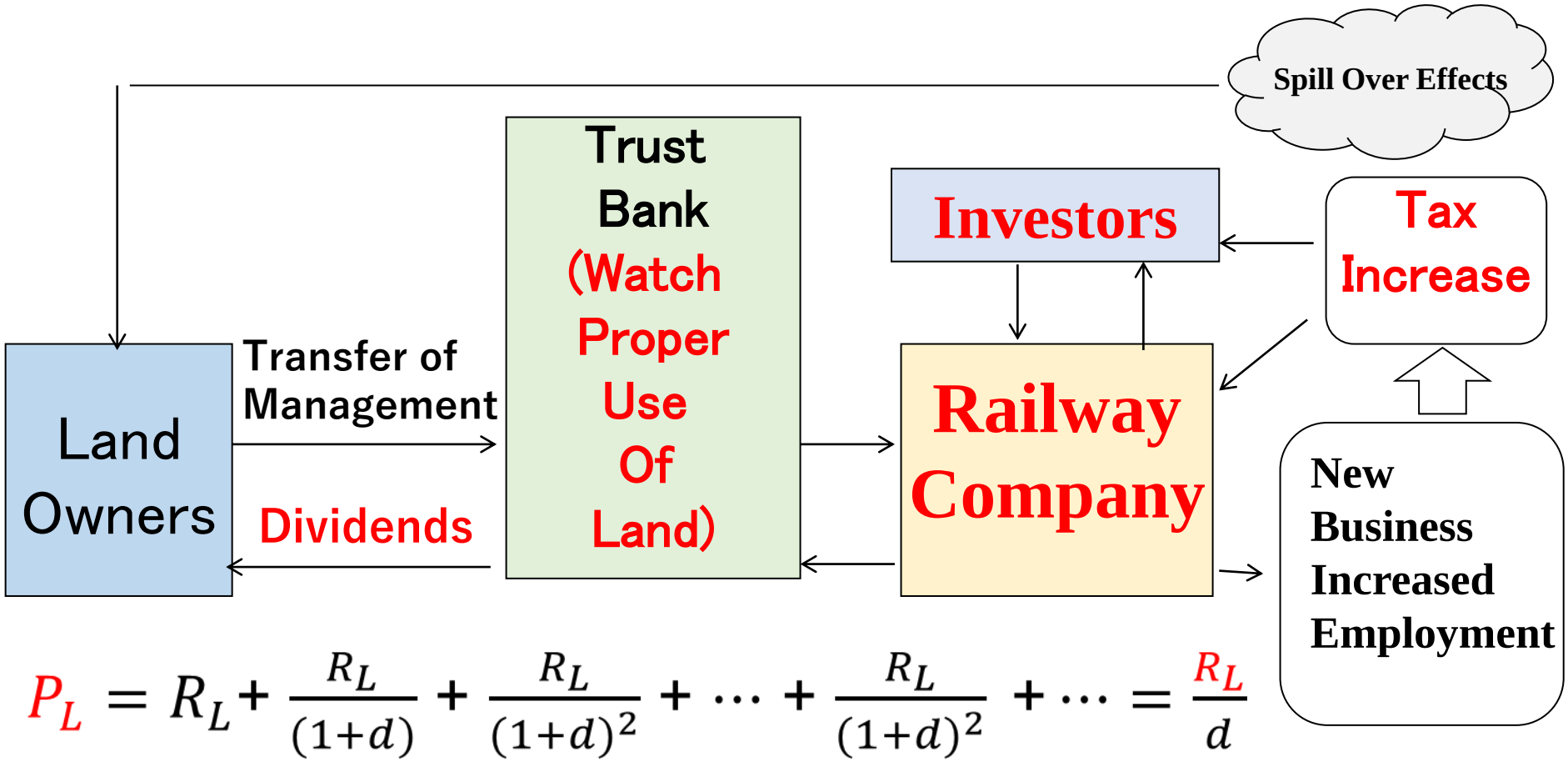
where ΔT is the tax revenue of the prefecture; x denotes time-varying covariates (vector of observed control variables); D is the binary variable indicating whether the observation relates to the affected group after the provision of the *shinkansen*; i indexes prefectures; g indexes groups of prefectures (1 = affected group; 0 = non-affected group); t indexes treatment before and after ($t=0$ before the *shinkansen;* $t=1$ after the *shinkansen*); α_i is the sum of autonomous (α) and time-invariant unobserved region-specific (γ_i) rates of growth[1]; φ_t is the year-specific growth effect; and ϵ_{it} is the error term, assumed to be independent over time.

$$\frac{Y_{it} - Y_{it-1}}{Y_{it-1}} = \alpha_i + \varphi_t + X'_{it} * \beta + \delta_1 * D_{terminal} * D_{2008} + \delta_2 * D_{terminal} * D_{2009-10} + \delta_2 * D_{terminal} * D_{2011-12} + \varepsilon_{it} \qquad (3)$$

Concept of Floating-Rate Infrastructure Bond



Land Trust for Infrastructure Investment



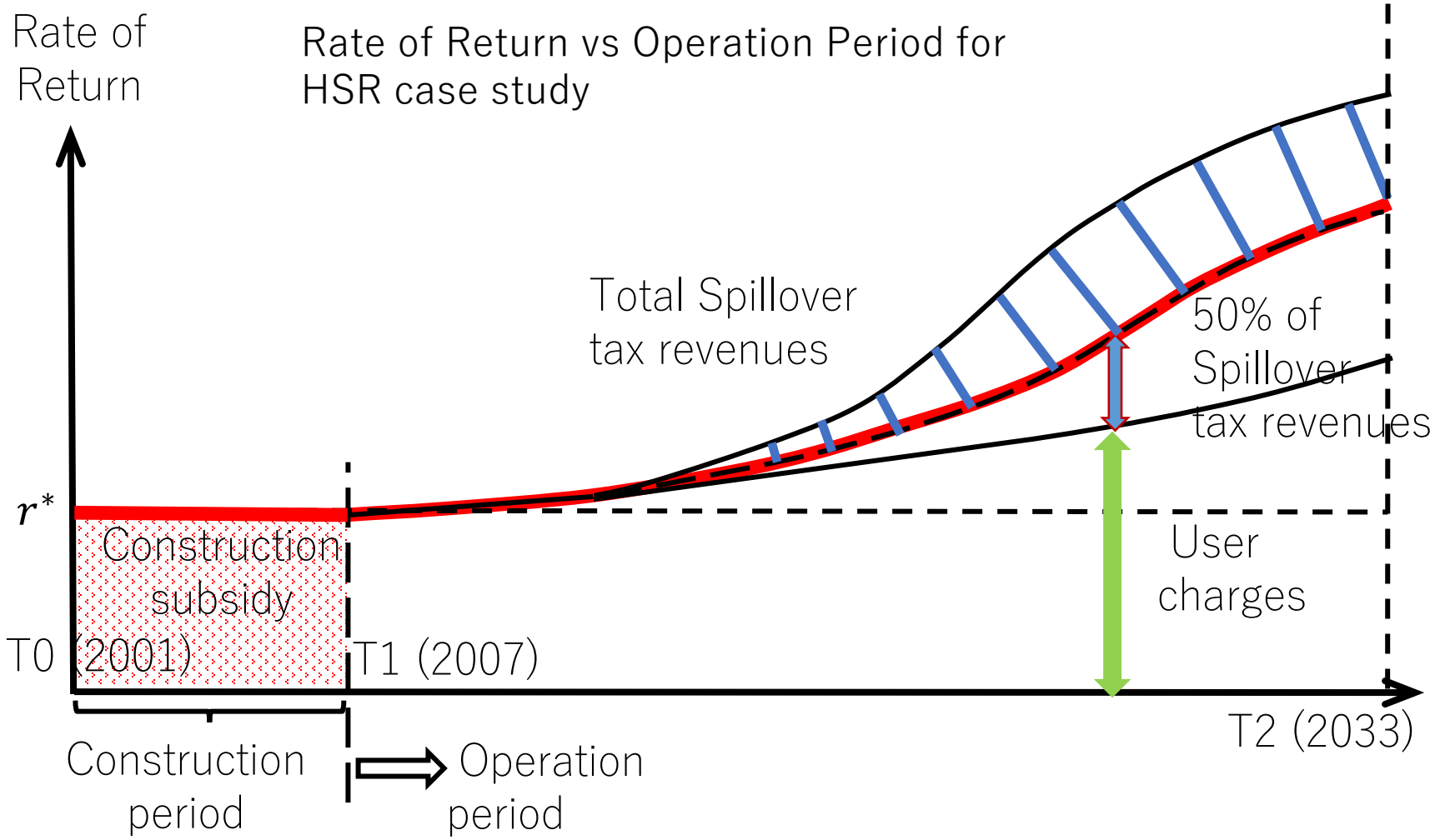
$$P_L = R_L + \frac{R_L}{(1+d)} + \frac{R_L}{(1+d)^2} + \cdots + \frac{R_L}{(1+d)^2} + \cdots = \frac{R_L}{d}$$

1, Reduction of Costs of Land Purchase
2, Leasing contract
3, future tax revenues can be used for repayment
4, Land owners keep their ownership

Case Study – HSR Project in Taipei,China

(unit: billion NT$)

Project phase	Year	Duration	Cost		Revenue	
Preparation	Before 1999	NA	Land acquisition cost	106	NA	
Construction	1999 - 2006	8 year	Construction cost	408	NA	
Operation	2007 - 2033	27 year	O&M cost	540*	User charge	1890*
					Spillover revenue	1005*
Total		35 year		1054*		2895*



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

Cost and Revenues of Taipei HSR

Subsidy scheme	construction period							operation period										
Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Subsidy (NT, Bill.)	118.4	58.3	58.3	58.3	58.3	58.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IRR	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	16.6%	22.4%	25.9%	28.3%	30.0%	31.2%	32.1%	32.8%	33.4%	33.8%	34.0%	34.3%
Total spillover tax rev.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.1	5.3	8.8	14.7	21.4	24.8	24.4	22.3	30.4

Subsidy scheme	operation period														
Year	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Subsidy (NT, Bill.)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IRR	34.4%	34.6%	34.6%	34.7%	34.8%	34.8%	34.9%	34.9%	34.9%	34.9%	34.9%	34.9%	35.0%	35.0%	35.0%
Total spillover tax rev.	33.7	37.0	40.3	43.6	46.9	50.2	53.5	56.7	60.0	63.3	66.6	69.9	73.2	76.5	79.8

Note: Spillover tax revenue for 2007-2017 is based on actual tax data, for 2018-2033 is based on author estimation

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
Total cost	-1054	-1134	-1134
NPV cost	-620	-606	-606
Total Revenue	1890	1890	2524
NPV revenue	628	628	808
Net NPV	8	22	202
IRR	5.1%	5.4%	7.7%

(d: discount rate 5%)

From the private sector's perspective: improved IRR

Table : Subsidy scheme summary (unit: NT, Billion)

From the public sector's perspective: less cost, more revenue

1	Subsidy in construction period (2001-2006)	409.9	(Cost)
2	Subsidy in operation period (2007-2033)	0	(Cost)
3	50% of Spillover tax revenue (2008-2033)	502.7	(Revenue)
4	Overall surplus for public sector	92.9	(Net revenue)

Thank You for Your Attention