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Innovative measures for infrastructure investments: Illustrating land trust scheme and spillover effect

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ADB Working Paper Series

**INNOVATIVE MEASURES FOR
INFRASTRUCTURE INVESTMENTS:
ILLUSTRATING LAND TRUST
SCHEME AND SPILLOVER EFFECT**

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Abstract

In many Asian countries, land acquisition is one of the main challenges for infrastructure development which delays the completion of projects and lowers the rate of return of infrastructure investment.

This paper investigates the potential application of the land trust scheme, which Japan has used extensively for the construction of commercial buildings in the infrastructure field. The land trust scheme calls for cooperation between infrastructure stakeholders to achieve a win-win outcome. Under the scheme, landowners transfer their land usage rights to infrastructure developers through the trust banks and retain ownership of the land instead of selling the land. Between landowners and infrastructure companies, the trust bank is the intermediary that smooths and monitors the process, and pays rent to landowners based on project revenues. From the perspective of infrastructure developers, the land trust scheme would dramatically reduce the initial cost of the project by replacing the land purchase cost with a much lower land rent. As a result, the costs and benefits of the infrastructure project would improve.

The concept of a spillover effect is introduced to complement the land trust scheme by returning part of the additional spillover tax revenue from infrastructure projects to private investors, to further increase the rate of return and attract more private investment. Empirical studies on the application of the land trust scheme and spillover tax revenues in cases of transport infrastructure are provided. The results indicate that the combination of the proposed innovative measures could yield optimal outcomes and improve the rates of return.

Keywords: infrastructure investment, land acquisition, land trust scheme, spillover effect, tax revenue

JEL Classification: C31, H54, R14

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1. BACKGROUND

There are huge infrastructure investment needs in Asia and the Pacific. As is shown in Table 1, infrastructure needs are very high compared with tax revenues in many regions of Asia and the Pacific. Based on the ratio of infrastructure investment to tax revenues in the last column, it is clear that, in Asia and the Pacific as a whole, 26.3% of the total tax revenue is needed for infrastructure investment. In South Asia, as shown in the third row, this is as high as 49.1%. If all the infrastructure projects are financed by tax revenues, a public budget deficit would accumulate. In this situation, private sector investment is the key to the sustainable development of infrastructure.

Table 1: Infrastructure Investment Needs in the Asia and Pacific Region

Region	Investment Gap (IG)	IG/GDP (%)	IG/Tax (%, as of 2015)
Central Asia	33	6.8	29.6
East Asia	919	4.5	21.4
South Asia	365	7.6	49.1
Southeast Asia	184	5.0	36.4
The Pacific	2.8	8.2	30.9
Asia and the Pacific	1,503	5.1	26.3

Note: Monetary values are in billions of US dollars at 2015 prices.

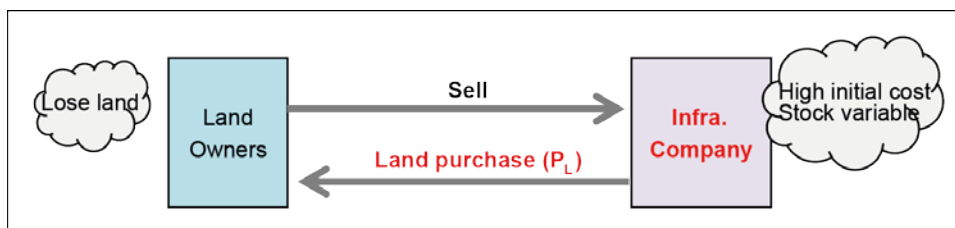
Source: Author estimation based on ADB database (2017).

In many Asian countries, such as Bangladesh, India, Indonesia, and Thailand, land acquisition is one of the main issues for infrastructure development which delays the completion of projects and lowers the rate of return of private investment. For instance, in Japan about thirty years ago, there was a plan for a high-speed railway linking Narita Airport with the center of Tokyo City (Nakamura et al. 2019). However, due to the opposition of a few landowners who did not want to sell their land, the construction of the high-speed rail project was hindered. Land acquisition is not only a problem for infrastructure projects; in the construction of commercial buildings and apartments in Japan, there has always been negotiation with landowners. Land trust has been extensively used in Japan in the field of commercial building and apartment buildings. Borrowing the concept of land trust, in this paper we will discuss the potential application of the scheme to infrastructure investment.

2. INTRODUCTION OF LAND TRUST SCHEME

Figure 1 shows the traditional method of land acquisition by purchase from landowners; the landowners sell the land to infrastructure companies, and the company pays the land price at the beginning of construction. The cost of the land is a major cost of infrastructure. In Malaysia, for example, about 50% of the total cost of transport infrastructure investment goes toward land purchase.

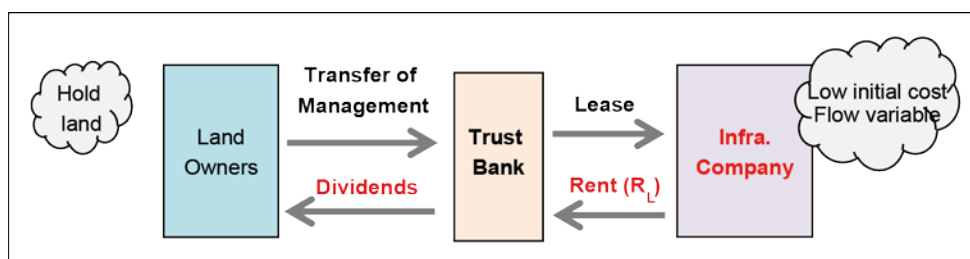
Figure 1: Traditional Land Acquisition Model



Source: Authors.

Figure 2 shows the proposed land trust scheme. Under this scheme, landowners can keep ownership of the land, but lease the land to the infrastructure company instead of selling the land. Between landowners and infrastructure companies, the trust bank is the intermediary that monitors whether the land is properly used and pays rent to landowners based on project revenues.

Figure 2: Proposed Land Trust Scheme



Source: Authors.

Equation (1) shows the relation between the cost of land purchase (P_L) and land rent (R_L). P_L is the present discounted value of land rent R_L . If the duration of rent is unlimited, the land price P_L equals land rent R_L divided by discount rate d . Therefore, the cost of land purchase P_L is much higher than land rent R_L , as indicated by Equation (2). If the land trust scheme can be applied to infrastructure investment, the initial cost of purchasing land will be significantly reduced. Under this proposal, the infrastructure company only needs to pay the annual land rent through the company revenue received from user charges. Furthermore, if we consider spillover tax revenues—as we shall discuss later—the payment of land rent to landowners would be easier.

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

$$P_L \gg R_L \tag{2}$$

This upper diagram in Figure 3 shows the current cost and benefit of infrastructure projects. The current cost includes the cost of land purchase P_L , construction cost, operation and maintenance costs, while the benefit comes from user charges, highway tolls, train tariffs, and so on, depending on the type of infrastructure project. Under the proposed land trust scheme, as shown in the lower diagram, the total cost of infrastructure investment will become the land rent cost R_L , replacing the land purchase cost P_L , the construction cost, as well as the operation and maintenance costs.

The benefit of infrastructure investment is not only user charges but also spillover tax revenues created by infrastructure investment.

Figure 3: Cost and Benefit of Infrastructure Investment

<p>Cost:</p> <p>Land purchase cost (P_t) Construction cost Operation cost Maintenance cost</p>	<p>$G_t = \text{Construction cost} + \text{Land purchase cost } (P_t)$ $G_{t+1} = \text{Operation cost} + \text{Maintenance cost}$ \vdots $G_{t+n} = \text{Operation cost} + \text{Maintenance cost}$ <i>Total cost</i> = $G_t + G_{t+1} + \dots + G_{t+n}$</p>	<p>Cost:</p> <p>Land rent cost (R_t) Construction cost Operation cost Maintenance cost</p>	<p>$G_t^* = \text{Construction cost} + \text{Land rent cost } (R_t)$ $G_{t+1}^* = \text{Operation cost} + \text{Maintenance cost} + \text{Land rent cost } (R_t)$ \vdots $G_{t+n}^* = \text{Operation cost} + \text{Maintenance cost} + \text{Land rent cost } (R_t)$ <i>Total cost</i> = $G_t^* + G_{t+1}^* + \dots + G_{t+n}^*$</p>
<p>Benefit:</p> <p>User charge</p>	<p>$T_t = 0$ $T_{t+1} = (\text{User charge})_{t+1}$ \vdots $T_{t+n} = (\text{User charge})_{t+n}$ <i>Total benefit</i> = $T_t + T_{t+1} + \dots + T_{t+n}$</p>	<p>Benefit:</p> <p>User charge Spillover tax revenue</p>	<p>$T_t^* = 0$ $T_{t+1}^* = (\text{User charge})_{t+1} + \text{Spillover}$ \vdots $T_{t+n}^* = (\text{User charge})_{t+n} + \text{Spillover}$ <i>Total benefit</i> = $T_t^* + T_{t+1}^* + \dots + T_{t+n}^*$</p>

Source: Authors.

3. INTRODUCTION OF SPILLOVER EFFECT

Infrastructure can create regional spillover effects, such as the construction of new apartments that increase the value of property; new businesses will come into the region and create new employment, new restaurants open and the services sector can be developed. This regional development will increase tax revenues along the infrastructure projects. The tax revenue includes property tax revenue, corporate tax revenue, income tax revenue, and sales tax revenue.

Theoretically, the concept of spillover effect can be expressed by the following equations. The production function (1) consists of three factors: infrastructure investment (K_G), new business opportunities (K_P), and the associated new employment (L).

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

$$\frac{dY}{dK_G} = \frac{\partial f(K_P, L, K_G)}{\partial K_G} + \frac{\partial f(K_P, L, K_G)}{\partial K_P} \frac{\partial K_P}{\partial K_G} + \frac{\partial f(K_P, L, K_G)}{\partial L} \frac{\partial L}{\partial K_G} \tag{4}$$

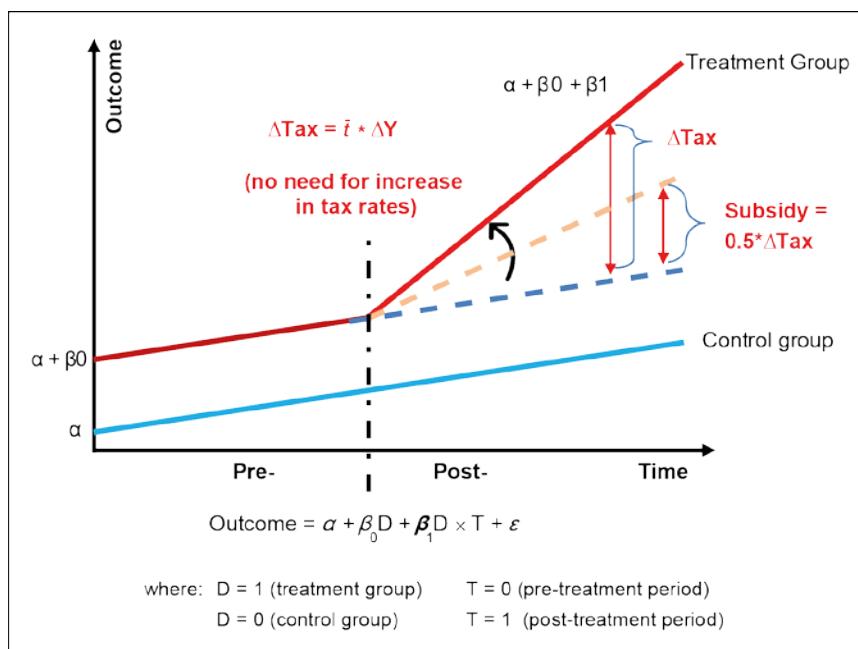
Infrastructure development has both direct and indirect impacts. Direct impacts reflect the immediate outcome of infrastructure development, such as the increase in road capacity due to the development of transport infrastructure, while indirect impacts are the short- and long-term effects of the investment, such as the improvement of capital inputs and employment from regional economic activities, which usually take time. The indirect impact is assumed to be the spillover effect.

Equations (3) and (4) show the impacts of infrastructure investment. The first component is the direct effect of infrastructure investment K_G , which creates economic activities in the region. The second component shows that the infrastructure investment will bring private businesses into the region, which is represented by changes in K_P , increasing regional GDP. The third component shows that infrastructure investment will bring employment into the region. New businesses are created, new restaurants are

opened, and new employees are hired. The second and third are called external effects, or the spillover effect.

All those spillover tax revenues are shown by the red line, as illustrated in Figure 4. Currently, this increase of spillover tax revenues is collected by the government and not returned to infrastructure investors. However, supposing 50% of these tax revenues were returned to infrastructure investors; then, infrastructure companies and investors would receive not only the user charges but also the spillover tax revenues, as shown by the blue dotted line, increasing their revenue and the rate of return of the investments.

Figure 4: Spillover Concept and DID Method



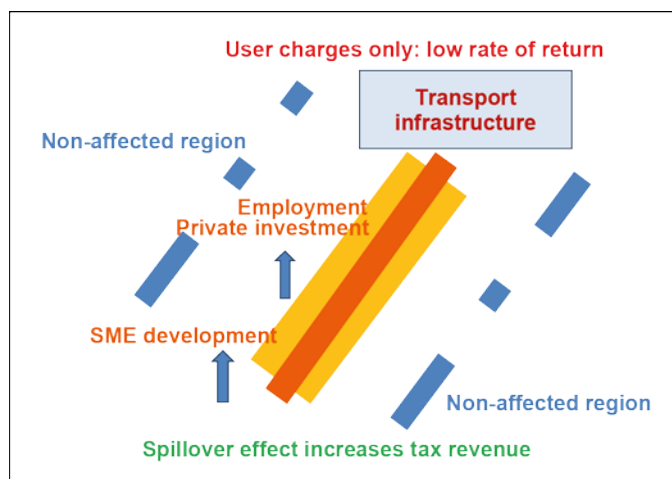
Source: Authors.

The difference-in-differences method is utilized to capture the spillover effect. As indicated by the name, the method computes the double difference over different times, regions, or groups, to estimate the impact of policy interventions or infrastructure projects on a certain subject.

The underlying assumption is that the changes in outcomes between groups are the same over time, and the policy or the project is the only intervention that creates a difference. To carry out a DID analysis for capturing the spillover effect, the differences between pre- and post- infrastructure investment and between treatment and control group are measured. To be specific, first the difference in pre- and post- outcomes for both groups is obtained (the time axis); second, for the treatment group, the difference is subtracted from the total difference to further exclude other time-varying factors (solid red line and dotted blue line); and, finally, the net difference is interpreted as the spillover effect of the infrastructure project.

Figure 5 shows an example of spillover tax revenues. The orange line in the middle shows the transport infrastructure or infrastructure investment: this could be a highway or high-speed rail. The yellow regions along this infrastructure investment line represent the area into which new businesses will come, employment will be created, and small and medium-sized enterprises (SME) will be established. These spillover effects of the yellow region will increase the local tax revenues compared with the non-affected regions outside of the blue dotted line.

Figure 5: Transport Infrastructure and Spillover Tax Revenue



Source: Authors.

Examples of transport infrastructure investments have been developed to investigate the spillover effects of infrastructure investment, providing a deeper understanding of the spillover effect. The DID method is applied to the highway project in Manila City and the high-speed rail project in the Kyushu region. Comparing the treatment region with the control group regions, evidence is found of an increase in tax revenue along transport infrastructure projects. This increment of tax revenue is the spillover tax revenue.

Yoshino and Pontines (2015) have estimated the impact of highways in Manila. Table 2 shows an example in Manila of the impact of the highway on regional tax revenues.

Table 2: Tax Revenues in Three Cities along the Highway
(million pesos)

Region	Year						
	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

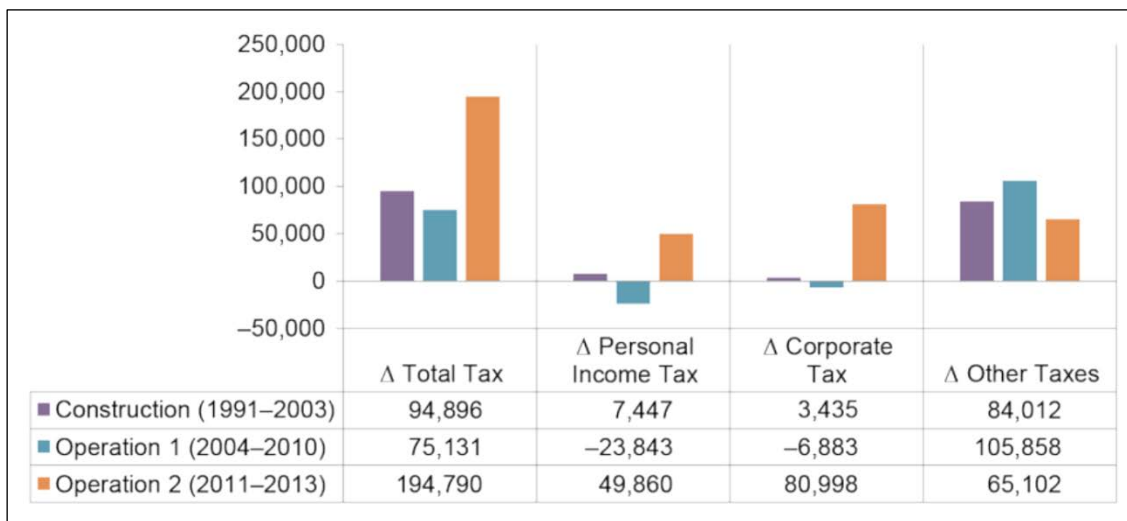
Source: Yoshino and Pontines 2015.

At T-2 the revenue was 134 million pesos. After four years of operation (last column, T+4), the tax revenue of Lipa City went up to 371 million pesos. This shows a significant increase in tax revenues after four years of operation. The same conclusion applies to tax revenues in Batangas City of up to 1,209.61 million pesos. Compared with the period before the construction of the highway, this is about three times as much as before the

construction started. Therefore, Manila’s highway project shows a big spillover into the region.

Yoshino and Abidhadjaev (2016) estimated the impact of the Kyushu rapid train in Japan.

Figure 6: Estimates of Connectivity-Increased Tax Revenues in Kyushu Region



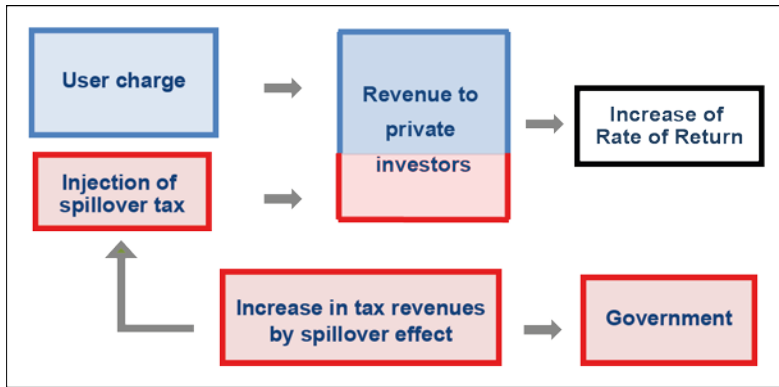
Source: Yoshino and Abidhadjaev, 2016.

In Figure 6, the three periods shown are the construction period, operation period without good connectivity, and the operational period with good connectivity (to Osaka and Tokyo).

Total tax revenue in the left block shows that after the connectivity was completed, tax revenue more than doubled. The personal income tax revenue shows a clear increase after connectivity. The corporate tax revenue also increased once this high-speed railway which connected large cities was completed. The last block of other tax revenues refers mainly to property tax revenues, which is different from personal income tax or corporate income tax. Property tax revenues started to increase during the construction period because speculators started to purchase these properties, which contributed to the increase in tax revenue. Different tax revenues illustrate different patterns of tax increments. Generally, connectivity is very important for high-speed rail in creating spillover tax revenues (Ishii et al. 2019).

Traditionally, all these increased tax revenues benefited government, such as the central government and local governments, rather than being returned to infrastructure investors. By relying on user charges only, the rate of return for infrastructure investors was very low. Suppose 50% of these increased tax revenues were returned to infrastructure investors; then, the rate of return would become the green dotted line instead of the blue dotted line. The spillover tax revenues should be returned to private investors in infrastructure investment, as shown in Figure 7; this would increase the rate of return.

Figure 7: Spillover Tax Revenues Increase the Rate of Return

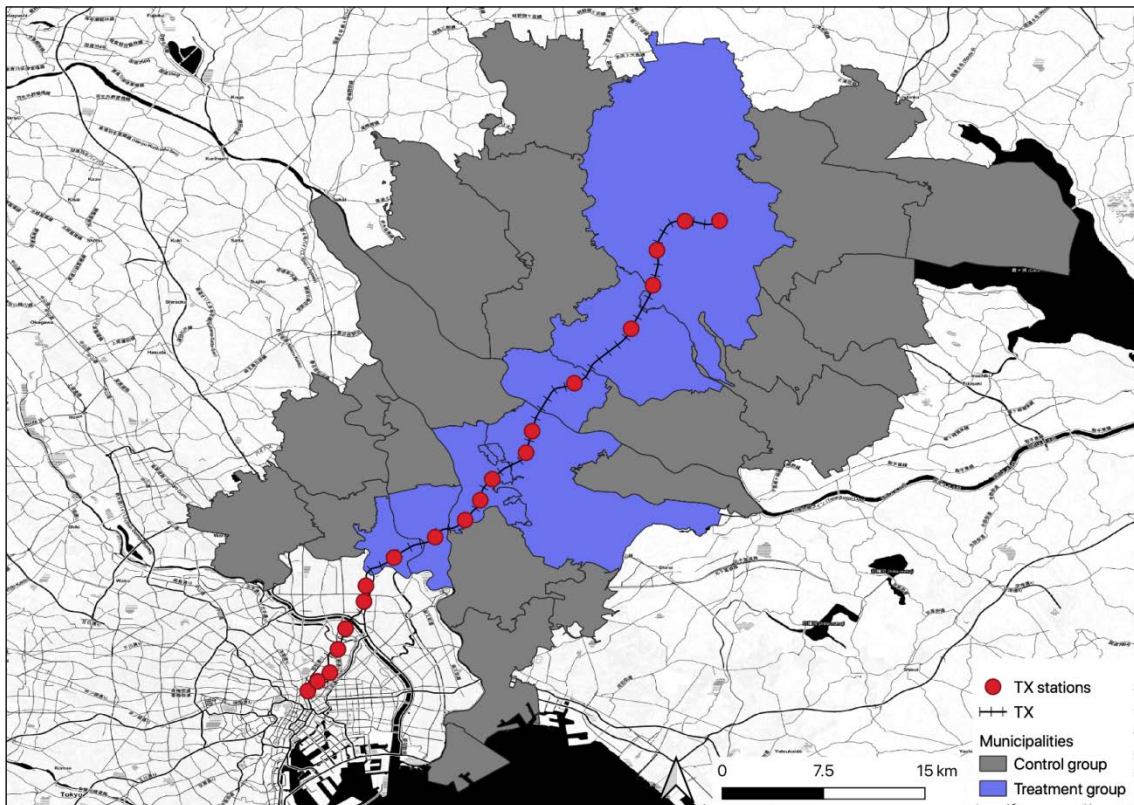


Source: Authors.

4. CASE STUDY: TSUKUBA EXPRESS

Tsukuba Express (TX) is a commuter railway between Tokyo and Tsukuba City (Figure 8). It aims to improve accessibility between Tsukuba and Tokyo, as well as accessibility to terminal cities in the region between.

Figure 8: Tsukuba Express



Source: National Land Information Division, National Spatial Planning and Regional Policy Bureau, MLIT of Japan, and OpenStreetMap contributors.

The red points are the stations on the TX line. We define the treatment group and the control group as follows:

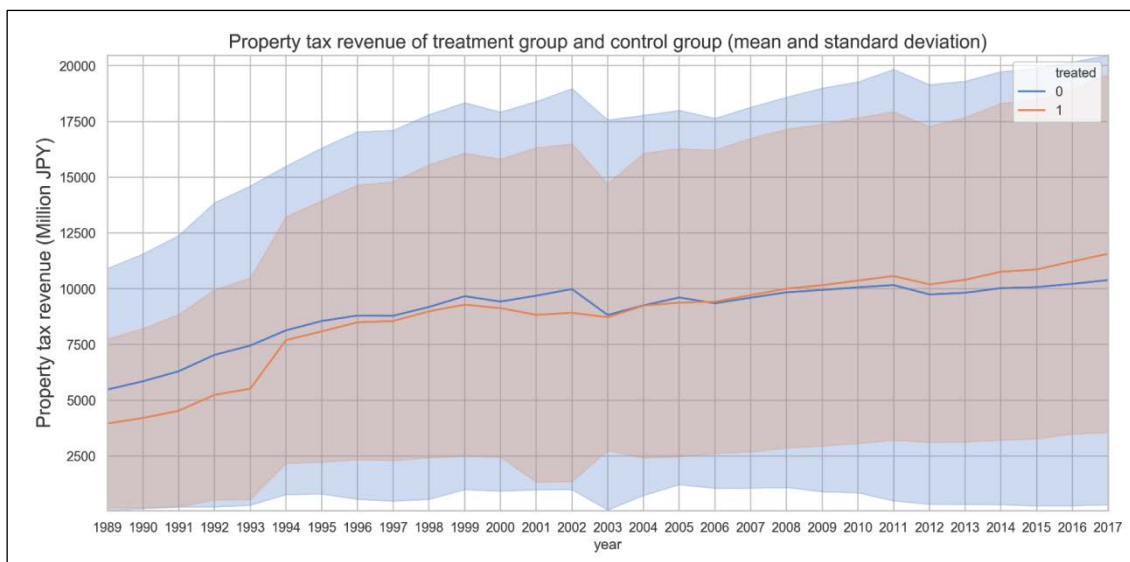
- Treatment group (blue): municipalities with TX stations (Kashiwa, Nagareyama, Misato, Yashio, Moriya, Tsukuba-mirai, and Tsukuba cities) (n=7)
- Control group (grey): other municipalities in a range of 10km from TX (n=20)

Tokyo prefecture and the municipalities not in a range of 10km from TX are also excluded in this study because the economic impact of the railway is relatively smaller.

The construction of the railway started in 1994, and the operation of all sections started in 2005. In this case study, we focus on property tax revenue. We used the annual reporting of property tax “settlement” revenue data from 1989 to 2017 of municipalities from e-Stat¹. The settlement revenue represents the ideal value of the revenue, which excludes any delinquency or overdue payments from the previous year. Some municipalities have been merged into neighboring municipalities over the years. To aggregate the tax revenues of those merged municipalities, we used the administration boundary in 2017 and performed a spatial join to summarize the revenues to the merged municipalities.

DID was applied to compare the treatment group and control group, and the result is shown in Figure 9. The aggregated temporal trend of the property tax revenue shows that, after 1994, the property tax revenue of the treatment group clearly increased compared with the control group.

Figure 9: Aggregated Property Tax Revenue of Treatment Group (orange) and Control Group (blue)



Source: Authors; website of Official Statistics of Japan (<https://www.e-stat.go.jp/>).

¹ <https://www.e-stat.go.jp/en>.

Table 3 shows the econometric results. Different project phases of pre-construction, construction, and operation are compared. From the pre-construction and construction period comparison, there is a significant increase in time effect, meaning that the construction impact is significant. The treatment effect of difference between the control group and the treatment group is shown, comparing the construction and operation period. After the operation started, the time effect became gradually significant as new businesses came to the region and new apartments were created. Even though the Adj. R² is not high, the DID effect shows the statistical significance in both Phase I and Phase III, suggesting a clear spillover effect on property tax revenue after the construction started in 1994.

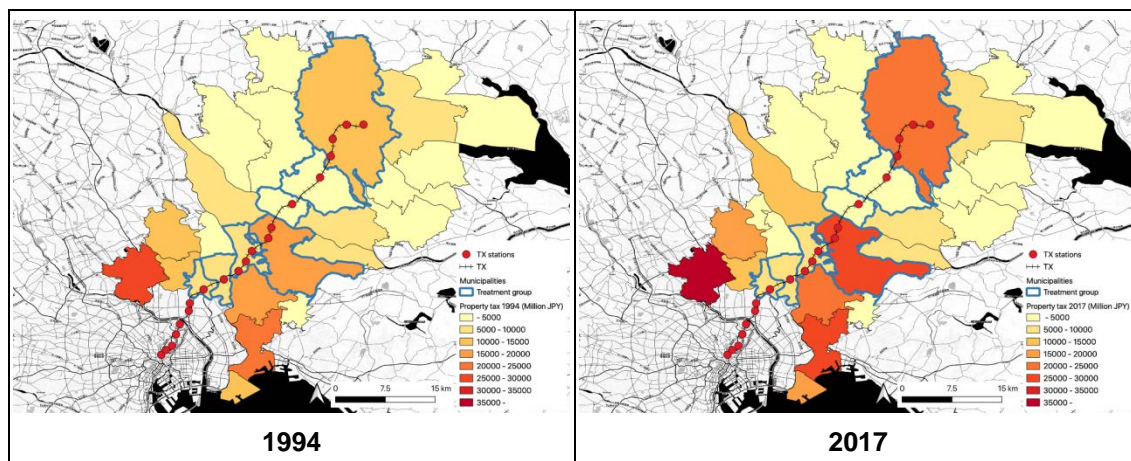
Table 3: DID Analysis and Econometric Results

Phase	I Preconstruction – Construction			II Construction – Operation			III Preconstruction – Operation		
	Estimate	t-stat	sig	Estimate	t-stat	sig	Estimate	t-stat	sig
Const.	14.87	343.20	***	15.254	528.288	***	14.879	340.932	***
c (treatment effect)	0.113	0.638		0.5195	4.310	***	0.1138	0.634	
t (time effect)	0.375	7.193	***	0.0079	0.203		0.3837	7.502	***
DID	0.405	1.880	*	0.1530	0.940		0.5588	2.646	***
Adj. R ²	0.041			0.019			0.047		
N	1,899			2,890			2,175		

Note: “****”: p < 0.01; “***”: p < 0.05; “**”: p < 0.1.
 Source: Authors; Miyazawa et al 2019.

Figure 10 shows the spatial distribution of the property tax revenue in the target municipalities. The left side represents 1994 and the right side represents 2017. The red color indicates significant increases in property tax revenues. Along the TX line, many regions saw an impact on property tax revenues. The property tax revenue of a few of the municipalities in the treatment group increased significantly. This shows the regional disparity between the control and treatment groups.

Figure 10: Spatial Distribution of Property Tax Revenue



Source: Authors; National Land Information Division, National Spatial Planning and Regional Policy Bureau, MLIT of Japan, and OpenStreetMap contributors.

5. CASE STUDY: HIGH-SPEED RAIL PROJECT IN TAIPEI, CHINA

Table 4 shows the background of the high-speed rail project in Taipei, China. Before 1999, there was a preparation period of land acquisition in order to construct the high-speed railway. The land acquisition cost was NT\$106 billion. The construction period was from 1999 to 2006, and the total construction cost was NT\$408 billion. Operation and maintenance costs from 2007 to 2033, a period of 27 years, are expected to be NT\$540 billion. In total, as shown in the cost column, NT\$1,054 billion will be spent. The generation of revenue started in 2007 when the high-speed railway began operation. User charges are expected to be NT\$1,890 billion. Therefore, for this case study, the total expected revenue is NT\$1,890 billion and the total cost is NT\$1,054 billion.

Table 4: Cost and Revenue of High-Speed Rail Project in Taipei, China

Project Phase	Year	Duration	Cost (billion NT\$)	Revenue (billion NT\$)
Preparation	Before 1999	NA	Land acquisition	106 NA
Construction	1999–2006	8 year	Construction	408 NA
Operation	2007–2033	27 year	Operation and maintenance	540* User charge 1,890*
Total		35 year		1,054* 1,890*

* Author estimates.

Source: Authors; Renzhi (2019).

The cost benefit structure under the proposed land trust scheme and spillover tax revenues was investigated. The original scenario is shown in the first column of Table 5. The second row shows the net present value (NPV) of the cost. If the high-speed rail project purchases land at the beginning, then total cost of NPV, as shown in the second row, is -NT\$620 billion. If the land trust scheme is applied such that the landowners lease the land to the high-speed rail company, the initial cost would be reduced and replaced by land rent cost. In this case, the NPV will be reduced from -NT\$622 billion to -NT\$606 billion, as shown in the second column.

Lastly, the scenario with both land trust scheme and spillover tax revenue is calculated in the last column. With the introduction of the return of spillover tax revenues, the NPV of the investment cost remains the same while the total revenue will increase from NT\$1,890 billion to NT\$2,524 billion, as shown in the last column. The NPV of total revenue now changes from NT\$628 billion to NT\$808 billion. Subtracting the NPV cost from the NPV revenue, the total net revenue will become NT\$202 billion. Compared to the original scenario without the land trust scheme and spillover tax returns, the net revenue is only NT\$8 billion. With only the land trust scheme, the net revenue becomes NT\$22 billion. In terms of internal rate of return (IRR), the original case was only 5.1%. The introduction of the land trust scheme will increase the IRR to 5.4%. And, lastly, if we combine the land trust scheme and return of spillover tax revenues, the IRR will become 7.7%, with which the infrastructure project can attract much more private investors compared with 5.1% in the original scenario.

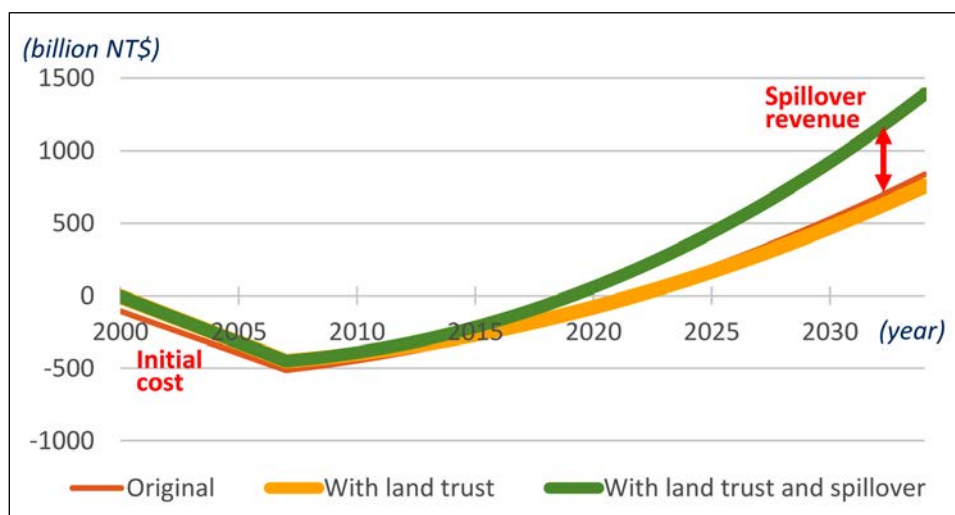
Table 5: NPV and IRR of High-Speed Rail Project in Taipei,China
(billion NT\$)

	Original	With Land Trust	With Land Trust and Spillover Revenue
Total cost	-1,054	-1,134	-1,134
NPV cost	-620	-606	-606
Total revenue	1,890	1,890	2,524
NPV revenue	628	628	808
Net NPV	8	22	202
IRR	5.1%	5.4%	7.7%

Source: Authors; Renzhi (2019).

The evolution of cashflow for the above three scenarios is plotted in Figure 11. It is clear that spillover effects will increase the NPV of cash flows. This will continue as long as this infrastructure is in operation. As time goes by, the spillover tax revenues will accumulate and the gap with the original scenario will widen.

Figure 11: Cash Flow of High-Speed Rail Project in Taipei,China



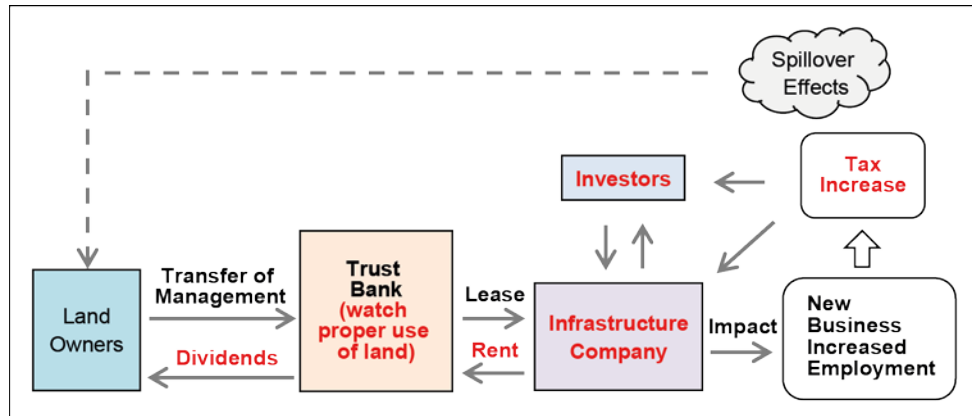
Source: Authors; Renzhi (2019).

6. SUMMARY

In many Asian countries, land purchase is a significant difficulty for infrastructure investment. Japan has extensively used land trust schemes for the construction of apartments and commercial buildings. This paper sheds light on the application of a land trust scheme in the case of construction infrastructure investment. As shown in Figure 12, the model in this paper proposes that landowners transfer their usage rights to the infrastructure company. The trust bank will become the middleman between infrastructure companies and landowners. The trust bank supervises the performance of spillover tax revenues and user charges, and calculates how much revenue the infrastructure company can earn, as well as the associated net present value of their revenue which can be distributed between landowners and infrastructure companies by

subtracting the corresponding costs. Furthermore, they guarantee that the dividends from the infrastructure company can be properly transferred to landowners.

Figure 12: Infrastructure Investment with Land Trust Scheme and Spillover Effect



Source: Authors.

In many Asian countries, there is no trust bank. In 2018, the Trust Bank Law was launched in Thailand. Trust businesses and functions can be established in ordinary banks by attaining trust bank licenses. Traditional banks can capture the trust bank function in their businesses by approval from the central banks of developing countries, which would smooth the transfer of land ownership and infrastructure investment.

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