Infrastructure Revenue Bond for Sustainable Growth

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ADB Institute

Sustainable Growth

1. **Domestic Savings → Investment**
2. **Human Capital Development**
   (Secondary School, University Education)
3. **Infrastructure investment**
   Long term investors: Insurance & pension funds
4. **Connectivity creates stronger effects**
5. **Private finance will create flexibility**

Forthcoming Book on Infrastructure

**"FINANCING INFRASTRUCTURE IN ASIA:
Capturing Impacts and New Sources"**

Edited by Naoyuki Yoshino, Matthias Helble, and Umid Abidhadjaev

- **the latest evidence on the impact of infrastructure investment on economic and social indicators**
- **country studies on how infrastructure investment can increase output, taxes, trade and firm productivity**
- **innovative modes of infrastructure financing**
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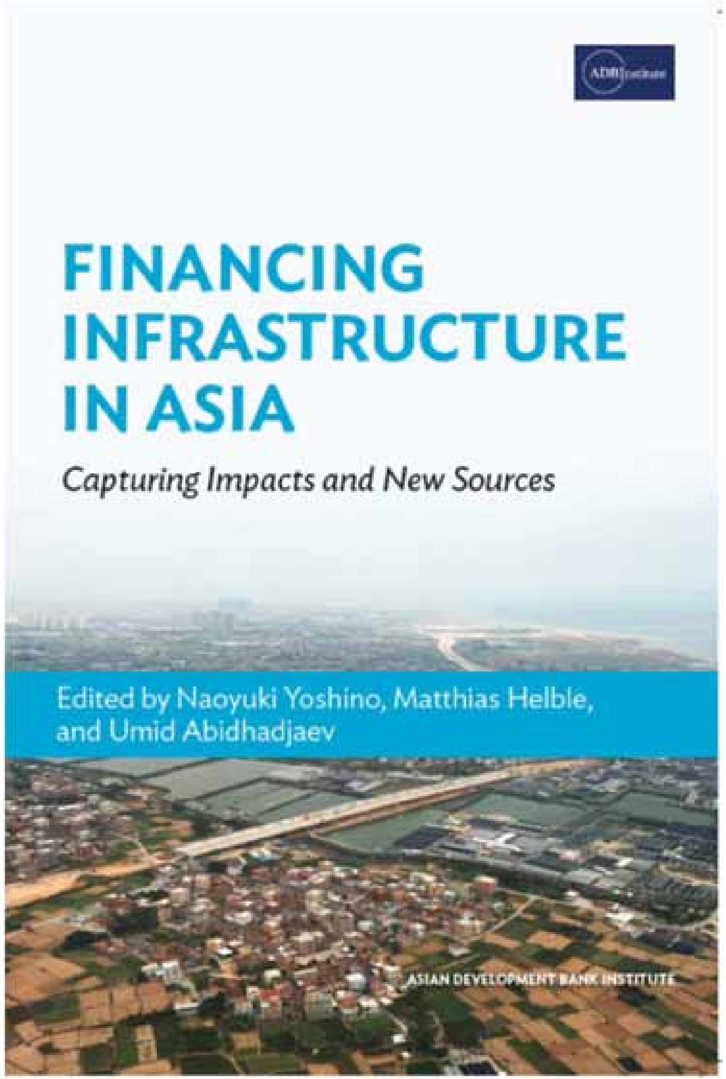

Infrastructure Investment Needs in Asia-Pacific (2016-2030)

($ billion in 2015 prices, annual average)

	Baseline Total	% of GDP	Climate Adjusted	% 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
The Pacific	2.8	8.2	3.1	9.1
Asia & Pacific	**1503**	**5.1**	**1744**	**5.9**

Source: Meeting Asia's Infrastructure Needs, ADB (2017)

Infrastructure Investment Needs by Sector, 2016-2030

($ billion in 2015 prices, annual average)

	$ billion	% share to total	Adaptation ($ billion)	Mitigation ($billion)
Power	982	56.3	3	200
Transport	**557**	**31.9**	37	-
Telecommunications	152	8.7	-	-
Water and Sanitation	23	3.1	1	-
Total	**1744**	**100**	**41**	**200**

Source: Meeting Asia's Infrastructure Needs, ADB (2017)

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Attract Private Financing to Infrastructure Investment by Injecting Spillover Tax Revenues

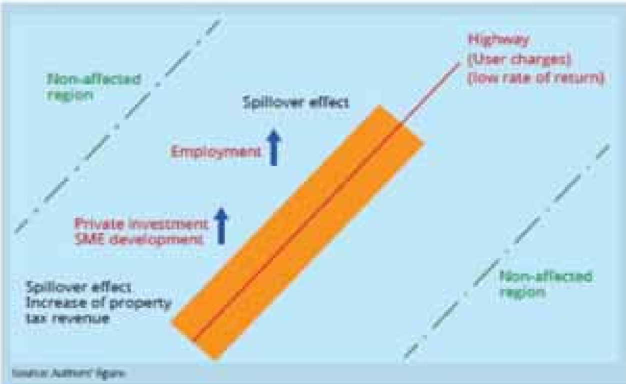
Need for Infrastructure Investment

In Southeast Asia, USD 8 billion in infrastructure investments are implemented every year. However, it is expected that USD 210 billion infrastructure investment is needed every year. Public money is insufficient to satisfy Asia's infrastructure needs. In many developing countries in Asia, we observe heavy traffic congestion in cities; highways, trains and various modes of public transport are lacking. Public-Private Partnerships (PPPs) have been promoted for infrastructure development in India, Thailand and other places in Asia. However, most PPP projects were disappointing since the rate of return on infrastructure depends mainly on user charges, such as train fares and highway tolls. When the region was hit by economic crisis after the Lehman shock, the private sector withdrew from infrastructure investment. Risks associated with infrastructure were so large that private investors were hesitant to put their money in infrastructure.

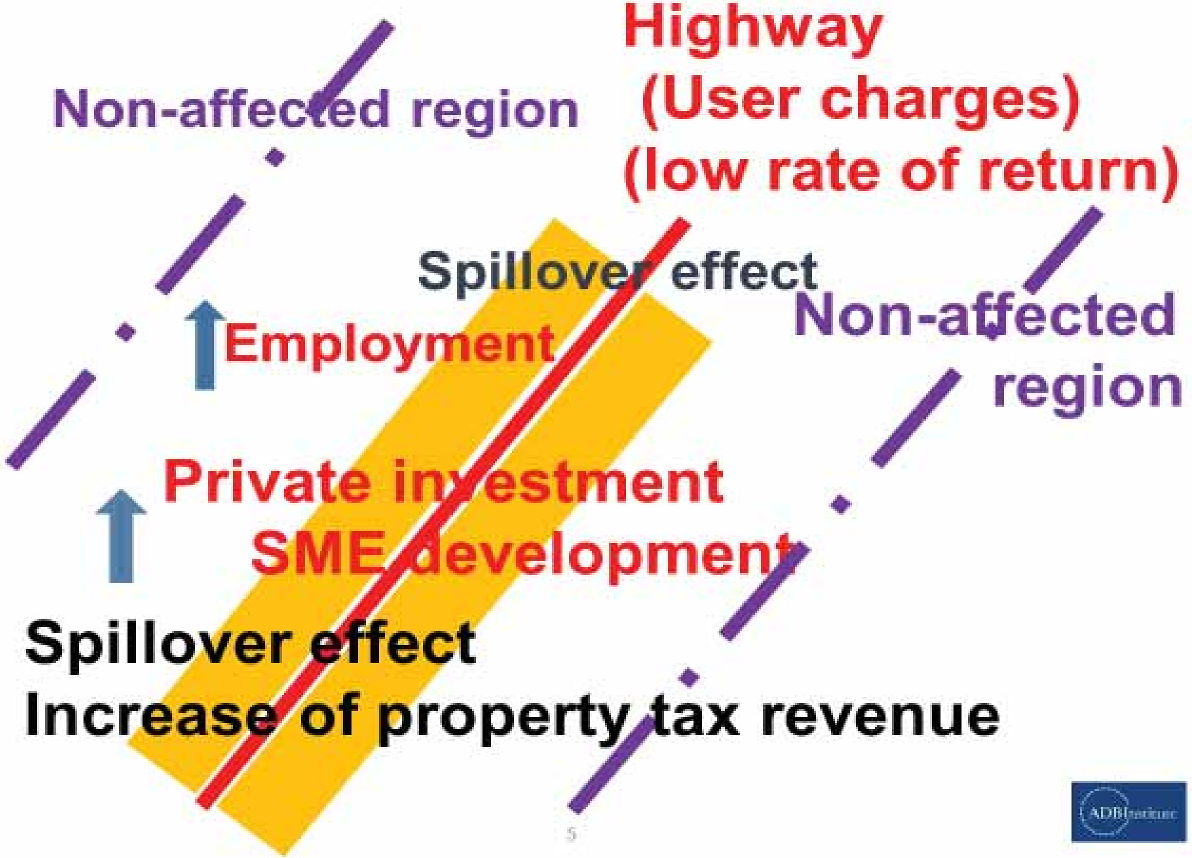
It is well known that good infrastructure creates huge spillover effects in the region around a project (Figure 1). Railways will bring manufacturing factories into the region by making the shipping of products faster and safer. Railways can connect manufacturers to markets and to ports. New industry creates jobs in the region. Eventually, service sector businesses such as restaurants and hotels will be constructed to meet the increased demand in the region. Farmers and small businesses can sell their products at the train stations.

The spillover effects of infrastructure investment will increase revenues from corporate, income, and property taxes. The difference-in-difference method (Yoshino and Abidhadjaev (2017), Yoshino and Pontines (2015a, 2015b)) can be used to compute the effect of spillovers on tax revenues in places where infrastructure investment occurred compared to ones where no infrastructure investment took place. A study by Yoshino and Abidhadjaev (2016) shows that good educational opportunities together with infrastructure investment create qualified workers who enhance regional productivity. In the past, all these tax revenues were collected by the government and not returned

Figure 1: Schemes of Spillover Effects of Infrastructure Investment



Source: Authors' figure



$$
\begin{aligned}
\ln Y - \ln \overline{Y} \quad = \quad & \alpha_0 + \alpha_K(\ln K_P - \ln \overline{K_P}) + \alpha_L(\ln L - \ln \overline{L}) \\
& + \alpha_G(\ln K_G - \ln \overline{K_G}) \\
& + \beta_{KK}\frac{1}{2}(\ln K_P - \ln \overline{K_P})^2 + \beta_{KL}(\ln K_P - \ln \overline{K_P}) \\
& + \beta_{KG}(\ln K_P - \ln \overline{K_P})(\ln K_G - \ln \overline{K_G}) \\
& + \beta_{LL}\frac{1}{2}(\ln L - \ln \overline{L})^2 + \beta_{LG}(\ln L - \ln \overline{L})(\ln K_G \\
& + \beta_{GG}\frac{1}{2}(\ln K_G - \ln \overline{K_G})^2 + \epsilon
\end{aligned}
$$

Trans-log Production Function

$$
dY = \frac{\partial Y}{\partial K_G} dK_G + \frac{\partial Y}{\partial K_P}\frac{dK_P}{dK_G} dK_G + \frac{\partial Y}{\partial L}\frac{dL}{dK_G} dK_G
$$

Table 1: Spillover Effects Estimated from a Macroeconomic Translog Production Function

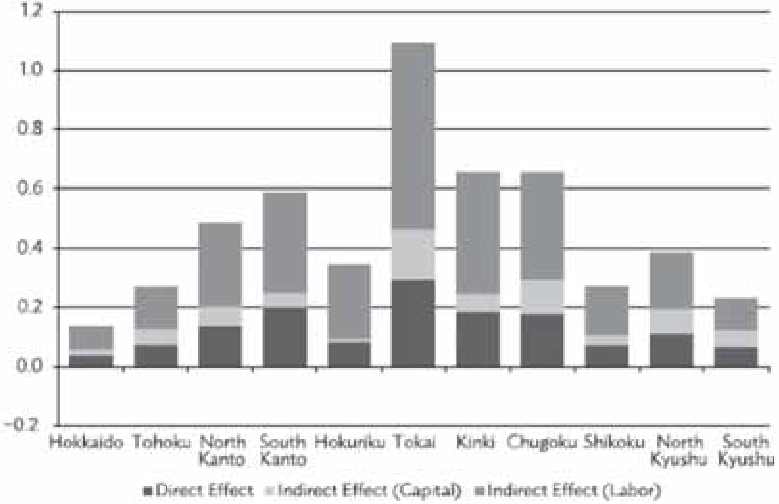
	1956-60	1961-65	1966-70	1971-75	1976-80	1981-85
Direct effect	0.696	0.737	0.638	0.508	0.359	0.275
Indirect effect(Kp)	0.452	0.557	0.493	0.389	0.270	0.203
Indirect effect(L)	1.071	0.973	0.814	0.639	0.448	0.350
20% returned	0.305	0.306	0.261	0.206	0.144	0.111
increment	0.438	0.415	0.410	0.404	0.400	0.402

	1986-90	1991-95	1996-00	2001-05	2006-10
Direct effect	0.215	0.181	0.135	0.114	0.108
Indirect effect(Kp)	0.174	0.146	0.110	0.091	0.085
Indirect effect(L)	0.247	0.208	0.154	0.132	0.125
20% returned	0.084	0.071	0.053	0.045	0.042
increment	0.392	0.392	0.390	0.390	0.391

Source: Authors' estimation based on Nakahigashi (2015)

Figure 4.3 Marginal Productivity of Public Capital in Secondary Industry, 1990 and 2010

(1) 1990



(2) 2010

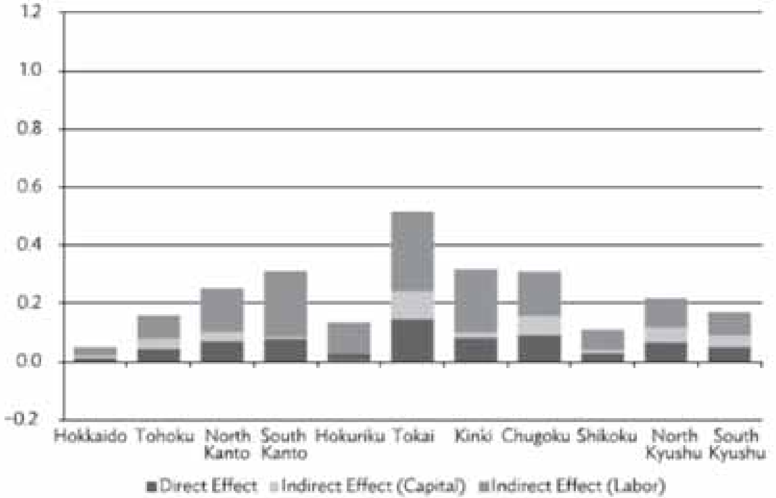
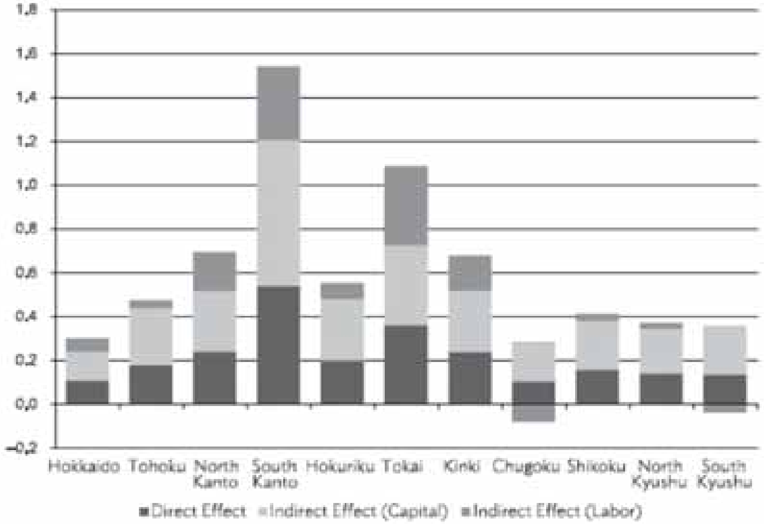
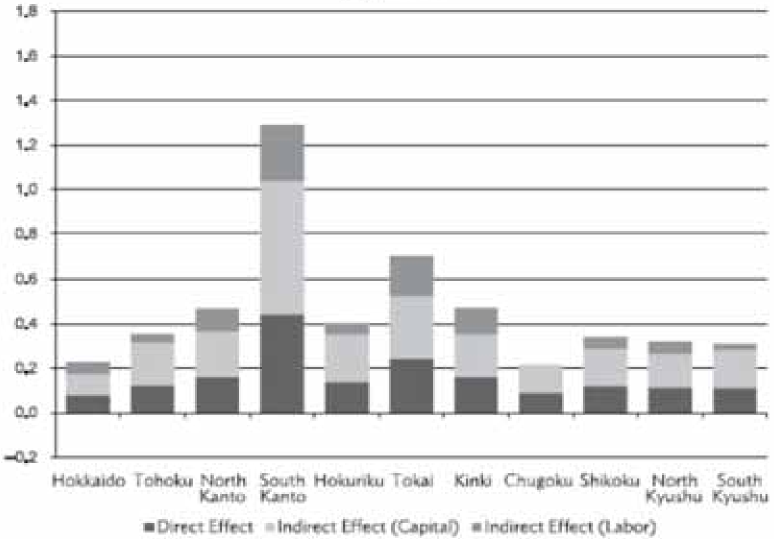


Figure 4.4 Marginal Productivity of Public Capital in Tertiary Industry, 1990 and 2010

(1) 1990

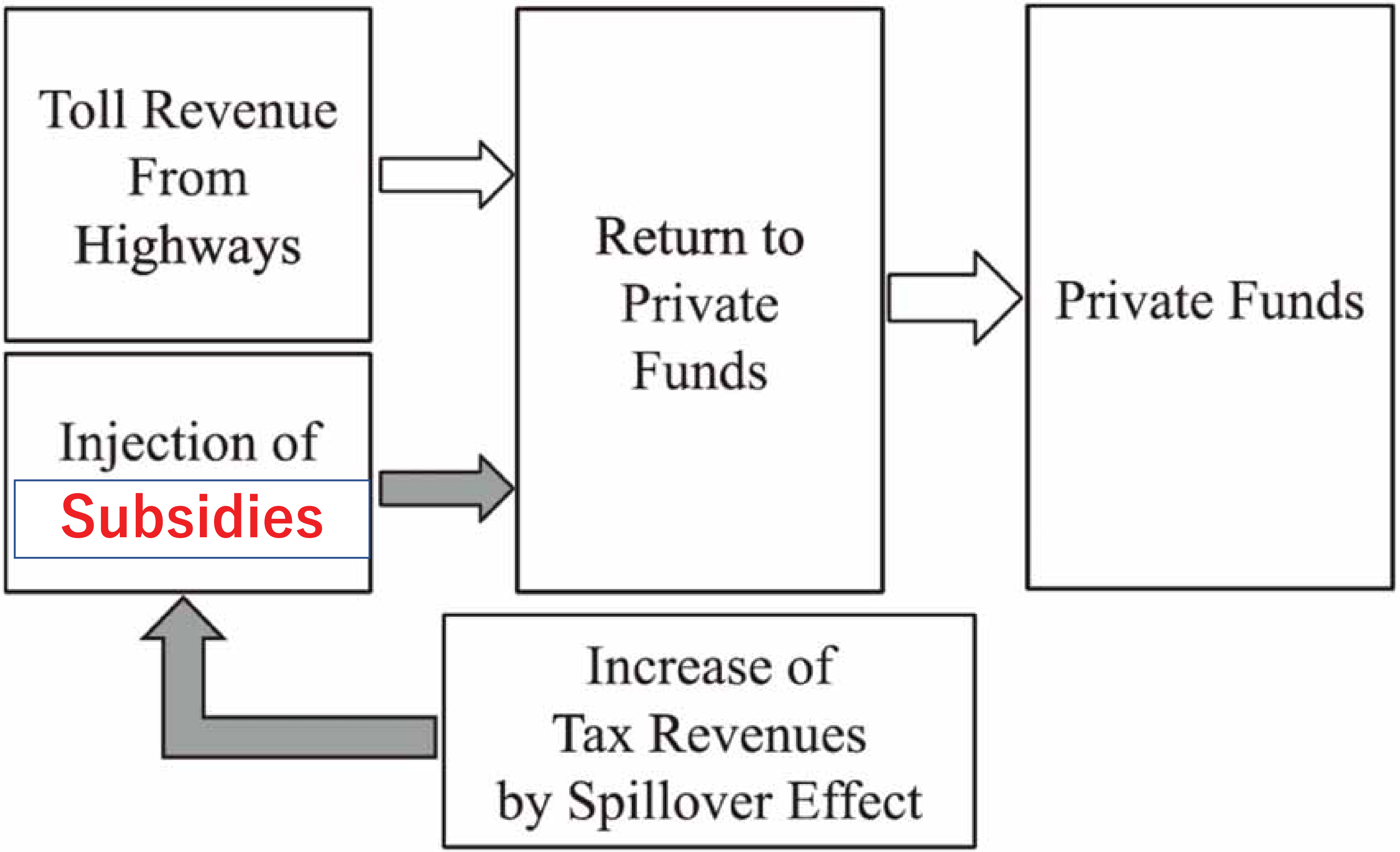


(2) 2010

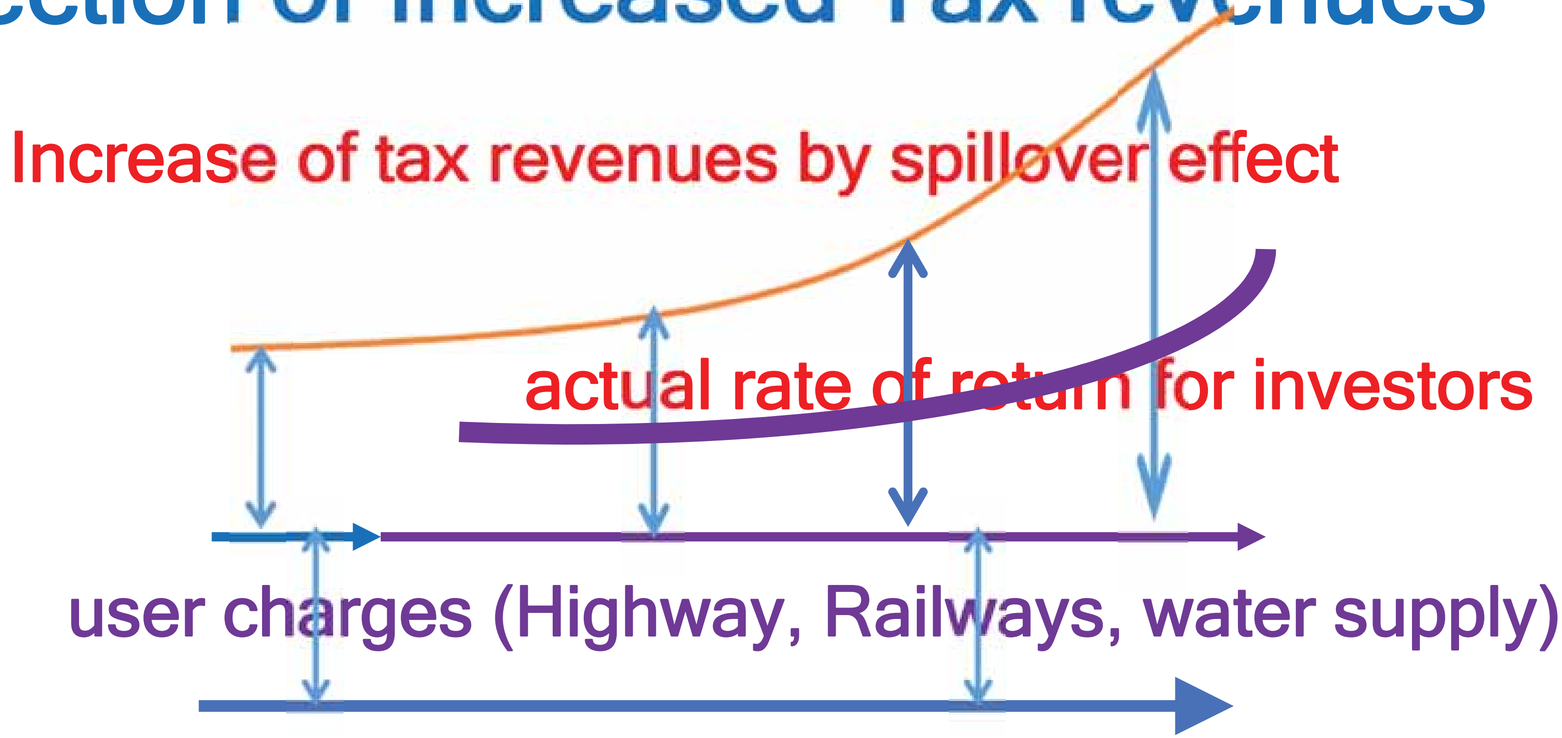


2010 Manufacturing	Private Capital	Public Capital	Direct Effect	Indirect Effect		20% Returned	Increment (%)
				Capital	Labor		
Hokkaido	0.084	0.028	0.008	0.005	0.016	0.004	50.8
Tohoku	0.111	0.054	0.018	0.018	0.018	0.007	40.0
Northern Kanto	0.068	0.297	0.064	0.019	0.215	0.047	73.2
Southern Kanto(TOKYO)	0.052	0.235	0.054	0.006	0.175	0.036	66.5
Hokuriku	0.077	0.079	0.018	0.001	0.061	0.012	69.1
Tokai	0.093	0.339	0.089	0.057	0.192	0.050	55.9
Kinki	0.056	0.202	0.068	0.020	0.114	0.027	39.5
Chugoku	0.075	0.198	0.059	0.043	0.096	0.028	47.0
Shikoku	0.089	0.073	0.021	0.010	0.042	0.010	50.8
Northern Kyushu	0.093	0.120	0.037	0.028	0.055	0.017	45.5
Southern Kyushu	0.098	0.091	0.028	0.022	0.041	0.013	45.7

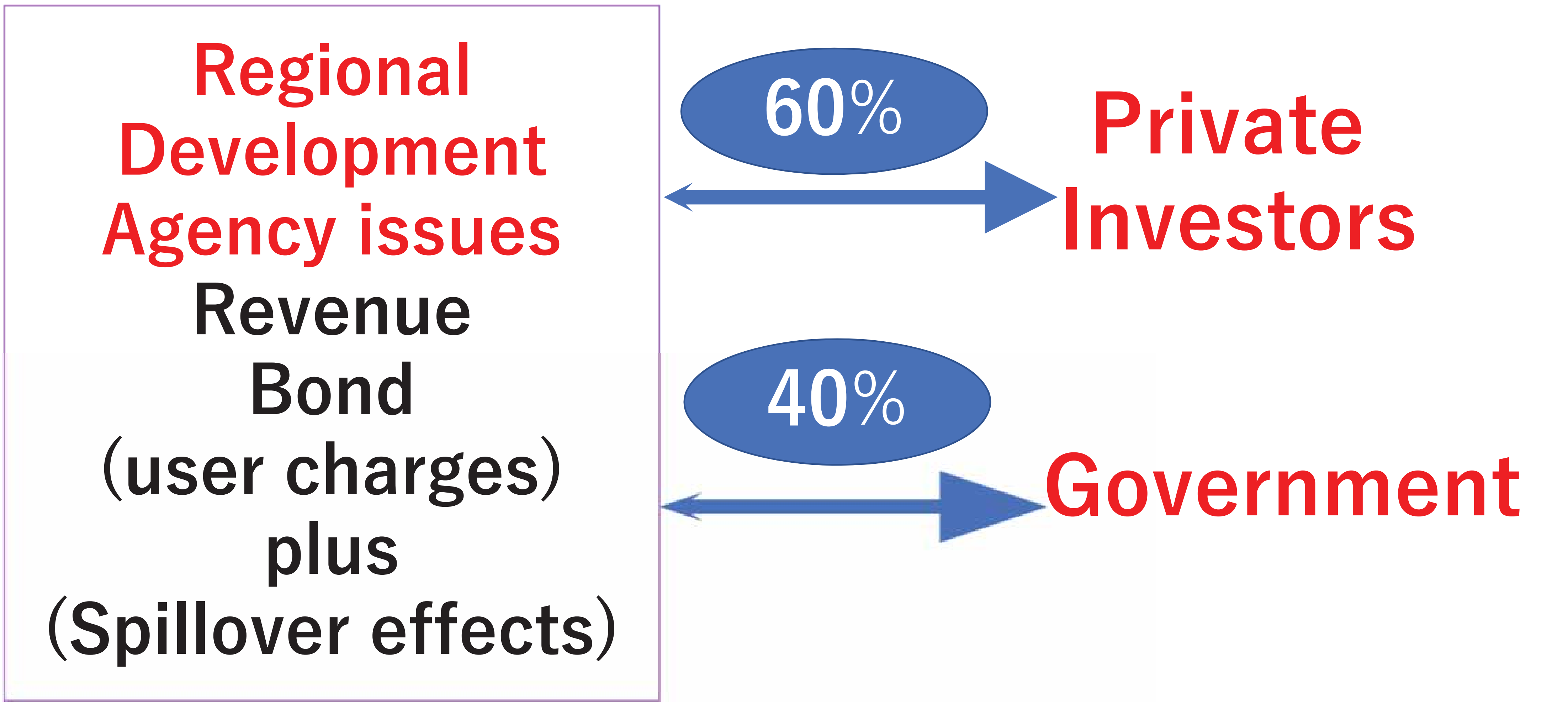
Figure 4
Injection of a fraction of tax revenues gained from spillover effect



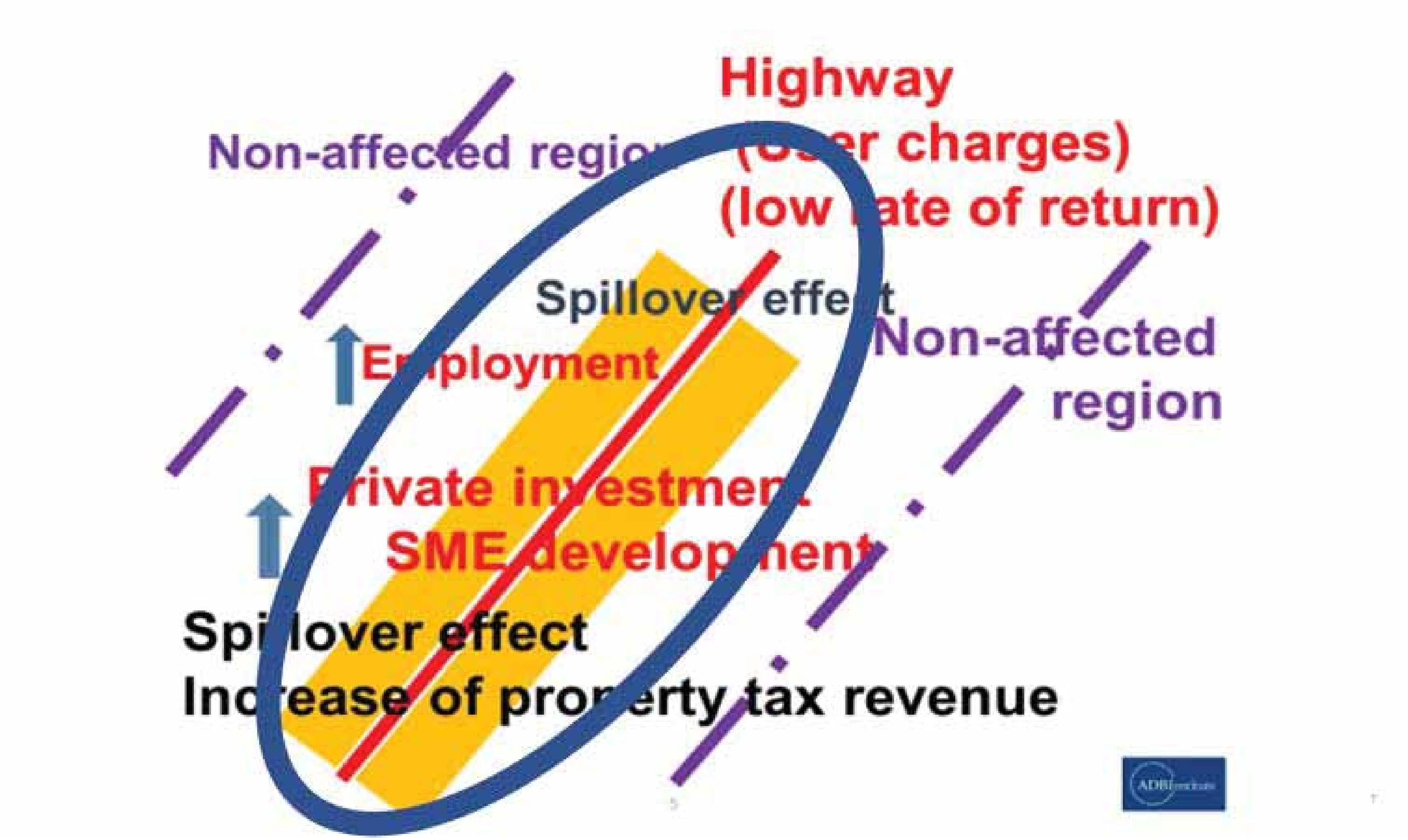
Injection of Increased Tax revenues



Infrastructure Revenue Bond



Regional Development Company issues bonds



Buyers of Infrastructure Bond (long term institutional investors)

1, Various maturities （10 years, 15 years, 20 years, 30years）

2, Rate of return（user charged +Spillover tax revenues）

Infrastructure bonds targeted to

banks,

insurance companies,

Pension funds

3, Sales channels to individuals（Internet, mobile phone）

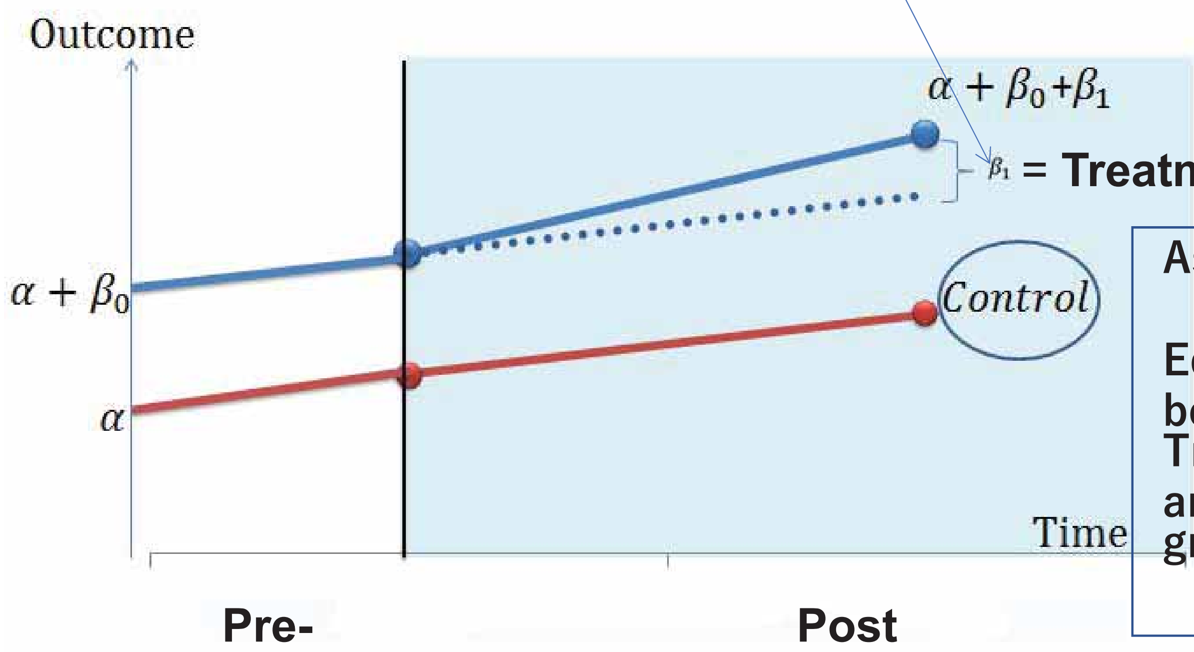
Case Study: Southern Tagalog Arterial Road (STAR) , Philippines Micro-data

- The Southern Tagalog Arterial Road (STAR) project in Batangas province, Philippines (south of Metro Manila) is a modified Built-Operate-Transfer (BOT) project.
- The 41.9 km STAR tollway was built to improve road linkage between Metro Manila and Batangas City, provide easy access to the Batangas International Port, and thereby accelerate industrial development in Batangas and nearby provinces.

Difference-in-Difference (DiD) Analysis

$$\text{Outcome} = \alpha + \beta_0 D + \sum_{t+2}^{t-4} \beta_1 D \times T + \varepsilon$$

where: D = 1 (Treatment group) T = Treatment period
D = 0 (Control group)



Assumption:

Equal trends between Treatment and Control groups

Difference-in-Difference Regression: Spillover

	(1) Property tax	(2) Property tax	(3) Business tax	(4) Business tax	(5) Regulatory fees	(6) Regulatory fees	(7) User charge	(8) User charge
Treatment D	1.55535	0.736	1.067	0.438	1.372	0.924	0.990	0.364
	(1.263)	(0.874)	(1.316)	(1.407)	(1.123)	(1.046)	(1.095)	(1.028)
Treatment D × $Period_{t+2}$	0.421**	-0.083	1.189***	0.991**	0.248***	-0.019	0.408***	-0.010
	(0.150)	(0.301)	(0.391)	(0.450)	(0.084)	(0.248)	(0.132)	(0.250)
Treatment D × $Period_{t+1}$	0.447**	0.574***	1.264***	1.502***	0.449**	0.515***	0.317**	0.434**
	(0.160)	(0.118)	(0.415)	(0.542)	(0.142)	(0.169)	(0.164)	(0.167)
Treatment D × $Period_{t0}$	0.497***	0.570**	1.440***	1.641***	0.604**	0.642***	0.350	0.422
	(0.128)	(0.223)	(0.417)	(0.482)	(0.183)	(0.181)	(0.271)	(0.158)
Treatment D × $Period_{t-1}$	1.294**	0.387	2.256**	1.779**	1.318**	0.838*	0.959	0.197
	(0.674)	(0.728)	(0.957)	(0.470)	(0.649)	(0.448)	(0.714)	(0.560)
Treatment D × $Period_{t-2}$	1.163*	0.336	2.226**	1.804**	1.482**	1.044**	0.941	0.247
	(0.645)	(0.594)	(0.971)	(0.531)	(0.634)	(0.413)	(0.704)	(0.531)
Treatment D × $Period_{t-3}$	1.702*	0.450	2.785**	2.070***	1.901***	1.238***	1.732***	0.676
	(0.980)	(0.578)	(1.081)	(0.544)	(0.630)	(0.369)	(0.598)	(0.515)
Treatment D × $Period_{t-4, forward}$	2.573***	1.100	3.428***	2.560***	2.288***	1.509***	2.030***	0.787
	(0.900)	(0.758)	(0.928)	(0.350)	(0.563)	(0.452)	(0.607)	(0.745)
Construction		2.283**		1.577		1.207		1.942*
		(1.172)		(1.196)		(0.855)		(1.028)
Constant	14.69***	-2.499	14.18***	2.230	13.66***	4.597	13.08***	-1.612
	(0.408)	(8.839)	(0.991)	(9.094)	(0.879)	(6.566)	(0.649)	(7.84)
N	80	73	79	73	80	73	77	73
R^2	0.29	0.41	0.37	0.44	0.43	0.50	0.26	0.39

Clustered standard errors, corrected for small number of clusters; * Significant at 10%. ** Significant at 5%. *** Significant at 1%.

The Southern Tagalog Arterial Road (STAR Highway), Philippines, Manila

Tax Revenues in three cities

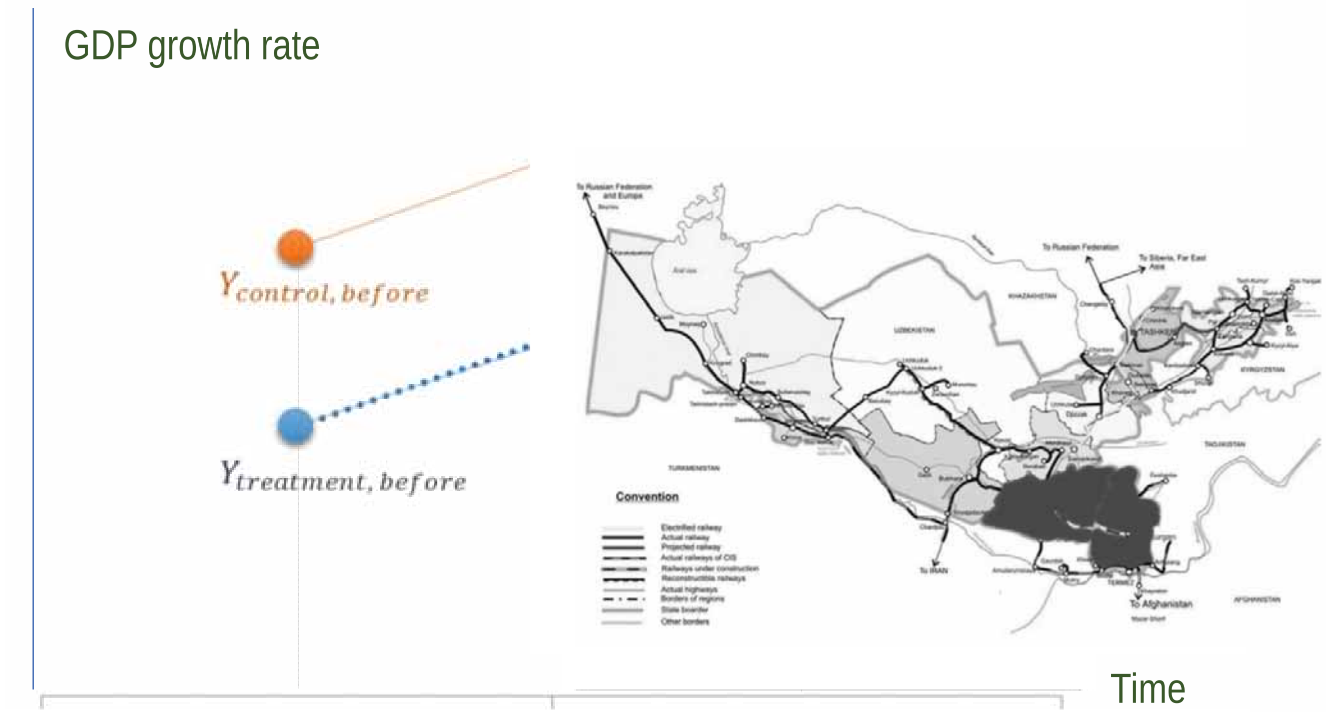
Yoshino and Pontines (2015) ADBI Discussion paper 549

Table 3.3 Calculated Increase in Business Tax Revenues for the Beneficiary Group Relative to Nonbeneficiary Group 4 (P million)

	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	5.84	7.04	7.97	6.80	5.46	10.05	12.94
Batangas City	490.90	622.65	652.83	637.89	599.49	742.28	1,208.61

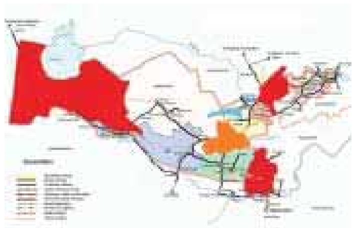
Completion

Uzbekistan Railway



Divide regions affected and not affected by railway connection to “Treated group” and “Control group”

GDP

	GDP	Term	Connectivity spillover effect	Regional spillover effect	Neighboring spillover effect
	Launching Effects	Short	2.83***[4.48]	0.70[0.45]	1.33[1.14]
		Mid	2.5***[6.88]	0.36[0.29]	1.27[1.46]
		Long	2.06***[3.04]	-0.42[-0.29]	2.29**[2.94]
1 year	Anticipated	Short	0.19[0.33]	0.85[1.75]	-0.18[-0.20]
		Mid	0.31[0.51]	0.64[1.30]	-0.02[-0.03]
		Long	0.07[0.13]	-0.006[-0.01]	0.50[0.67]
	Postponed Effects		1.76*[1.95]	-1.49[-0.72]	2.58*[2.03]
2 years	Anticipated	Short	-1.54[-1.66]	1.42[0.78]	-1.32[-0.92]
		Mid	0.32[0.44]	0.84[1.42]	0.13[0.13]
		Long	0.11[0.15]	0.10[0.16]	0.87[1.19]
	Postponed Effects		-0.14[-0.20]	-1.71[-1.35]	1.05[1.44]

Note: t-values are in parenthesis. t-value measures how many standard errors the coefficient is away from zero.

legend: * p<.1; ** p<.05; *** p<.01

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Journal of Asian Economics

Full length article

An impact evaluation of investment in infrastructure: The case of a railway connection in Uzbekistan

Naoyuki Yoshino[a], Umid Abidhadjaev[b,*]

In the spectrum of economic sectors, the positive effect reflected in regional GDP seems to be driven by approximate increases of 5% in industrial output and of 7% in aggregate services. The effect on agricultural output is moderate relative to other sectors, constituting around 1% for connectivity effects, which is consistent with previous literature on the impacts of public capital.

Japanese Bullet Train

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doi: 10.24294/jipd.v1i2.69

ORIGINAL ARTICLE

Impact of infrastructure on tax revenue: Case study of high-speed train in Japan

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Impact of Kyushu Shinkansen Rail on CORPORATE TAX revenue during 1st PHASE OF OPERATION period {2004-2010} , mln. JPY (adjusted for CPI, base 1982)

1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013

Variable	Regression 1	Regression 2	Regression 3	Regression 4	Regression 5
Treatment2	-4772.54				
	[-0.2]				
Number of tax payers	5.8952514*	5.8957045*	5.896112*	5.8953585*	5.8629645*
	[1.95]	[1.95]	[1.95]	[1.95]	[1.91]
Treatment3		-15947.8			
		[-0.87]			
Treatment5			-13250.4		
			[-1.06]		
Treatment7				-6883.09	
				[-0.7]	
TreatmentCon					-28030.8
					[-0.65]
Constant	-665679	-665418	-665323	-665358	-658553
	[-1.35]	[-1.35]	[-1.35]	[-1.35]	[-1.32]
N	799	799	799	799	799
R2	0.269215	0.269281	0.269291	0.269241	0.269779
F	1.934589	2.106448	2.074548	2.100607	8.497174

COMPOSITION OF GROUPS

Group2	Group3	Group7	Group5	GroupCon
Kagoshima	Kagoshima	Kagoshima	Kagoshima	Kagoshima
Kumamoto	Kumamoto	Kumamoto	Kumamoto	Kumamoto
	Fukuoka	Fukuoka	Fukuoka	Fukuoka
		Oita	Oita	Osaka
		Miyazaki	Miyazaki	Hyogo
		Saga		Okayama
		Nagasaki		Hiroshima
				Yamaguchi

Note: Treatment2 = Time Dummy {1991-2003} x Group2. etc. t-values are in parenthesis. Legend: * p<.1; ** p<.05; *** p<.01. Clustering standard errors are used, allowing for heteroscedasticity and arbitrary autocorrelation within a prefecture, but treating the errors as uncorrelated across prefectures

Impact of Kyushu Shinkansen Rail on CORPORATE TAX revenue during 2nd PHASE OF OPERATION period {2011-2013} , mln. JPY (adjusted for CPI, base 1982)

1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013

Variable	Regression 1	Regression 2	Regression 3	Regression 4	Regression 5
Treatment2	72330.012**				
	[2.2]				
Number of tax payers	5.5277056***	5.5585431***	5.558603***	5.5706545***	5.9640287***
	[3.13]	[3.14]	[3.14]	[3.14]	[3.07]
Treatment3		104664.34*			
		[2]			
Treatment5			82729.673**		
			[2.1]		
Treatment7				80998.365**	
				[2.34]	
TreatmentCon					179632
					[1.58]
Constant	-568133.98**	-573747.28**	-574245.87**	-576867.56**	-642138.87**
	[-2.07]	[-2.08]	[-2.08]	[-2.09]	[-2.1]
N	611	611	611	611	611
R2	0.350653	0.352058	0.352144	0.352874	0.364088
F	5.062509	5.486197	5.351791	5.431088	16.55518

COMPOSITION OF GROUPS

Group2	Group5
Kagoshima	Kagoshima
Kumamoto	Kumamoto
	Fukuoka
Group3	Oita
Kagoshima	Miyazaki
Kumamoto	
Fukuoka	
	GroupCon
Group7	Kagoshima
Kagoshima	Kumamoto
Kumamoto	Fukuoka
Fukuoka	Osaka
Oita	Hyogo
Miyazaki	Okayama
Saga	Hiroshima
Nagasaki	Yamaguchi

Note: Treatment2 = Time Dummy {1991-2003} x Group2. etc. t-values are in parenthesis. Legend: * p<.1; ** p<.05; *** p<.01. Clustering standard errors are used, allowing for heteroscedasticity and arbitrary autocorrelation within a prefecture, but treating the errors as uncorrelated across prefectures

Total tax revenue, mln. JPY

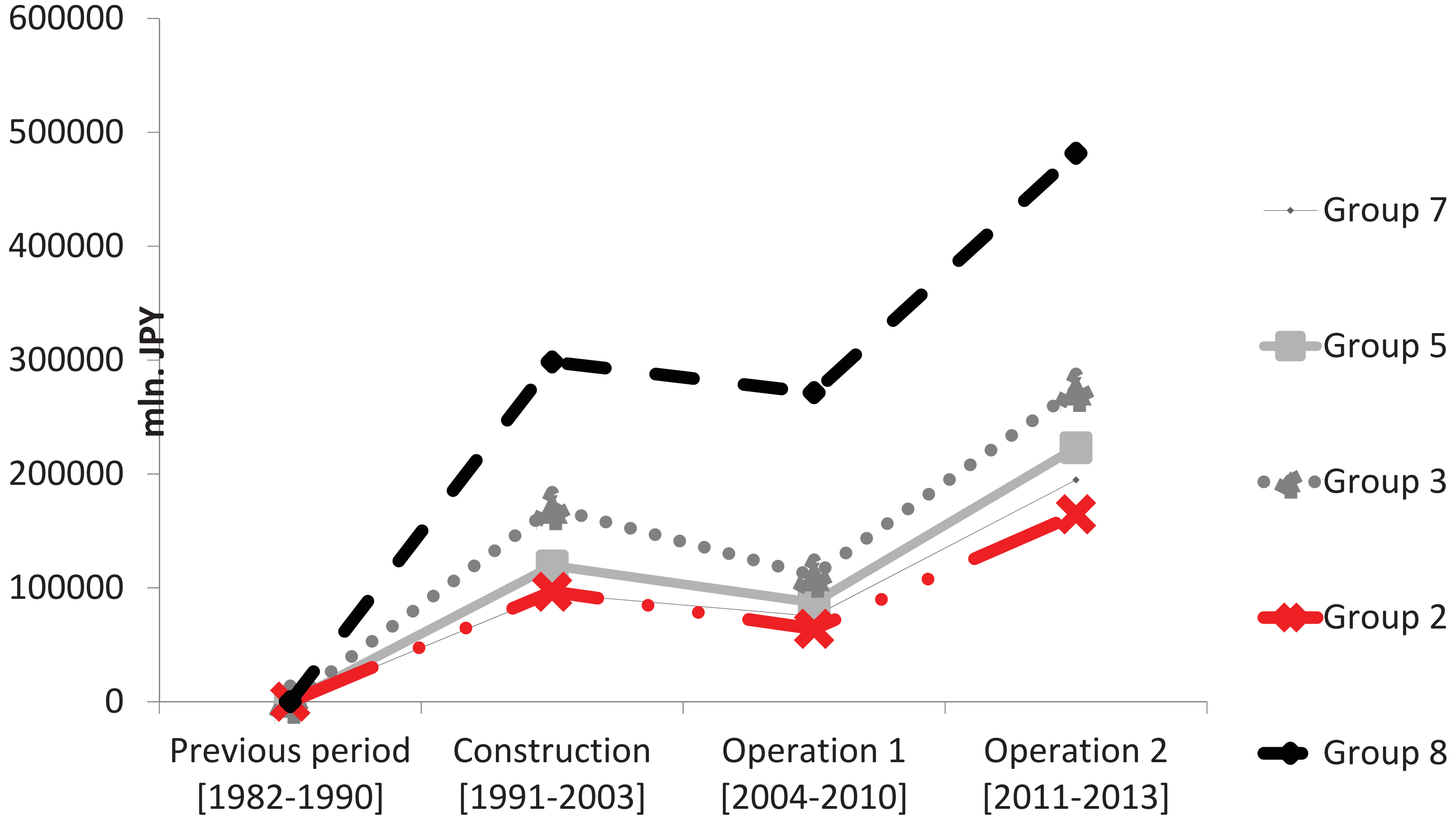

Table 2.5b Difference-in-Difference Empirical Results with the Outcome Variable of Personal Income Tax Revenue

Scale of Focus	Affected Group of Prefectures	Construction Period (1991–2003)	Operation Phase 1 (2004–2010)	Operation Phase 2 (2011–2013)
Spillover Effect by Region	Treatment Group 1	25,724	–19,033	42,035**
		(1.32)	(–0.75)	(2.34)
	Treatment Group 2	25,783*	–35,023	66,498**
		(1.93)	(–1.63)	(2.41)
Spillover Effect by Adjacency	Treatment Group 3	10,915	–30,029**	51,675**
		(0.85)	(–2.18)	(2.59)
	Treatment Group 4	7,448	–23,844**	48,690***
		(0.74)	(–2.13)	(3.01)
Spillover Effect by Connectivity	Treatment Group 5	65,186**	–23761	151,360**
		(2.02)	(–0.55)	(2.59)
Number of Observations		1,034	799	611

() = t-value.

Table 2.13 Difference-in-Difference Empirical Results with the Outcome Variable of Corporate Income Tax Revenue, Using Nearest Neighbor Matching Based on the Euclidian Distance between Mean Tax Revenues, 1982–1990 (¥ million)

Scale of Focus	Affected Group of Prefectures	Construction Period (1991–2003)	Operation Phase 1 (2004–2010)	Operation Phase 2 (2011–2013)
Spillover Effect by Region	Treatment Group 1	12,132.33***	−6,292.71*	6,629.05
		(14.06)	(−2.71)	(2.04)
	Number of Observations	88	68	52
	Treatment Group 2	17,473.79**	−13,261.77	18,730.36**
		(3.56)	(−1.61)	(2.72)
	Number of Observations	132	102	78
Spillover Effect by Adjacency	Treatment Group 3	13,695.24***	−9,138.27	15,128.06**
		(3.37)	(−1.61)	(2.93)
	Number of Observations	220	170	130
	Treatment Group 4	10,902.40***	−6,382.728	15,794.54***
		(3.28)	(−1.54)	(3.84)
	Number of Observations	308	238	182
Spillover Effect by Connectivity	Treatment Group 5	−46,276.71	−46,440.24*	117,806.95**
		(−1.09)	(−1.79)	(2.28)
	Number of Observations	330	255	195

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Explicit and Implicit Analysis of Infrastructure Investment: Theoretical Framework and Empirical Evidence

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Infrastructure & Education

- Steady state equation in logarithmic form

$$
\begin{aligned}
& lny(2010) - lny(1991) = \\
& (1 - e^{-\lambda t})\left(\frac{\theta}{1-\theta-\beta-\alpha}\right) ln(\varphi) + \\
& (1 - e^{-\lambda t})\left(\frac{\beta}{1-\theta-\beta-\alpha}\right) ln(1-\varphi) + \\
& (1 - e^{-\lambda t})\left(\frac{\theta+\beta}{1-\theta-\beta-\alpha}\right) ln(\tau) + \\
& (1 - e^{-\lambda t})\left(\frac{\alpha}{1-\theta-\beta-\alpha}\right) ln\big(s(1-\tau)\big) - \\
& (1 - e^{-\lambda t})\frac{\alpha+\beta+\theta}{(1-\theta-\beta-\alpha)} ln(n+\delta+g) - \\
& (1 - e^{-\lambda t}) lny(1991)
\end{aligned}
$$

NOTE:
Context: 44 developing countries, 1991-2010
Methodology: Production function approach
Point of novelty and findings:
Study incorporated infrastructure variable into neoclassical growth framework and demonstrated that controlling for share of working age population with university level of education infrastructure investment to GDP ratio constituted statistically significant determinant of accumulated growth rate of GDP per capita

Estimation of The Neoclassical Growth Model with Infrastructure Investment			
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

Public-Private Partnership (PPP)
Give incentives to operating companies
SOE Reform

Payoff table for infrastructure operating entity and investors

	Normal Case	Effort Case
Normal Case	(50 , r) Operating Entity, Investors	(50 , αr) Operating Entity, Investors
Effort Case	(100 , r) Operating Entity, Investors	(100 , αr) Operating Entity, Investors

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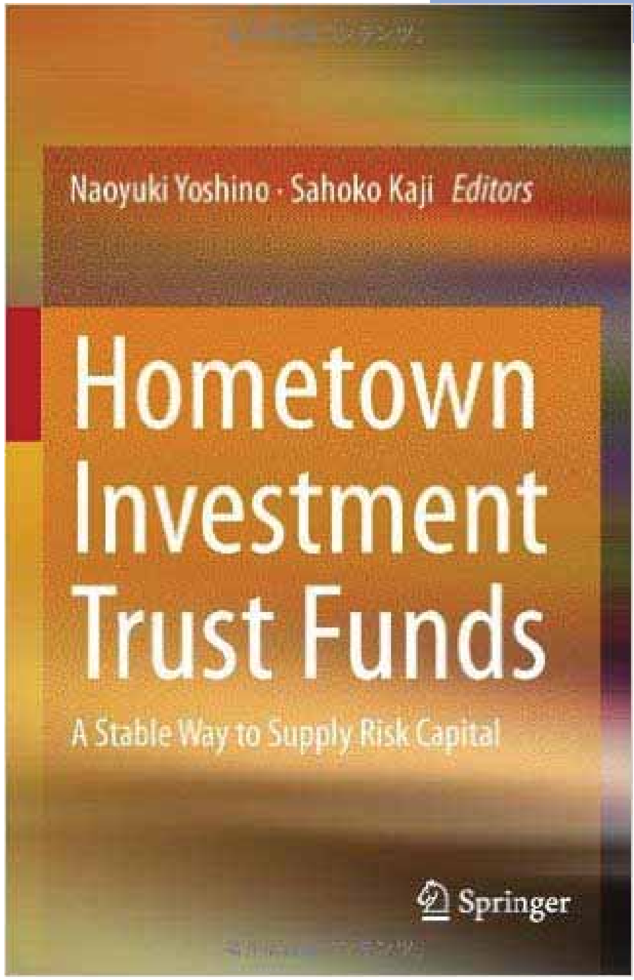
Enhance regional economy

Start up businesses, farmers, SMEs



Hometown Investment Trust Funds

A Stable Way to Supply Risk Capital

Yoshino, Naoyuki; Kaji, Sahoko (Eds.)
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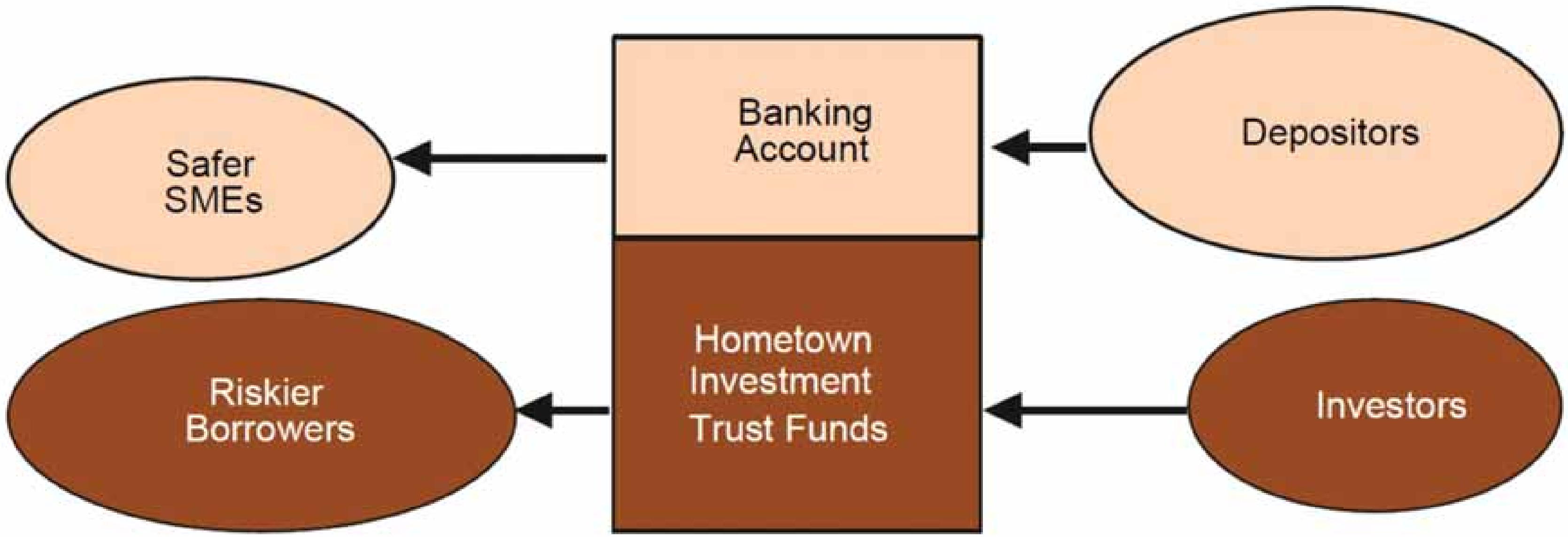

SME =small and medium-sized enterprise.

Source: Yoshino and Taghizadeh-Hesary (2014).

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