The Direct and Indirect Effects of Infrastructure on Firm Productivity

Guanghua WAN
Director of Research

Yan ZHANG
Project Consultant

Asian Development Bank Institute

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Outline

1. Motivation of study
2. Empirical model and data
3. Empirical results
4. Conclusions

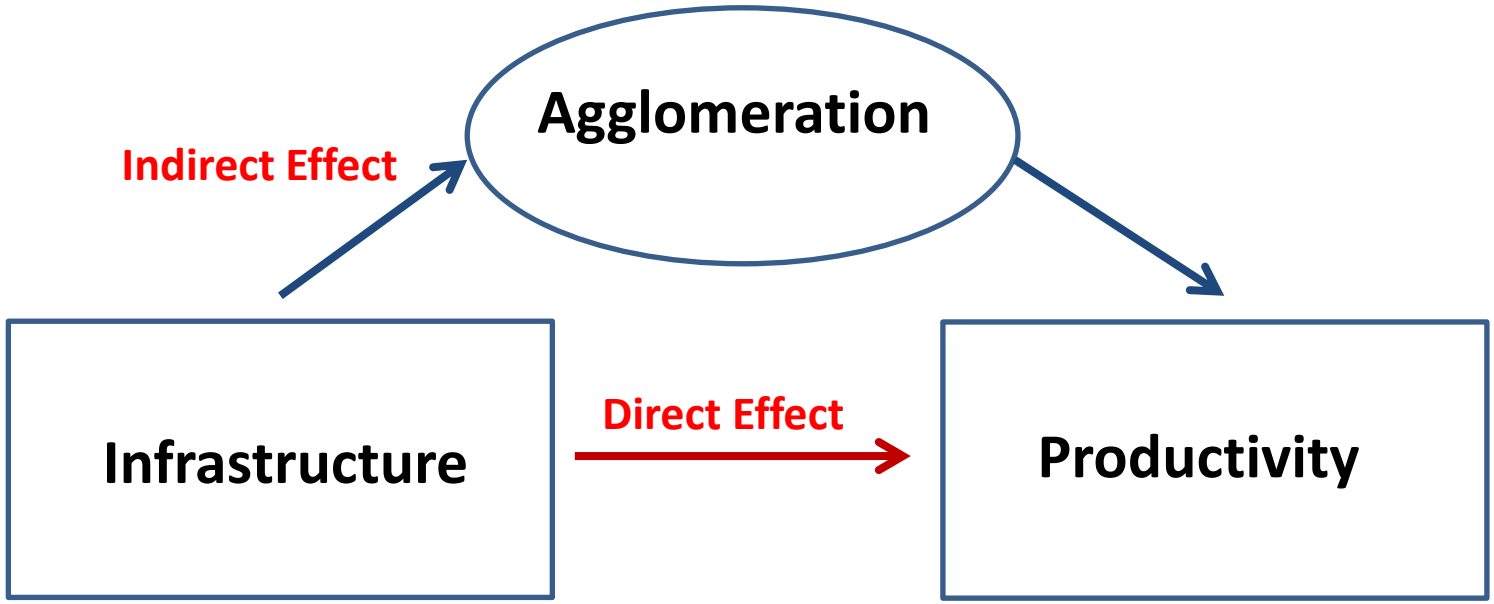
Motivation

- **Existing studies on the productivity impacts of infrastructure mostly focus on direct effect** (Démurger 2001; Mikelbank 2000).
- **Expand catchment areas**
- **Access larger labor markets**
- **Reduce logistic costs**

Motivation

- **Infra. is known to help promote agglomeration of economic activities** (Lewis and Bloch 1998; McCann and Shefer 2003).
- **Agglomeration Economies:**
    - Lower cost access to shared intermediate inputs
    - Easier flow of ideas across firms
    - Allow cities to accommodate greater population
- **Eg. Silicon Valley**

Conceptual Map



Total Effect= Direct + Indirect

Why distinguish Direct/Indirect?

- **Total Effect= Direct + Indirect**

- **Agglomeration economies/diseconomies**
- **Financing new projects, PPP or not**
- **Inviting firms, infra. users or spillover-lovers**

What we do

- We distinguish Direct/Indirect of infrastructure impact on firm productivity
- We use a large scale of Chinese manufacturing data from 2002-2007
- We test different regions which has huge spatial differences.

Empirical model and data

- Baseline model
- $prod_{i,j,k,t} = \beta_0 + \beta_1 inf_{k,t} + \delta' X_{i,j,k,t} + \rho_k + \pi_j + \theta_t + u_{i,j,k,t} \quad (1)$
- Considering agglomeration
- $prod_{i,j,k,t} = \alpha_0 + \alpha_1 inf_{k,t} + \alpha_2 agg_{j,k,t} + \zeta' X_{i,j,k,t} + \rho_k + \pi_j + \theta_t + \nu_{i,j,k,t} \quad (2)$
- Endogeneity Issue
- $agg_{j,k,t} = \gamma_0 + \gamma_1 inf_{k,t} + \beta' Z_{j,k,t} + \varepsilon_{j,k,t}. \quad (3)$

Direct/ Indirect effect

- substituting Eq. (3) into Eq. (2)
- $prod_{i,j,k,t} = \alpha_0 + \alpha_2\gamma_0 + (\alpha_1 + \alpha_2\gamma_1)inf_{k,t} + \alpha_2\beta' Z_{j,k,t} + \zeta' X_{i,j,k,t} + \rho_k + \pi_j + \theta_t + \nu_{i,j,k,t} + \alpha_2\varepsilon_{j,k,t}$

- The direct effect α_1 and indirect effect $\alpha_2\gamma_1$
- Indirect effect depends on two factors: agglomeration diseconomies $\alpha_2 < 0$; fails to promote agglomeration ($\gamma_1 < 0$)
- the two different effects cannot be disentangled by the conventional model $\beta_1 = \alpha_1 + \alpha_2\gamma_1$

Data

Panel A: Descriptive statistics of variables used in regression models					
Variable	Obs	Mean	Std.Dev.	Min	Max
road	186	77510.58	51214.44	6286	238676
tele	186	1588.996	1555.583	31	11365.8
cable	186	20241.34	10900.45	618	55910
agg_sal	5,375	0.03	0.05	0.00	0.38
agg_ast	5,375	0.03	0.05	0.00	0.40
tfp	1,314,378	6.48	1.13	-3.85	12.93
asset	1,335,926	76571.59	681988.60	3.00	155000000.00
cap	1,335,926	74.37	109.08	0.98	691.60
export	1,335,589	0.18	0.35	0.00	1.00
age	1,335,311	9.69	9.48	1.00	51.00
poe	1,335,926	0.46	0.50	0.00	1.00
foe	1,335,926	0.22	0.42	0.00	1.00
westmid	1,335,926	0.23	0.42	0.00	1.00

Panel B: Infrastructure Variables						
	2002	2003	2004	2005	2006	2007
All country						
road	0.38	0.39	0.41	0.42	0.72	0.74
tele	0.02	0.02	0.02	0.02	0.03	0.04
cable	0.10	0.12	0.13	0.14	0.14	0.15
Eastern						
road	0.57	0.59	0.62	0.64	0.96	0.99
tele	0.04	0.04	0.05	0.06	0.07	0.08
cable	0.15	0.19	0.20	0.22	0.20	0.21
Western&Central						
road	0.26	0.26	0.27	0.28	0.56	0.58
tele	0.00	0.00	0.00	0.01	0.01	0.01
cable	0.07	0.08	0.09	0.09	0.10	0.11
Panel C: Agglomeration variable						
	2002	2003	2004	2005	2006	2007
All country	0.03	0.03	0.03	0.03	0.03	0.03
Eastern	0.06	0.07	0.07	0.06	0.06	0.06
Western&Central	0.014	0.013	0.012	0.013	0.013	0.014

	Dependent Variable: firm-level TFP					
lnroad	0.2728***			0.2552***		
	(0.0069)			(0.0069)		
lntele		0.3559***			0.3149***	
		(0.0069)			(0.0070)	
lncable			0.1670***			0.1720***
			(0.0068)			(0.0068)
agg				0.499***	0.363***	0.564***
				(0.014)	(0.014)	(0.014)
asset	0.3862***	0.3881***	0.3881***	0.3866***	0.3884***	0.3883***
	(0.0025)	(0.0025)	(0.0025)	(0.0025)	(0.0025)	(0.0025)
cap	-0.1890***	-0.1885***	-0.1881***	-0.1887***	-0.1882***	-0.1878***
	(0.0015)	(0.0015)	(0.0015)	(0.0015)	(0.0015)	(0.0015)
export	-0.0042	-0.002	-0.0033	-0.0023	-0.0008	-0.0011
	(0.0050)	(0.0050)	(0.0050)	(0.0050)	(0.0050)	(0.0050)
age	0.1265***	0.1259***	0.1272***	0.1265***	0.1261***	0.1271***
	(0.0027)	(0.0027)	(0.0027)	(0.0027)	(0.0027)	(0.0027)
poe	0.0216***	0.0232***	0.0225***	0.0217***	0.0233***	0.0224***
	(0.0039)	(0.0039)	(0.0039)	(0.0039)	(0.0039)	(0.0039)
foe	0.0399***	0.0385***	0.0373***	0.0417***	0.0400***	0.0393***
	(0.0098)	(0.0098)	(0.0098)	(0.0098)	(0.0098)	(0.0098)
province_dummy	yes	yes	yes	yes	yes	yes
year_dummy	yes	yes	yes	yes	yes	yes
industry_dummy	yes	yes	yes	yes	yes	yes
N	1313465	1313465	1313465	1313465	1313465	1313465
adj. R-sq	0.211	0.212	0.209	0.212	0.212	0.211

	Dependent Variable: firm-level TFP		
agg_sal_road	1.18***		
	(0.19)		
lnroad	0.2668***		
	(0.0070)		
agg_sal_tele		1.07***	
		(0.19)	
lntele		0.3451***	
		(0.0072)	
agg_sal_cable			1.15***
			(0.19)
lncable			0.1622***
			(0.0069)
province_dummy	yes	yes	yes
year_dummy	yes	yes	yes
industry_dummy	yes	yes	yes
N	1304472	1304472	1304472
adj. R-sq	0.211	0.212	0.21

Direct and indirect effects of infrastructure

	(1)	(2)	(3)	(4)	(5)	(6)
	Direct effect in Eq. (1)	Direct effect in Eq. (4)	Indirect in Eq.(4)			(2)+(3)
	β_1	α_1	$\alpha_2\gamma_1$	α_2	γ_1	$\alpha_1 + \alpha_2\gamma_1$
Road	0.273	0.267	0.006	1.181	0.005	0.272905
Tel	0.356	0.345	0.011	1.069	0.01	0.35569
Cable	0.167	0.162	0.005	1.148	0.004	0.166592

- $prod_{i,j,k,t} = \alpha_0 + \alpha_1 inf_{k,t} + \alpha_2 agg_{i,k,t} + \alpha_3 inf_{k,t} * westmid_k + \zeta' X_{i,j,k,t} + \rho_k + \pi_j + \theta_t + \nu_{i,j,k,t}$

	Dependent variable: firm-level TFP		
agg_sal_road	0.48***		
	(0.15)		
lnroad	0.20***		
	(0.007)		
westmid*road	0.11***		
	(0.006)		
agg_sal_tele		0.67***	
		(0.15)	
lntele		0.28***	
		(0.0074)	
westmid*tele		0.18***	
		(0.006)	
agg_sal_cable			0.52***
			(0.15)
lncable			0.1107***
			(0.0079)
westmid*cable			0.25***
			(0.021)
N	1304472	1304472	1304472
adj. R-sq	0.197	0.199	0.196

Direct effect is stronger in Western and Central Provinces

$$prod_{i,j,k,t} = \alpha_0 + \alpha_1 inf_{k,t} + \alpha_2 agg_{i,k,t} + \alpha_3 agg_{i,k,t} * westmid_k + \zeta' X_{i,j,k,t} + \rho_k + \pi_j + \theta_t + \nu_{i,j,k,t}$$

	Dependent variable: firm-level TFP		
agg_sal_road	-0.09		
	(0.10)		
lnroad	0.26***		
	(0.0070)		
westmid*road	8.69***		
	(0.77)		
agg_sal_tele		-0.16	
		(0.10)	
lntele		0.35***	
		(0.0070)	
westmid*tele		9.33***	
		(0.78)	
agg_sal_cable			-0.024
			(0.099)
lncable			0.15***
			(0.0070)
westmid*cable			9.26***
			(0.77)
N	1304472	1304472	1304472
adj. R-sq	0.196	0.198	0.195

Agglomeration Economies is stronger in Western and Central provinces

$$agg_{j,k,t} = \gamma_0 + \gamma_1 inf_{k,t} + \gamma_2 inf_{k,t} * westmid_k + \beta' Z_{j,k,t} + \varepsilon_{j,k,t} \qquad (7)$$

	Dependent variable: agglomeration		
lnroad	0.0124***		
	(0.0008)		
westmid*lnroad	-0.0033***		
	(0.0001)		
lntele		0.0189***	
		(0.0010)	
westmid*lntele		-0.0037***	
		(0.0002)	
lncable			0.0105***
			(0.0008)
westmid*lncable			-0.0037***
			(0.0002)
ind_export	0.0023	0.0013	0.0025
	(0.0029)	(0.0029)	(0.0030)
N	4495	4495	4495
adj. R-sq	0.6	0.615	0.591

Infrastructure effect on agglomeration is stronger in Eastern provinces

Conclusions

- We distinguish the direct and indirect effect of infrastructure on firm productivity. Both effects are significantly positive and direct effect is higher.
- Two effects vary on regions.

Policy Implications

- Along with the infrastructure investment, the government should pay attention to the increasing of agglomeration.
- For regions relatively short of infrastructures, the direct effect would be high. Considering PPP.
- Infrastructure in remote areas would lead to less agglomeration than the developed areas.

Thank you