Infrastructure Financing in China

By Naoyuki Yoshino, Bihong Huang, Yan Zhang
Asian Development Bank Institute
Astana, Nov 30, 2018

Outline

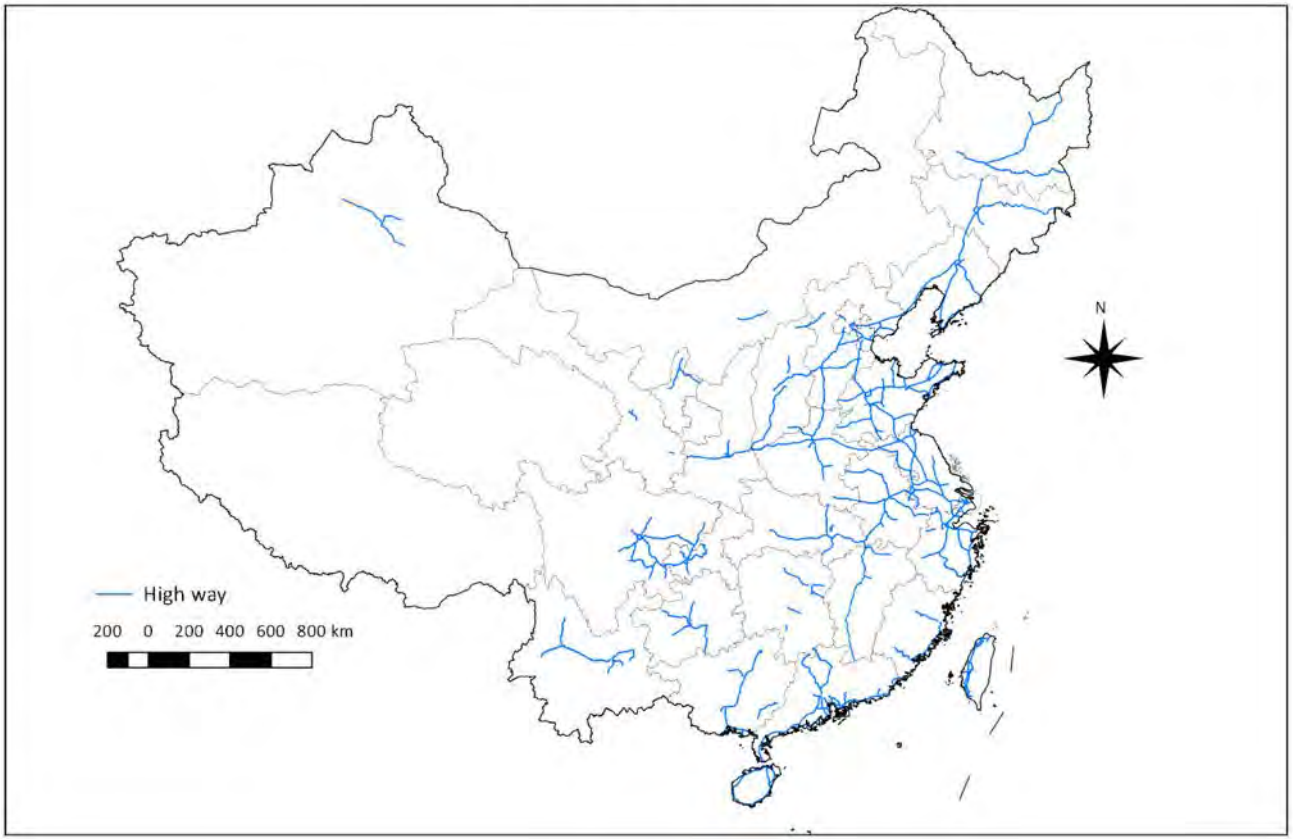
- China’s achievement in infrastructure
- Infrastructure financing model in China
- Empirical analysis: expressway and regional economy in northwestern China

1. China’s achievement in Infrastructure

Establishment of Expressway Network in China

- **Stage 1, 1984-2004**
  - On 7 June 1984, China began the construction of the first highway *Shenyang–Dalian Expressway*
  - In December 1987, construction of the 142.69 kilometers long *Jingjintang* Expressway started. This is the first expressway in mainland China that uses a World Bank loan for international open bidding.
  - The 1990s saw the start of the country‘s massive plan to upgrade its network of roads, especially after the Asian Financial Crisis. By the end of 2004, the total length of expressway has exceeded 34,000 km, ranking as No 2. in the world.

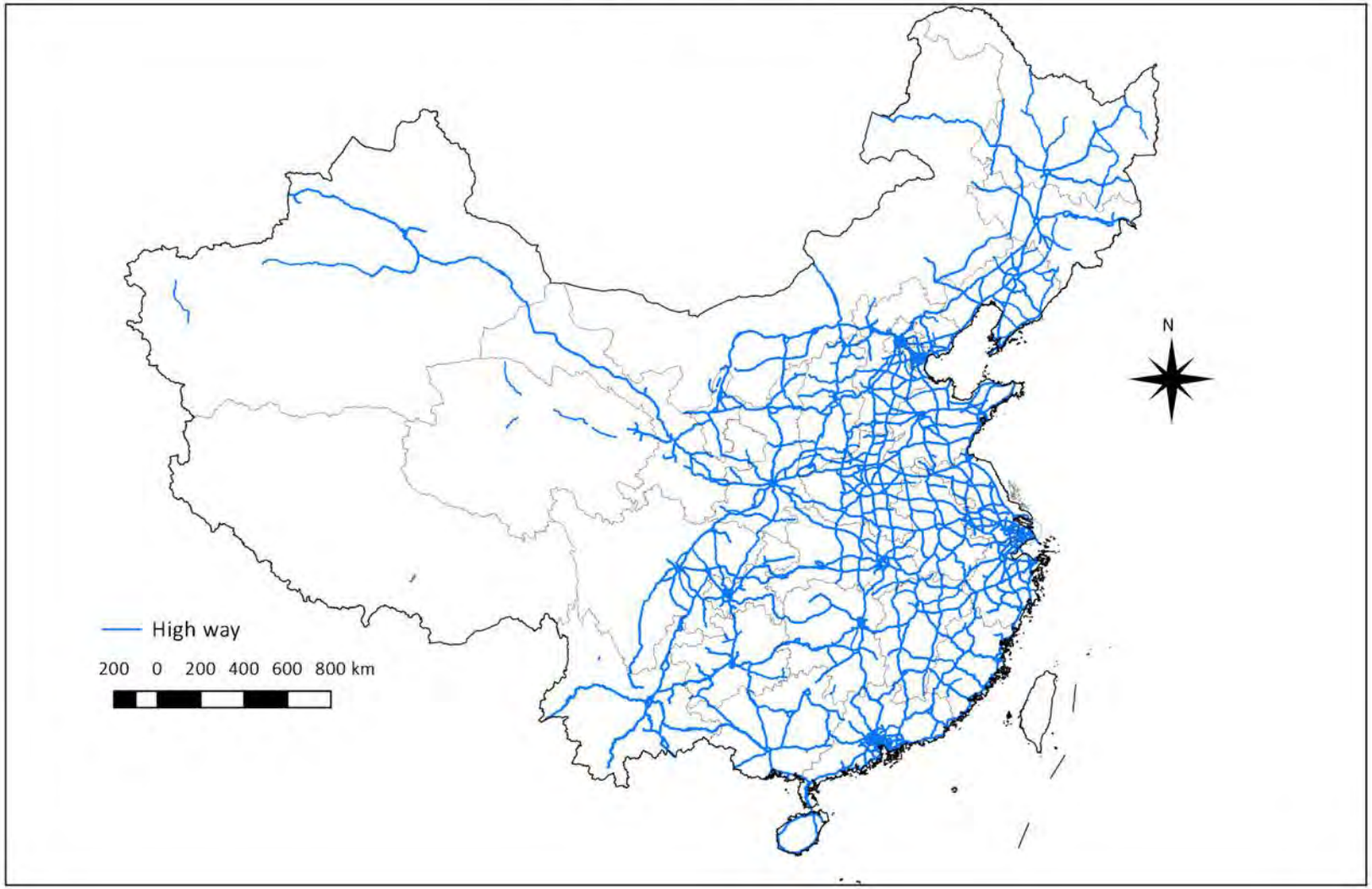
The China' high way in 2003



Establishment of Expressway Network in China

- **Stage 2, 2005-2013**
  - On 13 January 2005， China introduced **7918 network**, later renamed the **71118 network.**
  - With a total length of 118,000km, the network composes of a grid of **7** radial expressways from Beijing, **9** north-south expressways (increased to **11**), and **18** east-west expressways that would form the backbone of the national expressway system
  - By 2011, China had the longest expressway in the world

The China' high way in 2013

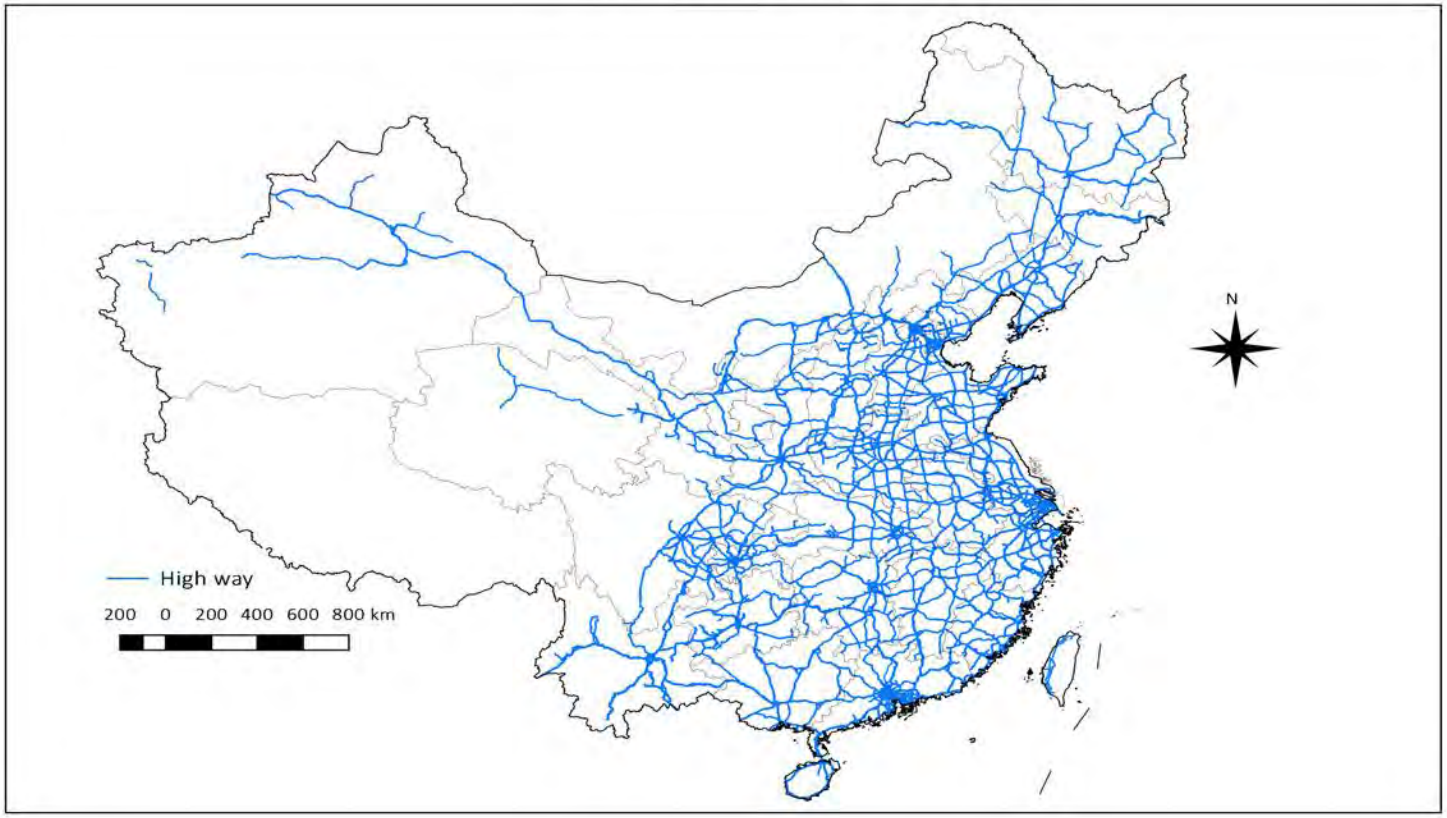


Expressway Network of China

- **Stage 3, 2013-2030**

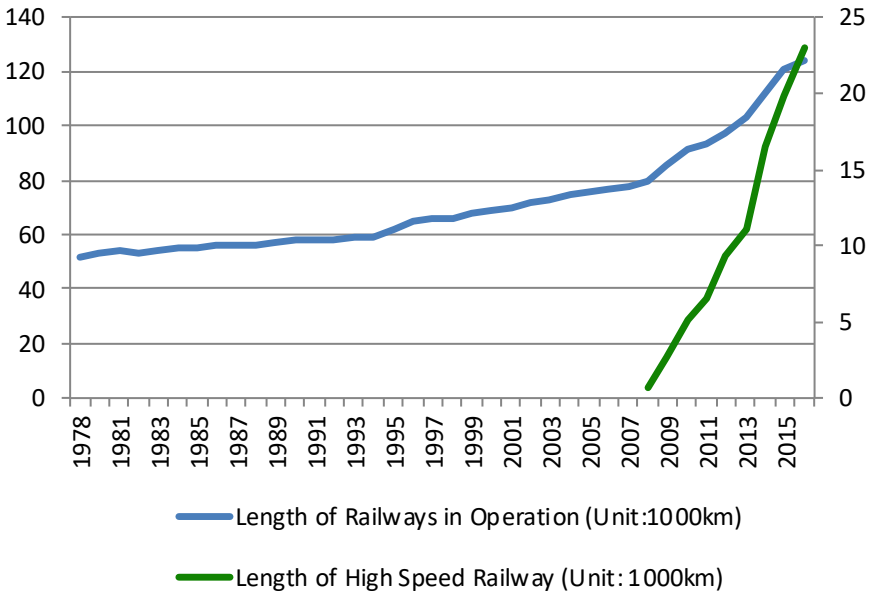
  - In June 2013, the Ministry of Transport introduced the National Highway Network Planning for 2013 to 2030. According to this plan, the total size of the national road network will reach 400,000 kilometers.
  - By the end of 2017, the total length of China's expressway network reached 136,500 kilometers, the world's largest expressway system by length

The China' high way in 2015



China’s achievement in Infrastructure

- In mid-2018, HSR has been extended to 30 of the country's 33 provinces
- 27,000 km in total length, accounting for about two-thirds of the world's high-speed rail tracks in commercial service
- The HSR building boom will continue with the HSR network set to reach 38,000 km (24,000 mi) in 2025



ADBInstitute


Railway map of People's Republic of China
Colored lines showing CRH and other
high speed rail services
Last update: 2018-01-15
Lines capable for speed above 300 km/h
Newly built lines capable for 200-299 km/h
Upgraded lines and other lines with CRH service
Conventional lines with no CRH service

2. Infrastructure financing model in China

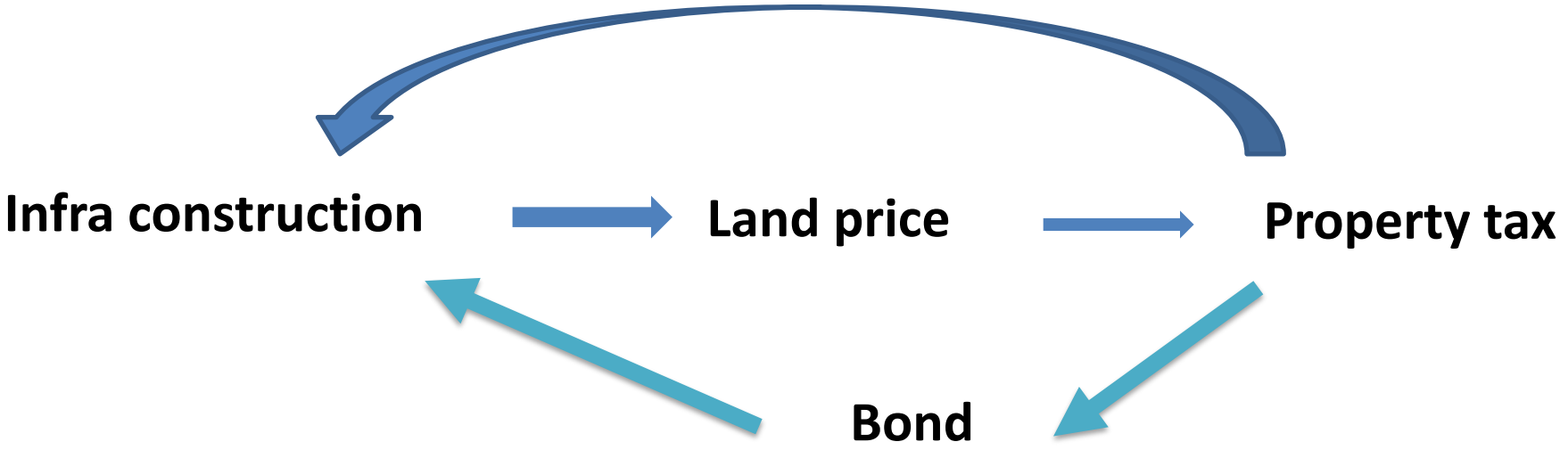
Financing Infrastructure in LDCs

- Urbanization along with infrastructure developments and industrialization are important facilitators of economic growth, increased productivity, and rising incomes

- How to finance the expensive process of urbanization and infrastructure for LDCs who are usually lack of financial resources in the early stage of development?

Financing mechanism for infrastructure

Dilemma of infra: large amount of capital investment in the short term vs benefit in the long term

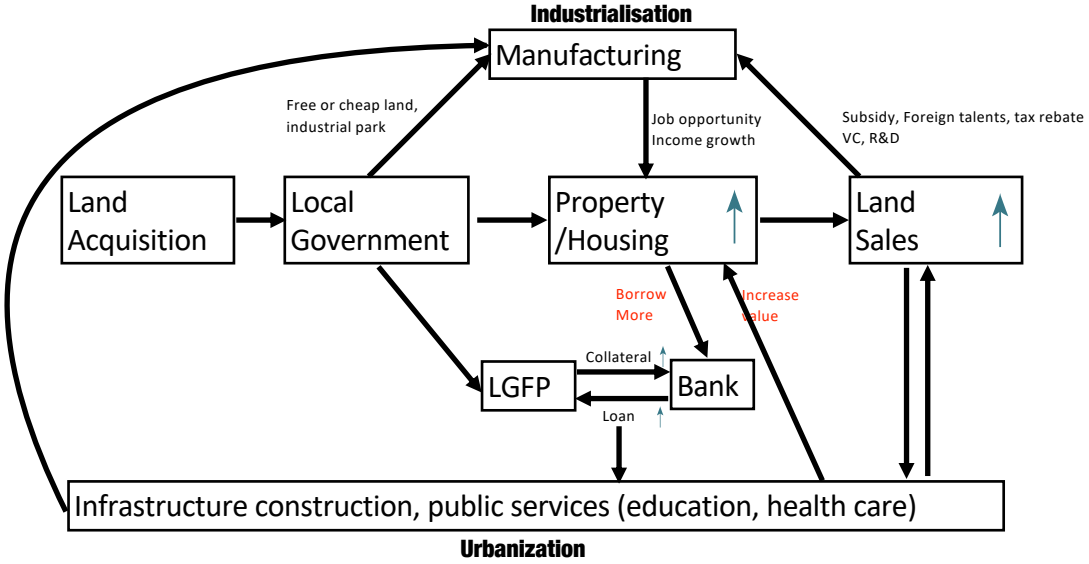


Preconditions

- **Privately owned land**
- **Efficiency of tax collection**
- **Financial market development**

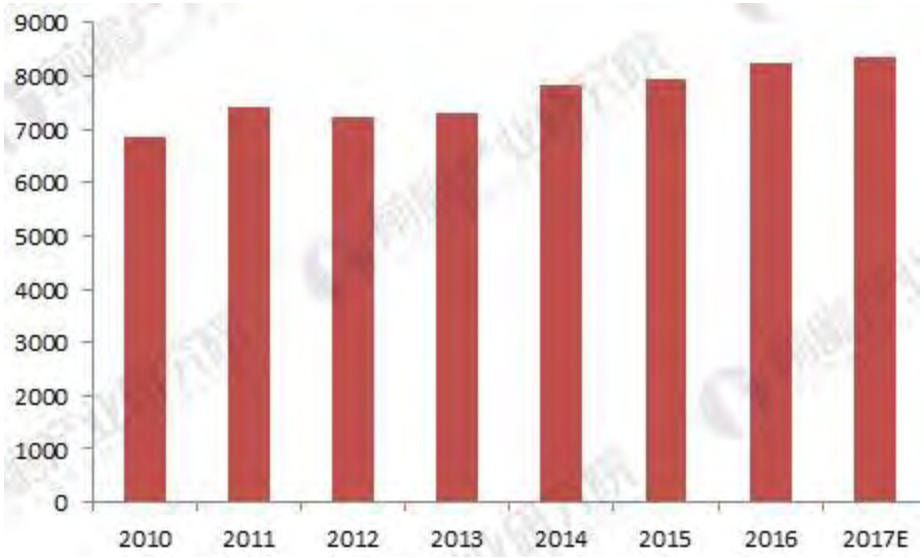
China's infrastructure financing model

- Tax reform in 1994
- Housing market reform: 1998
- Land auction system: 2003



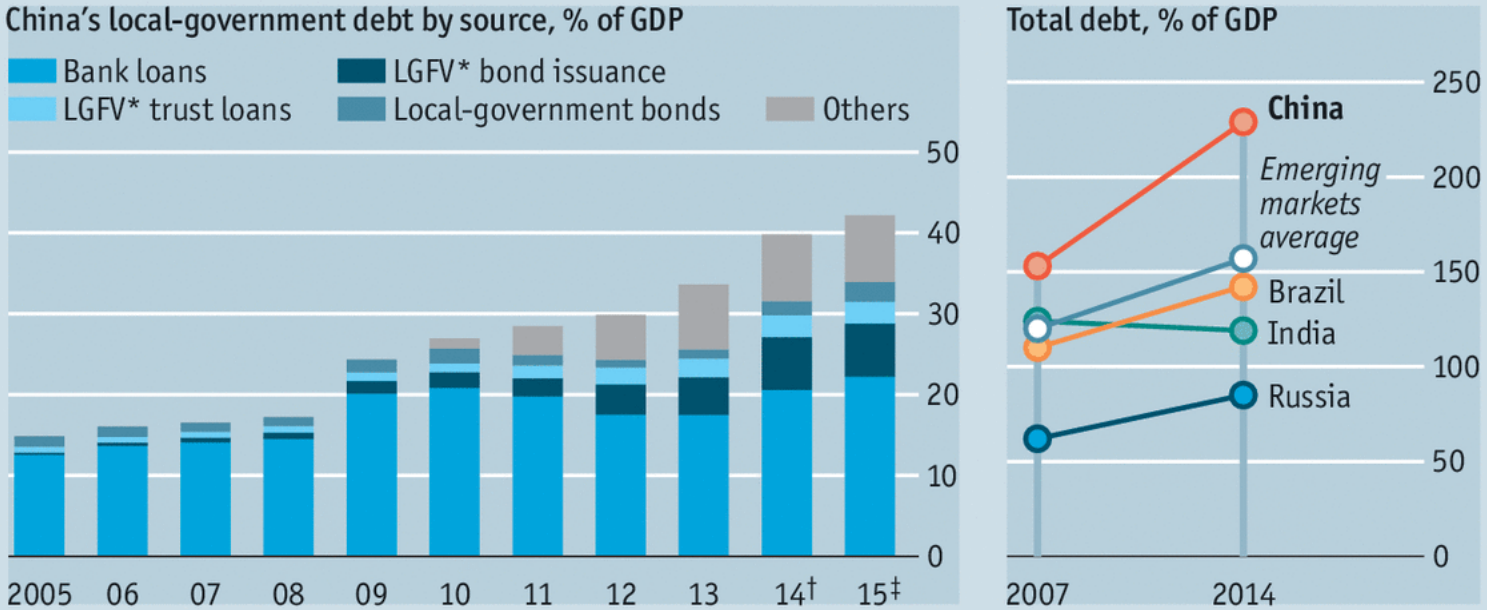
Problems of China's infrastructure financing model

- Enlarging inequality: home ownership, wealth inequality
- Over construction: ghost cities, a vacancy rate of 22.4% in 2013
- Local government debt: as high as 30 trillion yuan to 40 trillion yuan, or about $4.34 trillion to $5.78 trillion (S&P Global Ratings, 2018)



ADBInstitute

Local difficulties

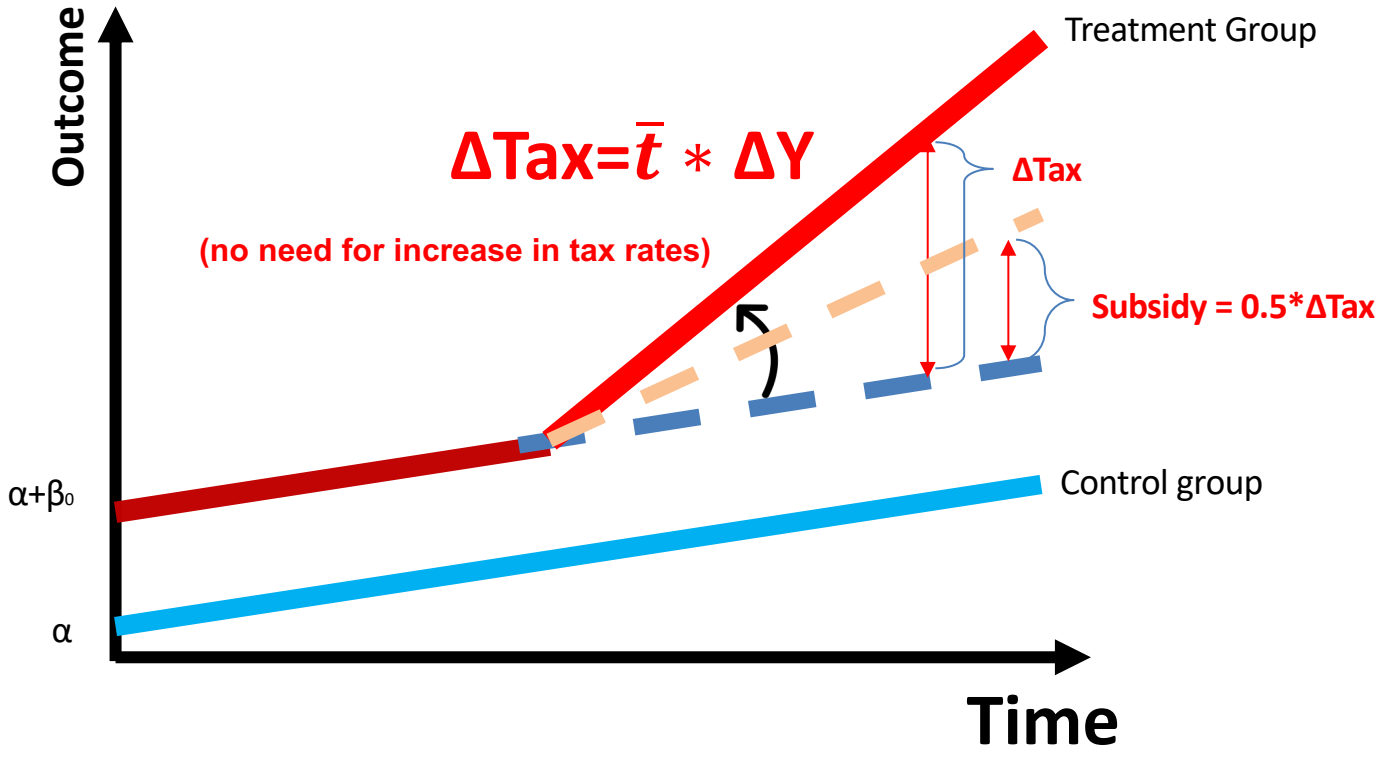


Economist.com

Solutions and future development

- Moving to a revenue system that would ensure a higher portion of local expenditures to be financed by local revenues, such as property taxes and higher charges for urban services.
- Property tax
  - In the short term: crash the housing market, destroy the value of land collateral
  - New directions
    - Law on property tax is under discussion
    - Local governments will decide the timing, rate, range, etc
    - Property tax will be implemented gradually
- Use municipal bond to replace bank loan
- Encourage private investment by internalize the spillover effects of infrastructure

Concept of additional flow of tax revenue due to infrastructure



$$Outcome = \alpha + \beta_0 D_i + \sum_{t=1}^{N} \beta_0 * D_i * T_t + \varepsilon_{i,t}$$

3. Assessing Economic Impacts of Expressway in Northwestern China

Importance of transportation for development

- Poor transport infrastructure is considered a major obstacle hindering the economic growth
- Roads and other transport utilities reduce transportation costs of both goods and people, facilitate trade flow among regions, leading to better integration and higher well-being of an economy
- Many early studies find a positive relation between economic growth and transport infrastructure stock (Antle, 1983; Aschauer, 1989; Binswanger et al, 1987; Binswanger et al., 1989, Easterly and Rebelo, 1993; Baffes and Shah, 1998; Rubin, 1991; Morrison and Schwartz, 1996; Cohen and Morrison Paul, 2004; Mamuneas and Nadiri, 1996).

Inferring the economic impacts of transportation

- Most of the existing studies specify an aggregated production function and include road stock as an input to estimate its contribution to the output growth. (Yoshino-Nakahigashi (2004,2016)
  - Reverse causality problem. On the one hand, better transport infrastructure may facilitate economic growth. On the other hand, better economy also demands more transport infrastructure.
- More recent studies use detailed geographic data of transport infrastructure and micro-level data to identify the channels through which the transport infrastructure affect regional economic growth, employment (Michaels, 2008); on household income(Chandar and Thompson, 2000; Burgess et al., 2012; Donaldson and Hornbeck, 2016); on trade flows (Bougheas et al., 1999; Baier and Bergstrand, 2001; Clark et al., 2004; Hummels and Skiba, 2004; Feyrer, 2009; Storeygard， 2016; Duranton et.al., 2014; Donaldson, 2018); on reginal development (Banerjee et.al., 2012; Faber,2014); on urbanization (Duranton and Turner,2012; Baum-Snow, 2007; Baum-Snow, 2012; Garcia-Lopez et.al., 2013; Baum-Snow et al., 2015)
- Researches on how transport affects development in rural and remote area are still rare.

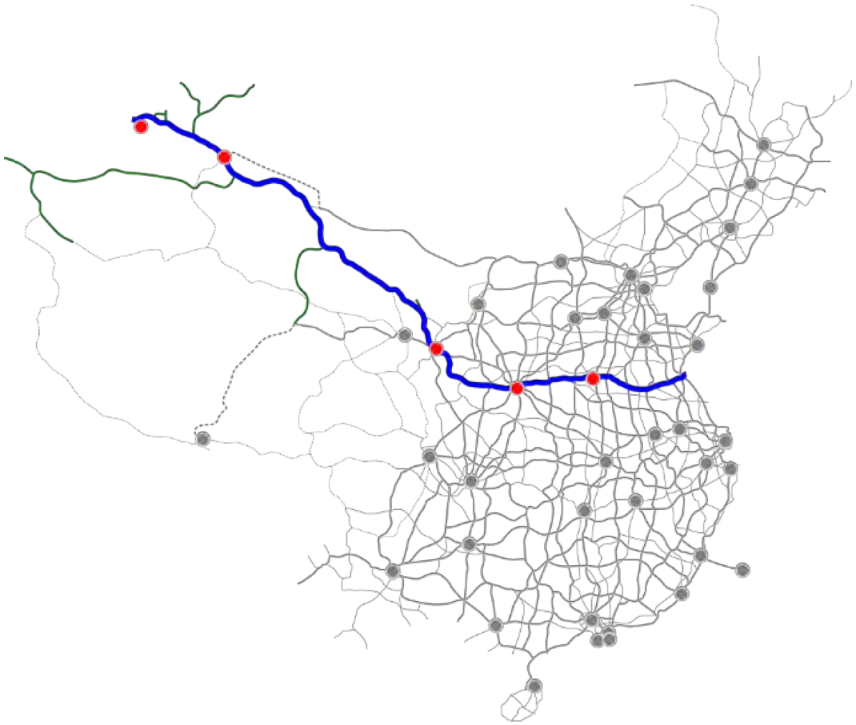
ADBInstitute

Focus of this study

- **G30 Lianyungang–Khorgas Expressway**

  - The longest contiguous highway with a length of 4,243 kilometer stretching across China
  - Connecting the cities of Lianyungang, in the province of Jiangsu, and Khorgas, on the border with Kazakhstan
  - Part of the Asian Highway Network
  - Going through Jiangsu, Anhui, Henan, Shaanxi, Gansu, and Xinjiang provinces.


ASIA
MIDDLE EAST
RUSSIA
SIBERIA
KAZAKHSTAN
MONGOLIA
CHINA
INDIA
SRI LANKA
MALDIVES
PHILIPPINES
INDONESIA
Asian Highway Network
as of November 2003
numbered highway
proposed highway
ferry
Scale 1:48,000,000
Azimuthal Equal-Area Projection
Indian Ocean
AUSTRALIA



Our focus


Habahe
Altay
Jeminay
Emin
Fuhai
Fuyun
Yumin
Toli
Karamay
Wenquan
Jinghe
Usu
Manas
Fukang
Qitai
Barkol Kazakh
Hubcheng
Nilka
Qapqal Xibe
Urumqi Xian
Yiwu
Zhaosu
Hejing
Toksun
Shanshan
Hami
Baicheng
Kuqa
Korla
Bohu
Subei Mongol
Ejin
Wensu
Toksu
Xinjiang Uygur
Akqi
Kalpin
Aksu
Shayar
Anxi
Dunhuang
Yumen
Jinta
Nei Mongol
Artux
Wuqia
Jiashi
Bachu
Aksai Kazakh
Gaotai
Ruoqiang
Sunan Yugur
Minqin
Akto
Makit
Zepu
Moyu
Qiemo
Qilian
Shandan
Lenghu
Delingha
Gangca
Wuwei
Taxkorgan Tajik
Pishan
Qira
Minfeng
Golmud
Gonghe
Khotan
Qinghai
Guide
Xinghai
Zêkog
Zhidoi
Qumarleb
Madoi
Maqên
Rutog
Raingoin
Golmud
Gadê
Magu
Gêrzê
Xizang
Chindu
Zoigê
Zadoi
Sêrxu
Yushu
Baima
Aba
Songpan
Amdo
Ge'gyai
Zanda
Gar
Baqên
Nangqên
Dêgê
Sêrtar
Barkam

Our focus

- With a length of around 3000 km, it directly passes through 23 relatively underdeveloped counties in Gansu Province and Xinjiang Uigur Autonomous Region
- Construction period: 2001-2011
- The line between Korla and Kuqa was funded by ADB loan

G30 in Gansu

G30 in Xinjiang

DID analysis

$$y_{it} = \beta_0 + \beta_1 Treat_i + \beta_2 Treat_i \times After_t + \beta_3 Z_i + \theta_i + \mu_t + \varepsilon_{it}$$

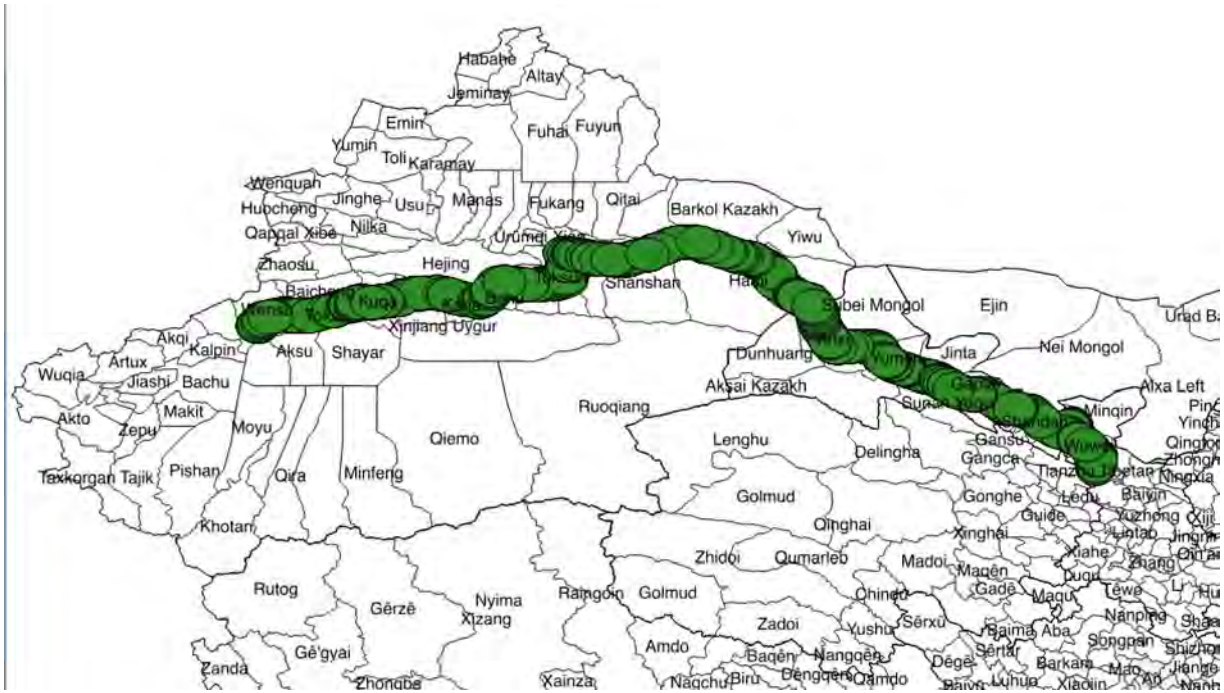
- y_{it}: outcome variables, including regional GDP and local government revenue
- $Treat_i$: the counties where its shortest distance to Lianhuo expressway is within 10km or 50 km
- Control: the counties between 50km and 200km buffer of the highway
- $After_t$: the year when the expressway goes through county i
- Z_i: county-level control variables
- θ_i: county-level fixed effects
- μ_t: time effects

Name	Under Construction	Begin Operation
Akesu City	2010-2011	2012
Wensu County	2010-2011	2012
Xinhe County	2010-2011	2012
Kuche County	2007-2010	2011
Luntai County	2007-2010	2011
Korla City	2003-2006	2007
Yanqi Hui Autonomous County	2003-2005	2006
Bohu County	2003-2005	2006
Heshuo County	2003-2005	2006
Tuokexun County	2000-2001	2002
Turpan City	2000-2001	2002
Shanshan County	2000-2001	2002
Hami City	2003-2004	2005
Guazhou County	2003-2004	2005
Yumen City	2003-2004	2005
Suzhou District	2003-2004	2005
Gaotai County	2003-2004	2005
Linze County	2003-2004	2005
Ganzhou District	2003-2004	2005
Shandan County	2001-2002	2003
Yongchang County	2001-2002	2003
Liangzhou District	2001-2002	2003
Gulang County	2001-2002	2003

10 km buffer


Habahe
Altay
Jeminay
Emin
Fuhai
Fuyun
Yumin
Toli
Karamay
Wenquan
Hoocheng
Jinghe
Usu
Manas
Fukang
Qitai
Barkol Kazakh
Qapqal Xibe
Nilka
Urumqi Xian
Yiwu
Zhaosu
Hejing
Shanshan
Hami
Baicheng
Subei Mongol
Ejin
Xinjiang Uygur
Akqi
Kalpin
Aksu
Shayar
Dunhuang
Jinta
Nei Mongol
Wuqia
Artux
Jiashi
Bachu
Aksai Kazakh
Ruoqiang
Akto
Makit
Zepu
Moyu
Qiemo
Lenghu
Delingha
Gansu
Taxkorgan Tajik
Pishan
Qira
Minfeng
Golmud
Gonghe
Khotan
Qinghai
Xinghai
Zhidoi
Qumarleb
Madoi
Rutog
Gêrzê
Nyima
Xizang
Rangoin
Golmud
Chindu
Zadoi
Yushu
Sêrxu
Amdo
Gê'gyai
Zanda
Zhongba
Xainza
Nagchu
Biru
Baqên
Nangqên
Dêngqên
Qamdo
Dêgê
Sêrtar
Baima
Aba
Barkam
Songpan
Luhuo
Xiaojin
Minqin
Alxa Left
Urad

50 km buffer


Habahe
Altay
Jeminay
Emin
Fuhai
Fuyun
Yumin
Toli
Karamay
Wenquan
Huocheng
Jinghe
Usu
Manas
Fukang
Qitai
Barkol Kazakh
Qapqal Xibe
Nilka
Yiwu
Zhaosu
Hejing
Shanshan
Hami
Ejin
Xinjiang Uygur
Akqi
Kalpin
Aksu
Shayar
Dunhuang
Jinta
Nei Mongol
Wuqia
Artux
Jiashi
Bachu
Aksai Kazakh
Alxa Left
Ruoqiang
Minqin
Akto
Makit
Zepu
Moyu
Qiemo
Lenghu
Delingha
Gansu
Gangca
Taxkorgan Tajik
Pishan
Qira
Minfeng
Golmud
Gonghe
Ledu
Baiyin
Guide
Yuzhong
Qinghai
Xinghai
Khotan
Zhidoi
Qumarleb
Madoi
Maqên
Xiahe
Gadê
Maqu
Rutog
Gêrzê
Nyima
Rangkon
Golmud
Chined
Nanping
Xizang
Zadoi
Yushu
Sêrxu
Haima
Aba
Songpan
Amdo
Baqên
Nangqên
Sêrtar
Dêge
Barkam
Gê'gyai
Zanda
Xainza
Naqchu
Biru
Dengqên
Qamdo
Luhuo
Xiaojin

Data

Data source: China Country Yearbook, China data online, 1996-2014

Variable	Definition	Unit	Obs	Mean	Std. Dev.	Min	Max
lgrev	local govn't reveune	100 mn yuan	1,158	1.67367	3.508478	0.01	36.35
lgexp	local govn't expend	100 mn yuan	1,158	5.491287	7.15278	0.19	54.59
gdp	regional GDP	100 mn yuan	1,120	28.03816	55.36935	0.5	728.26
ten	counties within 10km buffer	# of counties	1,159	0.47541	0.499611	0	1
fifty	counties within 50km buffer	# of counties	1,159	0.655738	0.475332	0	1
pop	population	10,000 persons	1,156	18.70354	16.56856	0.77	102.84
employed	number of employees	10,000 persons	801	1.677203	1.941546	0	26.9
vaosi	value added of primary industry	100 mn yuan	1,159	13.14058	40.05808	0.03	574.84
vaopi	value added of secondary industry	100 mn yuan	1,159	5.996747	6.319489	0.08	53.85
olfin	Outstanding loan	100 mn yuan	1,098	17.70587	37.11011	0	357.37
numlie	number of industrial enterprises (above size)	# of firms	888	17.375	18.14212	0	147
outplie	output of industrial enterprises (above size)	100 mn yuan	1,131	21.66809	59.1496	0	696.31

Empirical Result 1: 10 km buffer

	lgrev	gdp	vaosi	vaopi	olfin	numlie	outplie
treated (10km)	3.253	-32.447***	162.606***	21.451***	-9.93	24.923***	203.647***
	(1.235)	(-2.687)	(3.763)	(6.919)	(-1.609)	(2.982)	(3.651)
treated (10km) * after	0.895**	24.170***	16.716***	2.394***	10.638***	2.759**	28.829***
	(2.237)	(5.183)	(4.433)	(6.572)	(4.305)	(2.006)	(4.921)
lnpop	0.823	12.381	17.373*	-1.819**	-0.158	1.924	9.264
	(1.141)	(1.005)	(1.664)	(-2.154)	(-0.028)	(0.886)	(0.707)
lnemployed	0.633**	-1.642	-2.162	-0.113	4.994*	3.706***	4.341
	(2.187)	(-0.300)	(-0.472)	(-0.271)	(1.895)	(3.069)	(0.706)
_cons	-0.133	36.308***	-8.617	1.138***	30.910***	147.274***	-2.59
	(-0.387)	-3.479	(-1.578)	-2.63	-4.773	-139.607	(-0.390)
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	656	649	656	656	655	625	631
adj. R-sq	0.614	0.76	0.732	0.85	0.749	0.824	0.697

t statistics in parentheses
* p<0.1, ** p<0.05, *** p<0.01

Empirical Result 2: 10 km buffer – control for govn't expenditure

	lgrev	gdp	vaosi	vaopi	olfin	numlie	outplie
lgexp	0.511***	5.732***	3.859***	0.496***	3.338***	0.540**	6.955***
	(7.672)	(5.426)	(4.252)	(7.955)	(6.807)	(1.968)	(6.137)
treated (10km)	-2.084***	-38.941***	-31.952***	0.301	-9.558	42.805***	-39.815***
	(-4.169)	(-3.782)	(-3.541)	(0.387)	(-0.448)	(3.571)	(-3.450)
treated (10km) * after	0.414*	19.119***	13.087***	1.927***	7.499***	2.257*	22.497***
	(1.867)	(5.538)	(4.555)	(6.204)	(3.724)	(1.719)	(5.493)
lnpop	2.157***	26.912**	27.443***	-0.525	8.553*	3.547	28.252**
	(4.617)	(2.385)	(2.684)	(-0.878)	(1.951)	(1.613)	(2.220)
lnemployed	0.081	-7.625	-6.323	-0.648*	1.395	3.082**	-3.277
	-0.479	(-1.548)	(-1.457)	(-1.779)	-0.626	-2.475	(-0.620)
_cons	-1.063***	-54.014***	-15.638***	0	-21.770***	146.179***	-15.671**
	(-4.523)	(-2.587)	(-2.758)	-0.718	(-2.755)	-128.116	(-2.316)
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	656	649	656	656	655	625	631
adj. R-sq	0.811	0.836	0.793	0.899	0.837	0.829	0.791

t statistics in parentheses
* p<0.1, ** p<0.05, *** p<0.01

Empirical Result 3: 10 km buffer DDD analysis

	lgrev	lgrev
treated (10km)	-0.445	-1.469**
	(-0.878)	(-2.325)
treated (10km) * after	-0.225	-1.040*
	(-0.583)	(-1.930)
L.olfin	0.054***	
	(3.782)	
treated (10km) * after *L.olfin	0.029***	
	(2.843)	
lnpop	0.518	0.019
	(1.170)	(0.038)
lnemployed	0	1.141***
	(1.403)	(2.922)
L.numlie		0.064***
		(4.286)
treated (10km) * after *L.olfin		0.062***
		(2.823)
_cons	2.045***	0.435
	-3.832	-1.007
Year	Yes	Yes
N	654	577
adj. R-sq	0.719	0.724

t statistics in parentheses

* p<0.1, ** p<0.05, *** p<0.01

ADBInstitute

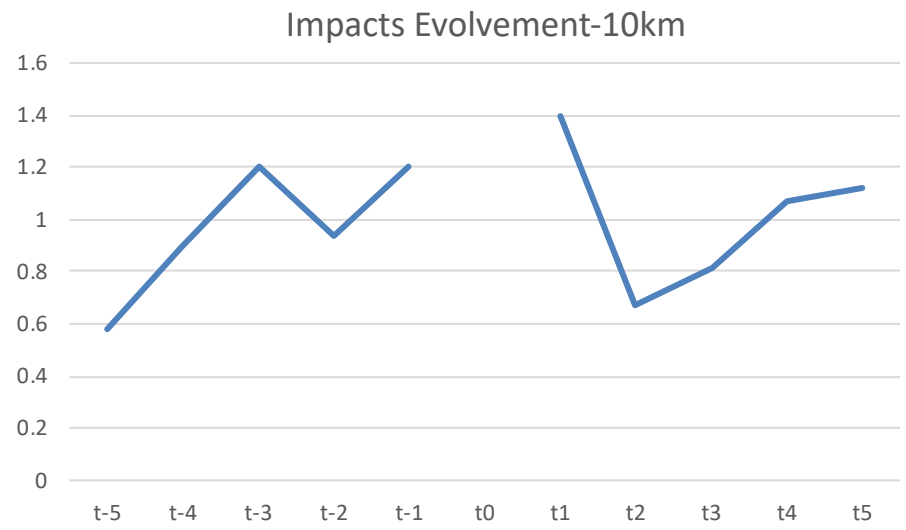
Empirical Result 4: 50 km buffer

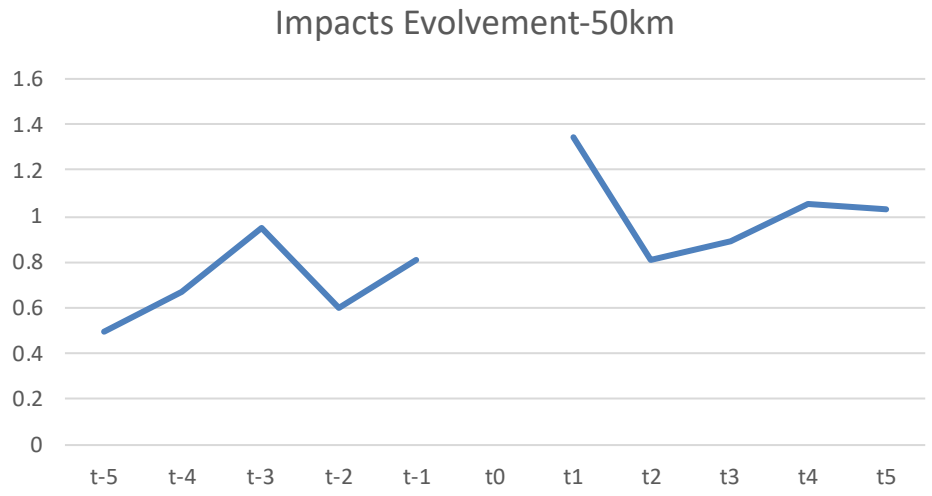
	lgrev	gdp	vaosi	vaopi	olfin	numlie	outplie
treated (50km)	-1.272	-11.277	-11.288	0.758	-4.011	4.203	25.398
	(-1.446)	(-1.011)	(-1.210)	-0.695	(-0.253)	-1.554	-0.892
treated (50km) * after	0.591*	18.146***	12.270***	1.912***	7.665***	3.425***	20.517***
	(1.839)	(5.031)	(4.214)	(6.283)	(3.891)	(3.024)	(4.450)
lnpop	1.094	12.614	17.339*	-1.806**	0	0.895	9.88
	(1.472)	(1.018)	(1.657)	(-2.151)	(-0.000)	(0.434)	(0.742)
lnemployed	0.624***	0.029	-0.863	-0.185	4.606**	3.010***	4.801
	(2.606)	(0.007)	(-0.234)	(-0.464)	(2.172)	(2.847)	(0.966)
_cons	-0.05	-51.058	-8.788	0.835	23.846	108.853***	-38.202
	(-0.095)	(-1.580)	(-1.326)	-0.914	-1.089	-4.675	(-0.923)
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	800	792	800	800	798	768	775
adj. R-sq	0.612	0.758	0.728	0.85	0.745	0.812	0.686

Empirical Result 5: 50 km buffer DDD analysis

	lgrev	lgrev
treated (50km)	-0.359	-0.402
	(-0.573)	(-0.382)
treated (50km) * after	-0.289	-0.994**
	(-0.977)	(-2.502)
treated (50km) * after *L.olfin	0.029***	
	(2.932)	
L.olfin	0.054***	
	(3.811)	
lnpop	0.783*	0.357
	(1.662)	(0.693)
lnemployed	0	1.083***
	(1.642)	(3.156)
L.numlie		0.055***
		(4.215)
treated (50km) * after *L.numlie		0.060***
		(3.090)
_cons	(0.472)	-0.187
	(-0.721)	(-0.138)
Year	Yes	Yes
N	797	710
adj. R-sq	0.718	0.716

How do the infrastructure impacts change over time?





Conclusion

- Using county level data and multiple-period DID analysis, we study the economic impacts of G30 Lianhuo expressway passing through Gansu and Xinjiang provinces

- We find that the expressway significantly enhance the GDP, local government revenue, value added of both primary and secondary industries, bank loan, number and output of industrial enterprises.

- The impact is more outstanding in counties having higher level of financial development and industrial bases.

Thank you very much!