China's Transport Infrastructure Investment: Past, Present, and Future

Yu Qin[1]
National University of Singapore

Abstract

China has been heavily investing in transportation infrastructure since the 1990s. Consequently, connectivity has been significantly improved, both within China and between China and other countries. Such large-scale investments have been made possible by various financing mechanisms from the central government, local governments and the private sector. Research findings generally indicate that these infrastructure investments bring economic prosperity to the country, affect the distribution of economic activities, reduce poverty to a certain extent, and promote economic integration. The future trends of connectivity changes in China and relevant policy recommendations are also discussed in this paper.

Keywords: China; connectivity; infrastructure investment; financing; impact evaluation

JEL codes: O18; R42; R48

[1] Correspondence: Yu Qin, Department of Real Estate, School of Design and Environment, National University of Singapore, SDE1-5-26, 4 Architecture Drive, Singapore 117566. Tel: 65-65163556. Email: rstqyu@nus.edu.sg

1. Introduction

Connectivity has significantly improved in China, especially in the past two decades, which was made possible by large-scale infrastructure investment. Since the mid-1990s, infrastructure investment has been regarded as a major policy priority by the Chinese central government and has been emphasized throughout the successive Five-Year Plans. On the one hand, infrastructure investment is necessary to support China's rapid economic growth, which has generated an increasing demand for infrastructure. On the other hand, infrastructure development is needed to combat worsening regional inequality by bridging the gap in infrastructure provision between inland provinces and coastal provinces (Démurger, 2014).

In Section 2, I present some stylized facts about connectivity improvements via various modalities. Section 3 discusses the ways in which infrastructure investments were financed with a special focus on the role of the private sector in infrastructure financing. Section 4 summarizes existing research on the impact of infrastructure expansion in China. Section 5 discusses the future trends of connectivity changes. Section 6 presents some conclusions and policy suggestions.

2. Connectivity Changes in China via Various Modalities

China has witnessed significant improvements in connectivity in the past 20 to 30 years, which were made possible by large-scale infrastructure investment. Infrastructure investment has been emphasized in all of the "Five-Year Plans." This section summarizes the facts surrounding connectivity changes via various modalities, including land transport (roads and railroads), air transport and maritime transport.

2.1 Connectivity Changes in Land Transport

2.1.1 Roads and Expressways

Road mileage in China reached 4,463,900 kilometers by the end of 2014, 4.8 times the road mileage three decades ago. Among the different types of roads, China's expressway system has been expanding quickly since 1990. Nationwide, the total mileage increased from 400 kilometers in 1990 to approximately 111,900 kilometers in 2014. The well-connected expressway network was made possible by the National Trunk Highway Development Program initiated under the Government's Ninth Five-Year Plan (1996–2000). Its stated objectives were to connect all provincial capitals and cities with an urban registered population of greater than 500,000 on a single expressway network and to construct routes between targeted centers and the border in border provinces as part of the Asian Highway Network (Faber, 2014). According to the original plan, the network was to be completed by year 2020, but it was actually completed in 2007. One reason for the early completion was that the highway construction became part of the stimulus package to cope with the Asian Financial Crisis (Duncan, 2007a).

Connectivity changes in road transportation differ by region. Road mileages in the eastern

provinces tripled between 1997 and 2013, while road length almost quadrupled in the central and western provinces during the same period.[1] Regional growth differences are even more pronounced in terms of the length of expressways. Expressway mileages increased from 3,163 to 36,102 kilometers (an 11.4-fold increase) between 1997 and 2013. In comparison, the expressway length in the western provinces increased from 358 to 33,843 kilometers (a 94.5-fold increase); this growth can likely be attributed to China's Western Development Program, which was initiated in the late 1990s.

2.1.2 Railroads, High-Speed Rail and Urban Rail Transit

China's national railroad network has been in good shape since the early 1990s. The total railroad mileage roughly doubled between 1990 and 2013, increasing from 57,600 kilometers to 103,100 kilometers; the railroad network did not grow as quickly as the road sector. However, 20 years ago, China's railways were not as modernized as those in developed countries. The average travel speed of passenger trains was only 48.3 kilometers per hour. Twenty-five percent of the locomotives were still steam engines in 1997 (Duncan, 2007b).

From 1997 to 2007, China's Ministry of Railways performed several rounds of speed acceleration on existing railway lines. The project had two stages. In the first stage, train speed was increased gradually in the first four waves, namely, in 1997, 1998, 2000 and 2001. In 1997, the first round of speed acceleration was initiated on three main railway lines connecting Beijing to Shanghai, Guangzhou, and Haerbin. The average speed of passenger trains increased from approximately 48.1 kilometers per hour to 54.9 kilometers per hour. Subsequently in 1998, 2000 and 2001, another three waves of speed acceleration were implemented on the main railway lines, increasing the average train speed nationwide to 61.6 kilometer per hour by the end of 2001. In the second stage, speed acceleration sought to upgrade the existing railways to high-speed rail, with sustained speeds of greater than 200 kilometers per hour. In 2004, approximately 1,960 kilometers of railroad had been upgraded to high-speed rail, with 19 pairs of city-to-city nonstop passenger trains in operation. In 2007, the upgraded high-speed rail was expanded to approximately 6,000 kilometers with 257 pairs of China Railway High-speed (CRH) trains operating on a daily basis, which significantly shortened the commuting time between large cities.

In addition to upgrading existing railroads, investments in railroad network expansion have also been made over the past decade. In 2004, the Mid-to-Long Term Railroad Network Plan was announced by the State Council. The target was to expand China's railroad mileage to 100,000 kilometers by 2020. However, the goal was then increased to 120,000 kilometers in a revised version announced in 2008. Specific plans of the expansion include the following: 1) the construction of four vertical and four horizontal inter-city passenger lines, which will add more than 16,000 kilometers, and 2) a further expansion of the railroad network in the western provinces, which may add approximately 41,000 kilometers. Indeed, by 2013, China had already reached the goal set in 2004. In

addition to mileage, the target for 2020 also includes an upgrade of technology and equipment. For example, double-track railways and electrified railways should account for more than 50% and 60% of the total mileage, respectively.

The rapid development of high-speed rail in China is probably the flagship infrastructure investment of the past decade. High-speed rail is defined as railways that can sustain train speeds of no less than 200 km per hour. The Ministry of Railways' Mid-to-Long Term Railway Network Plan, announced in 2004 and then revised in 2008, called for the building of a national high-speed rail grid composed of four north-south corridors and four east-west corridors, which, together with the upgraded existing lines (in 2004 and 2007), would be a total of 12,000 km (7,456 miles) in length.

By the end of 2013, provincial capitals in the eastern region have almost been connected by the high-speed rail in operation. The high-speed rail connecting cities in central and western provinces have been either in operation or under construction. The ultimate target of the high-speed rail network is to connect any two provincial capitals in less than eight hours (except Lhasa and Urumuqi, which are extremely far away from the inland areas).[2]

Urban rail transit systems have also been constructed and completed in many Chinese cities in the past decade. Mmetro systems were only available in Beijing, Shanghai, Guangzhou and Tianjin in the 1990s, but have expanded to another 18 cities during 2000-2014. Another 18 cities are expected to have urban rail transit systems in operation before 2020.

2.2 Connectivity Changes in Air Transport

Connectivity by air transport has been significantly improved over the past ten years. The number of airports has increased from 135 in 2005 to 202 in 2014. The number of domestic and international routes has more than doubled during the same period. Since 2014, Beijing Capital International Airport has been ranked as the second busiest airport in the world, with 86,130,396 passengers travelling through the airport annually. Airports in Guangzhou, Shanghai (both Pudong and Hongqiao), Chengdu and Shenzhen are also among the world's top 50 busiest airports.

Air transport is crucial for the distribution of high-value weight products. Airfreight only accounts for 0.5% of the tonnage of global trade with the rest of the world, but in terms of value, airfreight constitutes approximately 34.6% of the total freight. Measured in terms of tonnage carried to and from China, nearly half of all trade is linked with the rest of the Asia Pacific region, with a further 38% destined for Europe. The North American region accounts for 11% of all airfreight, and the Middle East and Africa accounts for the remaining 3%. Shippers pay airlines RMB 210 billion annually to carry 11 million tons of freight to, from and across China. The benefit to shippers, in excess of this expenditure, is estimated as RMB 88 billion. Based on the share of exports in total merchandise trade, Chinese shippers receive over half of this benefit (RMB 46 billion) (Oxford Economics,

2011).

2.3 Connectivity Changes in Maritime Transport

China has rapidly developed its maritime transport. Among the top 10 world container ports, seven are located in China, including Shanghai, Shenzhen, Hong Kong, Ningbo-zhoushan, Qingdao, Guangzhou and Tianjin. The major ports are located around China's three key manufacturing hubs: the Pearl River Delta around Guangdong, the Yangtze River Delta around Shanghai, and the Bohai Rim around Beijing/Tianjin. The 12th Five-Year Plan has also highlighted China's need for better inland transport systems and provided for a number of inland waterway expansions. Channel extensions in the Yangtze estuary, increasing the capacity of Xijiang River trunk, and the Beijing-Hangzhou canal improvement project are all slated for completion by 2015 (KPMG, 2013).

2.4 Modal shift

Road transport has undoubtedly been the dominant mode of intercity passenger traffic over the past few decades. Up until 2012, more than 90% of passenger travel was made via roads and expressways. However, as is indicated in Figure 1, that number declined to 87.3% in 2013 and further declined by 1% in 2014. Instead, the share of passengers travelling by railway doubled from 2012–2013 (from 4.98% to 9.92%) and further increased in 2014. The modal shift between railway and road transport is very likely to be attributed to the introduction of high-speed rail, which is more time-efficient than road transport. With the further expansion of the high-speed rail network, it is likely that high-speed rail will increase its share in passenger traffic, which puts competitive pressure on other sectors, such as the airline and road transport industries. For example, Fu et al. (2012) suggest that the high speed rail service will be competitive in terms of network connectivity, total travel time and cost efficiency, which may pose a threat to the airline industry, especially in city pairs of short to medium distance. Road transport also plays a dominant role in terms of the total weight shipped (Figure 2). In addition, the share of goods (measured in weight) shipped via road transport has increased over the past decade. By contrast, the share of goods shipped by freight rail has decreased over the same period.

【Figure 1 here】

【Figure 2 here】

With the rapid development of the urban rail transit system in Chinese cities, it is expected that more passengers in these cities would like to shift from travelling by car or taxi to public transit, such as buses and metros. However, it seems that the willingness to take public transit is still relatively low in cities like Beijing (Marukawa, 2016), which weakens the impact of urban rail transit in alleviating congestion and emissions in the road sector. Five cities, namely, Beijing, Shanghai, Guangzhou, Shenzhen and Hangzhou, have implemented policies restricting the issuance of new car plates. Efforts should still be made to encourage more ridership via the public transit system, such as improving the

connections in transfer stations and promoting transit-oriented development (ToD) near transit stations.

3. Financing of Large-Scale Infrastructure Investment

3.1 Traditional Financing Mechanisms

The burden of financing infrastructure investment in China is generally shared between the central government, local governments, and the private sector. However, for different types of infrastructure, the central government's investment share is not the same. For example, the railway financing system is based on the principles of the "government taking the leading role, diversified investment and market oriented". Major financing channels include railway construction funds, treasury bonds and budgeted funds from the central government; contributions from local governments due to the cooperative agreement between the Ministry of Railway and 31 provincial governments; bank loans from home or abroad; and strategic investors, such as power plants, coal mines, ports, and insurance groups, either public or private.[3] The local investment share (including investments by private firms) for railway infrastructure was between 7% and 28% in the period 2001–2009 (Wang et al. 2012).

By contrast, to finance the road network, the central government encouraged province- and county-level governments to raise funds by borrowing against future toll revenues (through various special purpose vehicles because direct borrowing by these levels of government is prohibited) (Duncan, 2007a). Toll rates are approved by provincial pricing bureaus on the recommendations of the provincial communications departments, which vary across provinces and vehicle types.[4] Based on the numbers in 2005, 12% of total spending on road development was funded by central government grants; 42% was funded by domestic and (to a lesser extent) international bank loans; 28% was funded by provincial government sources (including revenues from the annual road maintenance fees charged to vehicle owners); 15% was funded by local government sources; and 4% was funded by the private sector and state owned enterprises (SOEs) (Yang & Lee, 2008).

Starting at the end of 2008, the Chinese central government introduced an economic stimulus package of RMB four trillion (equivalent to $US 586 billion)—about three times the size of the U.S. stimulus package at the time—in an attempt to minimize the impact of the global financial crisis. According to Ping Zhang, chairman of the National Development and Reform Commission (NDRC) at that time, approximately RMB 1.5 trillion would be invested in infrastructure, including roads, railroads, airports and seaports, and approximately RMB 1.18 trillion would come from the central government's budget. The rest would be matched by local governments and social capital.[5] However, the actual investment was estimated to be much more than RMB 1.5 trillion.[6] According to the National Bureau of Statistics, the total investment in infrastructure in 2009 was RMB 6.18 trillion, and that rose to RMB 7.2 trillion in 2010.

As part of the stimulus package, the infrastructure boom plunged many local governments

into debt. According to an official audit by the National Audit Office in early 2011, the total borrowing by the local government investment vehicles (LGIVs), that is, entities set up by local governments for infrastructure development, was RMB 10.7 trillion, which was equivalent to 27% of GDP. (Huang, 2014). The total debt in toll road projects grew from RMB 2.3 trillion in 2010 to RMB 3.8 trillion in 2014, more than 90% of which was associated with expressways.[7]

3.2 Financing through Public–Private Partnerships (PPPs)

There has been an increasing trend of private participation in infrastructure investment in the form of public–private partnerships (PPPs). A PPP is defined as a long-term contract between a private party and a government entity that provides a public asset or service, in which the private party takes on a significant risk and management responsibility and remuneration is linked to performance (World Bank, 2014). PPPs are found in a wide range of investments in transportation infrastructure, including airports, railways and urban mass transit, road systems (rural, urban, and highway), and water transport (ports and inland water systems).

Compared with traditional financing, financing infrastructure via PPPs includes the following benefits, as summarized by the Asian Development Bank (ADB) (2012). First, involving private-sector financing can ease public-sector debt and expenditure burdens. China's local debt has surged since the 2008 financial crisis, as regional governments borrowed to finance infrastructure projects in an effort to stimulate their regional economy, which likely poses a risk to the banking system. Second, private-sector financing via PPPs can act as a catalyst to help domestic financial markets develop. Avoiding the use of public funding reduces the risk of public-sector borrowing crowding out private investment. Third, infrastructure provisions via PPPs may have shorter project cycles due to more specialized, experienced and skilled personnel. In addition, PPPs may bring better service quality and lower service costs because of the competitive managerial skills in the private sector. Lastly, the act of investing in large infrastructure systems, employing people, and buying construction materials can stimulate broader economic activity.

The Chinese Ministry of Finance (MoF) has been increasingly promoting infrastructure investment via PPPs Because of the fiscal constraints that local government face in financing infrastructure investment in recent years,. MoF and NDRC announced a series of regulations and guidelines on PPP in 2014 and 2015.[8] The first bottleneck to PPP development in China, as discussed in Thieriot and Dominguez (2015), is the high degree of uncertainty faced by private entities when joining PPP projects. Among all the risks faced by a PPP project, survey results suggest that government-related ones were predominant, and government intervention topped the list (Ke et al., 2011).

Secondly, improper risk evaluation and allocation may create barriers for the private sector to enter the PPP market. Consistent with the international common practice, the local government bears the legal and policy risks, while the commercial risks (such as

planning, construction, financial, operational and management) are assumed by the private sector.[9] However, the process of risk assessment is complex and requires advanced technical capacity. With many local governments lacking experience in this domain, risks are often improperly evaluated and not efficiently allocated (Thieriot and Dominguez, 2015).

Thirdly, the lack of grounded evaluations of selected projects may lead to failures of PPP investment. Proper project selection is a very important first step in PPP infrastructure development. A PPP project should be selected only if it brings advantages relative to the traditional government construction-and-management model (Thieriot and Dominguez, 2015). To deal with the bottleneck on project evaluation and selection, the MoF announced a guideline on value for money (VFM) analysis for PPP projects in June 2015, which established a standardized practice for PPP project selection.[10]

Lastly, limited guaranteeing capacity of local governments might serve as a bottleneck to PPP infrastructure developments. Guarantees are part of the government's implicit debt in its balance sheet. Therefore, increasing government guarantees causes a further deterioration of the fiscal liabilities of local government. In addition, guarantees may not be used properly in an environment which lacks the proper regulatory mechanisms. For example, local government may overpromise and leave more debt to their successors.

Infrastructure financing via PPP is not a panacea. For example, infrastructure in poor provinces may not be able to attract sufficient private financing due to profitability concerns, which is one problem with infrastructure financing via PPPs. Indeed, there is a positive correlation between total PPP investment in a province and its GDP per capita (as indicated in Figure 3). For example, toll roads connecting urban areas are easier to pitch to investors than rural roads because rural roads often have low traffic density, making revenue collection more difficult. Rural roads may also yield lower financial returns on the investment than toll roads that connect economic centers. However, rural roads can have high social returns because they link people, schools, and health facilities. Accordingly, they may require considerable public subsidies to bring partnerships to fruition, which can complicate their implementation (ADB, 2012).

【Figure 3 here】

In addition, other factors may also contribute to PPP failures, as summarized by the ADB (2012), including political risks, unforeseen economic conditions, low capacity on the part of government agencies or the private sector, an uncertain or unreliable legal system, uncertain access to financing, and a lack of continuous dialogue between the government and the private sector. Overall, due to the public goods feature of infrastructure investment, successful PPP cases require smooth coordination between the public and private sectors.

4. The Impact of Improved Connectivity

What is the impact of China's connectivity change on the overall economy? On the one hand, improvements in transportation infrastructure are likely to boost economic growth. On the other hand, infrastructure expansion may also affect the distribution of economic activities, as this investment is not distributed evenly across regions. In this section, I summarize the existing literature's understanding of the impact of improved connectivity in China.

4.1 The Impact on Economic Growth

A handful of papers examine the impact of transport infrastructure investment in China, and most find a significantly positive impact of infrastructure investment on economic growth. Using a growth model framework, the well-cited work by Démurger (2001) finds that infrastructure investment had a significant impact on the differences observed in growth performances across provinces from 1985–1998. Fan and Zhang (2004) suggest that rural infrastructure, such as road access, significantly impacts on the differences in non-farming rural productivity across regions in China. Oxford Economics (2011) estimates the economic footprint of the aviation sector in China. According to its estimates, aviation has a significant footprint in the Chinese economy, supporting 0.8% of China's GDP and 4.8 million jobs (or 0.6% of the Chinese workforce). Including the sector's contribution to the tourism industry, these figures increase to 1.0% of GDP and 6.0 million jobs (or 0.8% of the workforce). Lin (2014) finds that high-speed rail connectivity increases employment by approximately 7 percentage points. Ouyang and Peng (2015) find that the 2008 stimulus package increased China's annual real GDP growth by approximately 3.2%, though only temporarily. However, they did not separately estimate the impact of the stimulus package devoted to infrastructure investment on economic growth. However, Banerjee et al. (2012) show that proximity to transportation networks has a moderately positive causal effect on per capita GDP levels across sectors, but that it has no effect on per capita GDP growth.

4.2 The Impact on the Distribution of Economic Activities

Infrastructure investment is not distributed evenly across regions. Therefore, the regions or sectors receiving more funding may benefit more than less-affected regions or sectors, which changes the distribution of economic activities within China. Qin (2015) studies the distributional impact of high-speed rail upgrades in China. She finds that counties being bypassed by the railway upgrades experienced a negative impact in terms of GDP and per capita GDP growth, which was largely due to the reduction of fixed-asset investments. Faber (2014) also documents this type of distributional effect in the National Trunk Highway System (NTHS). He finds that peripheral counties connected to the NTHS experienced a reduction in GDP growth after the connection, which was mainly driven by the reduction in industrial output growth. Baum-Snow et al. (2015) provide evidence of the impact of roads and railroads on the decentralization of Chinese cities. According to their estimates, each radial highway displaces approximately 4% of the city center's population to the surrounding regions, and ring roads displace an additional 20%. Each radial railroad reduces the city center's industrial GDP by approximately 20%, with

ring roads displacing an additional 50%.

4.3 The Impact on Poverty Reduction

Several studies have discussed the impact of infrastructure investment on poverty mitigation. Fan and Chan-Kang (2005) find that the GDP return on investment in rural roads was significantly higher than that of an equivalent investment in higher-standard roads. They note that the gross increase in economic activity nationwide is higher with expressways and that the cost effectiveness of expenditures on roads is much higher for local roads because they cost much less. According to their estimates, the impact of local roads on poverty reduction is also much greater than that of expressways. For high-quality roads, every million yuan invested raises 13 individuals living in rural poverty above the official poverty line. Low-quality roads are much more beneficial lifting 161 rural people out of poverty for every million yuan invested. For both high- and low-quality roads, the poverty impacts are greatest in the southwest and northwest regions when the official poverty line is used. Qin and Zhang (2016) study the impact of rural road access on poverty reduction in 17 villages in Guizhou. They find that rural roads significantly reduce poverty headcounts in the affected villages. They discuss two possible mechanisms. First, rural roads are likely to increase the level of agricultural specialization and increase the agricultural income of rural households. Second, rural roads particularly help poor households engage more in the local non-farm sector, thus increasing their non-farm income.

Even though we should acknowledge that the impact of local roads on poverty reduction is significant, poverty reduction cost-effectiveness via rural roads is not a universal solution. Before prioritizing such investments in a localized area, one must carefully establish the underlying causes of the observed poverty and from such understanding determine if and when—and in what context—investing in rural roads (upgrading and/or building new roads) is the best way to proceed (Duncan, 2007c).

4.4 The Impact on Economic Integration

Several papers demonstrate that infrastructure investment, as a way of reducing trade barriers and improving connectivity, produces a more integrated economy. Li et al. (2012) analyze the role of high transport costs as trade barriers among agricultural traders in China. These studies find that transport costs contribute to 42% of trade barriers. In addition, road quality upgrades seem capable of effectively reducing transport costs. According to their estimates, by increasing the transport speed by 1 km per hour, the total transport costs for Chinese agricultural traders would decrease by 0.6%, mainly due to improved fuel-burning efficiency and reduced labor requirements. Li and Li (2013) find that investing in roads reduces firms' inventory costs. According to their estimates, one dollar of road spending saves around two cents in inventory costs. Zheng and Kahn (2013) find that China's high-speed rail stimulates the development of second- and third-tier cities, which facilitates market integration. Bullet trains help protect the quality of life of the growing urban population by offering households and firms a wider array of location

alternatives. In addition, high-speed rail is associated with increasing real estate prices in the nearby second-tier cities.

5. Future Trends of Connectivity Changes in China

5.1 Cross-border Arrangement of Infrastructure

As the world's economy becomes more integrated, China has been arranging cross-border investments in infrastructure to reduce cross-border trade barriers. The total amount of cross-border investments in infrastructure grew from $US 4.51 billion in 2005 to $US 39.5 billion in 2014.

Figure 4 plots the destination continents of China's outward foreign direct investment (FDI) in infrastructure. Countries in Asia receive the largest investment. The three top destination countries in Asia are Indonesia, Russia and Kazakhstan, accounting for 8.5%, 8.1% and 6.7%, respectively, of China's outward FDI infrastructure investment in Asia. China's investment in Africa had increased over the years, but it declined in 2014. By contrast, China's investment in Europe and North America, mostly developed economies, significantly increased in 2014.

【Figure 4 here】

In the end of 2013, President Xi proposed "One Belt, One Road" and announced a $US 40 billion Silk Road fund at the 2014 APEC Summit, which would finance infrastructure projects. Much of that money will fund Chinese-led projects in other countries. "One Belt, One Road" consists of the Silk Road Economic Belt and the 21st-Century Maritime Silk Road (MSR). The Silk Road Economic Belt includes countries situated on the original Silk Road through Central Asia, West Asia, the Middle East, and Europe, while the Maritime Silk Road aims to invest and foster collaboration in Southeast Asia, Oceania, and North Africa through several contiguous bodies of water—the South China Sea, the South Pacific, and the wider Indian Ocean area. In addition, Kenya will form part of the MSR after it improves local ports and constructs a modern standard-gauge rail link between Nairobi and Mombasa. (Figure 5)

【Figure 5 here】

In addition to the Silk Road fund, the "One Belt, One Road" initiative will also be financed by the recently established Asian Infrastructure Investment Bank (AIIB), an international financial institution proposed by China in October 2013. With 57 member countries at present, the AIIB focuses on supporting infrastructure construction in the Asia-Pacific region. The AIIB will complement existing multilateral lenders, such as the Asian Development Bank and the World Bank because it will focus on large-scale infrastructure projects, such as toll roads, power plants, seaports and airports in Asia.

5.2 New Modalities of Infrastructure

5.2.1 The Internet

By the end of 2013, China had approximately 618 million Internet users, almost six times

the number in 2005. The internet penetration rate grew from 8.5% in 2005 to 45.8% in 2013. The increase in the number of internet users is likely due to a few factors. First, the central government has formulated a series of policies to promote the construction of basic network facilities. From 1997 to 2009, a total of RMB 4.3 trillion was invested in such construction, building a nationwide optical communication network with a total length of 8.267 million km. Of that total length, 840,000 km were long-distance optical cables. By the end of 2009, China's basic telecommunications companies had 136 million broadband Internet access ports, and the international outlet bandwidth was 866,367 Mbps, with seven land-submarine cables and 20 land cables that had a combined capacity exceeding 1,600 GB. As such, 99.3% of Chinese towns and 91.5% of Chinese villages had internet access, and 96.0% of the towns had access to broadband.[11] Second, operators and major manufacturers have been actively promoting internet applications, speeding up the penetration of internet applications, such as online payment systems and taxi-calling platforms, into social life, which attracted more people to use internet. In addition, the interaction of traditional media and new media and the popularity of instant communication (such as WeChat) attracted more people to the internet.

5.2.2 E-commerce and Internet Finance

One noted change due to the high penetration rate of the internet is the explosion of e-commerce in China. China recently overtook the U.S. as the largest e-commerce market in the world, and it is set to be valued at $US 541 billion by 2015. Among all the e-commerce players in China, Alibaba is the market share leader of business-to-consumer (B2C) and consumer-to-consumer (C2C) e-commerce. Alibaba operates two platforms. Taobao is a C2C platform similar to eBay that was founded in 2003. Sellers can directly sell new or used goods to consumers at a fixed price or via auction. Taobao mainly derives its profit from advertising fees on the platform, not from commission charges. Alibaba's other platform is Tmall, which was created in 2008 as a B2C platform. Brands create their own virtual stores on Tmall and directly sell to consumers. Tmall earns a commission on each transaction. By the second quarter of 2014, Tmall was the dominant leader in B2C market in China, having a market share of 57.3%, followed by Jingdong (21.2%).

E-commerce in China is a market dominated by mobile devices, with 464 million of its 591 million internet users choosing to go online via smartphone or wireless device.[12] In 2012, mobile transactions totaled $US 7.8 billion, representing 3.7% of all e-commerce transactions in China. However, in 2015, mobile commerce in China is expected to more than quintuple (to $US 41.4 billion), representing 8% of all e-commerce transactions. Fifty-five percent of China's internet users have made a mobile payment compared with only 19% of internet users in the U.S. (KPMG, 2014).

E-commerce is likely to provide more non-farm opportunities to rural residents. Approximately 2 million out of 8 million sellers on Taobao or Tmall are registered in rural areas in China. Village- and township-level e-commerce clusters have been growing quickly in rural areas, especially in the eastern provinces. In the most recent report

published by Aliresearch (2014), the research institute affiliated to Alibaba, there are 211 Taobao villages, with more than 70,000 active sellers, located in 10 provinces (most of them in the coastal provinces).[13]

With the development of internet infrastructure and e-commerce, internet finance has been growing rapidly in recent years in China. For example, the total amount of online peer to peer (P2P) loans increased from 21.2 billion *yuan* in 2012 to 252.8 billion *yuan* in 2014 (Liu, 2015). Another example is Yu'E Bao, which allows customers of Alipay, Alibaba's online payment service, to invest their idle money in Alipay's account in a money market fund (Takeshi, 2014). The market capitalization of Yu'E Bao reached approximately 579 billion *yuan* by the end of 2014.

China's government has been aware of the emergence of internet finance and implemented regulations to control the potential risks in the internet finance sector. The government issued guidelines in June 2015 to call for closer supervision of the internet finance sector, such as clarifying the division of responsibilities among regulatory agencies in supervising the risks in different subsectors of internet finance. However, the guidelines also outlined measures to foster innovations in internet finance, which would be further encouraged by the Government.[14]

6. Conclusion and Policy Suggestions

Significant connectivity changes have been made in various modalities in China since the early 1990s. Such improvements in the infrastructure network were made possible by large-scale financing, predominantly from the central government and local governments, as well as the private sector. Connectivity improvements in China have also proved to have positive effects on economic growth, to redistribute economic activities within the country, to reduce poverty, and to promote a more integrated economy. Looking into the future, connectivity will improve between China and other countries, and newer modalities, such as e-commerce, will gain traction. In this section, I hope to conclude by providing my thoughts on two policy questions regarding China's infrastructure investment in the future.

6.1 Efficiency of China's Infrastructure Investment

China's infrastructure investment boom has triggered debates about the efficiency of such investments. For example, connecting any of the two provincial capitals within eight hours by high-speed rail may lead to inefficient investment since high-speed rail investment is more justifiable in relatively short travel distance (for example, for distances less than 1000 km). In China, cost benefit analysis (CBA) has been undertaken in the feasibility study before the implementation of each infrastructure project. According to the Ministry of Housing and Urban-Rural Development of the People's Republic of China (MOHURD, 2006), CBA of infrastructure projects should refer to "the Method and Parameters in the Economic Analysis of Construction Projects" (version 3), which recommends a discount rate of 8% for infrastructure projects. This is a balance between

the estimated time preference rate (4.5-6%) and the estimated rate of return for social capital (9-11%). However, CBA has primarily served as a bar for project selection. The sequencing and prioritization of infrastructure projects is less subject to CBA, but more driven by local need and incentives.

Shi and Huang (2014) estimate the return on infrastructure investment using province-level data from China. By comparing the investment efficiency of infrastructure investment and private capital, their findings indicate that the large-scale infrastructure investment in China following the 1997 Asian Financial Crisis was efficient, as most Chinese provinces exhibited a clear shortage of infrastructure at that time. However, in 2008, most of the western provinces already exhibited an oversupply of infrastructure relative to private capital because of the "Western Development" plan, whereas some eastern and central provinces still showed a clear shortage of infrastructure.

On the other hand, it is very difficult to estimate the return on infrastructure *ex ante* as extra demand is derived from new infrastructures (Duranton & Turner, 2011) and is dependent on the existing infrastructure network. In addition, due to the public goods feature of infrastructure, the investment efficiency between infrastructure and private capital may not be comparable, as private capital will not be willing to initiate in infrastructure investment.

Thus, there is no definite answer as to whether China has overinvested in infrastructure. However, policymakers should pay closer attention to the utilization rate of the existing infrastructure stocks before making or requesting new investments, especially in the western provinces that potentially have an oversupply of infrastructure.

6.2 Sustainable financing

The success of connectivity improvements is made possible by large-scale infrastructure financing from the central government, local governments and the private sector. However, as the stock of infrastructure increases, the marginal return on infrastructure investments may decline, which attenuates the revenue collected by investors. For example, the financing of expressways heavily relies on borrowing against future toll revenues. As the density of expressways increases, toll revenues from each expressway may decline due to traffic diversion. With an unprecedented expansion of the road network (predominantly the expressway network) after the fiscal stimulus package, toll roads in China have been running a deficit since 2011, with an widening gap between revenue and expenses (from RMB 32.3 billion in 2011 to RMB 157.1 billion in 2014). Consequently, the Ministry of Transport plans to extend the charging period on all highways across the country until the local governments have paid back their debt in full.[15] However, high tolls may not be an appropriate solution to these financing problems, as toll increases have caused important operational problems on toll roads, the most significant of which has been substantial traffic diversion, reducing both the financial and economic rates of return. Indeed, toll rates in China are the highest in the world relative

to average income (Duncan, 2007a). Therefore, a vicious cycle may exist that hinders the sustainability of infrastructure financing.

To relieve the financing burden of central and local governments, policymakers have encouraged the participation of social capital in infrastructure investment in the form of PPPs. However, a prerequisite for private capital entering into the market is a reasonable financial return. Therefore, innovations in private sector participation are needed to attract private capital investments. A successful practice in the provision of urban transit infrastructure is land value capture (LVC), which captures and shares the land value appreciation during the infrastructure development process among various stakeholders, including governments, developers and property owners. There are two main categories of LVC: development-based LVC and tax- or fee-based LVC. Development-based LVC can be facilitated through direct transactions for properties whose values have increased via public regulatory decisions or infrastructure investment. Tax- or fee-based LVC is facilitated through indirect methods, such as extracting surplus from property owners, using various tax or fee instruments (for example, property taxes, betterment charges, and special assessments) (Suzuki et al., 2015).

As China has not implemented a nationwide property tax scheme, the current LVC practices are predominantly development-based. Xue and Fang (2015) summarize the successful LVC practices in the development of urban rail transit in Shenzhen. Specifically, the Shenzhen municipal government sold the land development rights of rail plus properties to the developers at a price lower than the prevailing market price. The municipal government and developers created opportunities for land value appreciation and shared such revenue based on negotiated schemes. LVC has also been applied to expressway projects in the manner of project-related land sales. For example, for major urban highway projects, land surrounding the highway can be transferred to a public-private development corporation. The corporation borrows against the land as collateral, finances highway construction, and then repays the debt and obtains a profit by selling land after its value has been enhanced by highway access. In this way, the municipality is able to realize major infrastructure projects at no out-of-pocket cost (Peterson, 2009). Overall, policymakers can capture the land value appreciation to finance infrastructure and to provide the right incentives to attract the private sector to participate in such investments.

Notes

1 Eastern provinces include Beijing, Tianjin, Hebei, Liaoning, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong and Hainan; central provinces include Shanxi, Jilin, Heilongjiang, Anhui, Jiangxi, Henan, Hubei and Hunan; and western provinces include Inner Mongolia, Guangxi, Chongqing, Sichuan, Guizhou, Yunnan, Tibet, Shaanxi, Gansu, Qinghai, Ningxia and Xinjiang.

2 http://politics.people.com.cn/n/2014/0307/c70731-24558402.html (accessed 4 December 2015)

3 For more discussions, see http://siteresources.worldbank.org/INTSARREGTOPTRANSPORT/6034746-1243944302638/22213053/3_Mar25_Zhang_Jianping_prsntn.pdf. (accessed 4 December 2015)

4 Approximately 98% of expressways, 61% of Level I roads and 42% of Level II roads are toll

roads in the current road system according to MoC.

5 http://lianghui2009.people.com.cn/GB/145749/8918179.html (accessed 4 December 2015)

6 http://www.scmp.com/business/global-economy/article/1063516/experts-warn-latest-china-stimulus-package (accessed 4 December 2015)

7 See the report on toll roads by the Ministry of Communications. http://www.moc.gov.cn/zfxxgk/bnssj/glj/201506/t20150630_1841985.html (accessed 4 December 2015)

8 For further discussion see Thieriot and Dominguez (2015).

9 See http://jrs.mof.gov.cn/ppp/zcjdppp/201410/t20141031_1155361.html (accessed 4 December 2015)

10 See http://hkmb.hktdc.com/en/1X0A2MSE/hktdc-research/China-Announces-PPP-Value-for-Money-Guide-in-June (accessed 4 December 2015)

11 http://china.org.cn/government/whitepaper/2010-06/08/content_20208003.htm (accessed 4 December 2015)

12 See discussions at http://www.the-future-of-commerce.com/2014/03/10/infographic-china-overtakes-u-s-e-commerce-market/. (accessed 4 December 2015)

13 A Taobao village is defined as an administrative village with 1) at least 100 Taobao sellers or at least 10% of the rural households actively involved in Taobao e-commerce; and 2) an annual revenue of more than RMB 10 million.

14 More discussions of the guidelines can be found in http://www.wsj.com/articles/china-looks-to-regulate-internet-finance-1437223179 (accessed 4 December 2015)

15 The new policy was announced on July 22, 2015: http://www.china.org.cn/china/2015-07/22/content_36117314.htm. (accessed 4 December 2015)

Acknowledgements:

I am grateful to Muhamad Chatib Basri, Euston Quah, Hal Hill, Kazumasa Iwata, Takatoshi Ito, Fukunari Kimura, Jong-Wha Lee, Gilberto M. Llanto, Tomoo Marukawa, Colin McKenzie, Jayant Menon, Toshiro Nishizawa, Marcus Noland, Shujiro Urata and the other participants at the Asian Economic Policy Review (AEPR) Conference held in October 2015 for their very helpful comments and suggestions. I thank Lulu Xue (World Resources Institute) and Shuai Ren (World Bank Beijing Office) for their valuable comments and suggestions on this paper, and Siyu Lu for her excellent research assistance. All remaining errors are mine.

References

Aliresearch (2014). China's Taobao village research report 2014. Accessed 15 April 2015. Available from URL: http://i.aliresearch.com/img/20141223/20141223163126.pdf

Asian Development Bank (ADB) (2012). Infrastructure for supporting inclusive growth and poverty reduction in Asia. Accessed 15 April 2015. Available from URL:http://www.adb.org/sites/default/files/publication/29823/infrastructure-supporting-inclusive-growth.pdf

Banerjee A., Duflo E. & Qian N. (2012). On the road: access to transportation infrastructure and economic growth in China, NBER Working Paper no. 17897, National Bureau of Economic Research (NBER), Cambridge MA.

Baum-Snow N., Brandt L., Henderson J.V., Turner M.A. & Zhang Q. (2015). Roads, railroads and decentralization of Chinese cities. Mimeo.

Démurger S. (2001). Infrastructure development and economic growth: an explanation for regional disparities in China?. *Journal of Comparative Economics*, **29** (1), 95-117.

Démurger S. (2014). Infrastructure in China. In: Shenggen F, Ravi K, Shang-Jin W & Xiaobo Z (eds), *The Oxford Companion to the Economics of China*. (pp. 348-352. Oxford: Oxford University Press.

Duranton G. & Turner M.A. (2011). The fundamental law of road congestion: Evidence from US cities. *American Economic Review*, **101**(6), 2616-2652.

Duncan T. (2007a). Retrospective analysis of the road sector 1997–2005. Asian Development Bank Evaluation Document. Manilla: Asian Development Bank.

Duncan T. (2007b). Retrospective analysis of the railroad sector 1997–2005. Asian Development Bank Evaluation Document. Manilla: Asian Development Bank.

Duncan T. (2007c). Findings from studies of poverty impacts of road projects. Asian Development Bank Evaluation Document. Manilla: Asian Development Bank.

Ernst &Young (2015). Riding the silk road: China sees outbound investment boom: outlook for China's outward foreign direct investment. Accessed 15 April 2015. Available from URL: http://www.ey.com/Publication/vwLUAssets/ey-china-outbound-investment-report-en/$FILE/ey-china-outbound-investment-report-en.pdf

Faber B. (2014). Trade integration, market size, and industrialization: Evidence from China's National Trunk Highway System. *Review of Economic Studies*, **81**(3), 1046-1070.

Fan S. & Chan-Kang C. (2005). Road development, economic growth, and poverty reduction in China. IFPRI Research Report 138, Washington, DC: International Food Policy Research Institute (IFPRI).

Fan S. & Zhang X. (2004). Infrastructure and regional economic development in rural China. *China Economic Review*, **15**(2), 203-214.

Fu X., Zhang A. & Lei Z. (2012). Will China's airline industry survive the entry of high-speed rail?. *Research in Transportation Economics*, **35**(1), 13-25.

Huang Y. (2014). Local government debts. In: Shenggen F, Ravi K, Shang-Jin W &

Xiaobo Z (eds), *The Oxford Companion to the Economics of China*. (pp. 207-211). Oxford: Oxford University Press.

Ke Y., Wang S., Chan A.P.C. & Cheung E. (2011). Understanding the risks in China's PPP projects: Ranking of their probability and consequence. *Engineering, Construction and Architectural Management*, **18**(5), 481–496. doi:10.1108/09699981111165176

KPMG (2013). Infrastructure in China: sustaining quality growth. Accessed 15 April 2015. Available from URL: https://www.kpmg.com/CN/en/IssuesAndInsights/ArticlesPublications/documents/Infrastructure-in-China-201302.pdf

KPMG (2014). E-commerce in China: driving a new consumer culture. Accessed 15 April 2015. Available from URL: https://www.kpmg.com/CN/en/IssuesAndInsights/ArticlesPublications/Newsletters/China-360/Documents/China-360-Issue15-201401-E-commerce-in-China.pdf

Li H. & Li L. (2013). Road investments and inventory reduction: Firm level evidence from China. *Journal of Urban Economics*, **76** 43-52.

Li Z., Yu X., Zeng Y. & Holst R. (2012). Estimating transport costs and trade barriers in China: Direct evidence from Chinese agricultural traders. *China Economic Review*, **23**(4), 1003-1010.

Lin Y. (2014). Travel costs and urban specialization: evidence from China's high speed railway. Mimeo.

Liu M. (2015). Internet finance and regulation in China. Fung Global Institute.

Marukawa T. (2016). Comment on "China's transport infrastructure: Past, present and future". *Asian Economic Policy Review*, 11 (2), xxx-xxx.

Ouyang M. & Peng Y. (2015). The treatment-effect estimation: A case study of the 2008 economic stimulus package of China. *Journal of Econometrics*, **188**(2), 545-557.

Oxford Economics (2011). Economic benefits from air transport in China. Accessed 15 April 2015. Available from URL: http://www.iata.org/policy/Documents/Benefits-of-Aviation-China-2011[1].pdf

Peterson G. (2009). Unlocking land values to finance urban infrastructure. Trends and Policy Options Series no. 7, Public-Private Infrastructure Advisory Facility (PPIAF), Washington, D.C.

Qin Y. (2015). No county left behind? The distributional impact of high-speed rail upgrade in China. Mimeo.

Qin Y. & Zhang X. (2016). The road to specialization in agricultural production: Evidence from rural China. *World Development*, **77**, 1-16.

Shi H. & Huang S. (2014). How much infrastructure is too much? A new approach and evidence from China. *World Development*, **56**, 272-286.

Suzuki H., Murakami J., Hong Y.H. & Tamayose B. (2015). Financing transit-oriented development with land values: Adapting land value capture in developing countries. Working Paper no. 92250,World Bank.

Takeshi J. (2014). Internet finance growing rapidly in China. *Iakyara* vol. 189. Nomura Research Institute, Ltd. Accessed 9 February 2016. Available from URL:

https://www.nri.com/~/media/PDF/global/opinion/lakyara/2014/lkr2014189.pdf

Thieriot H. & Dominguez C. (2015). Public-private partnerships in China: On 2014 as a landmark year, with past and future challenges. Discussion Paper. International Institute for Sustainable Development.

Wang J.J., Rong C., Xu J. & Or S.W.O. (2012). The funding of hierarchical railway development in China. *Research in Transportation Economics*, **35**(1), 26-33.

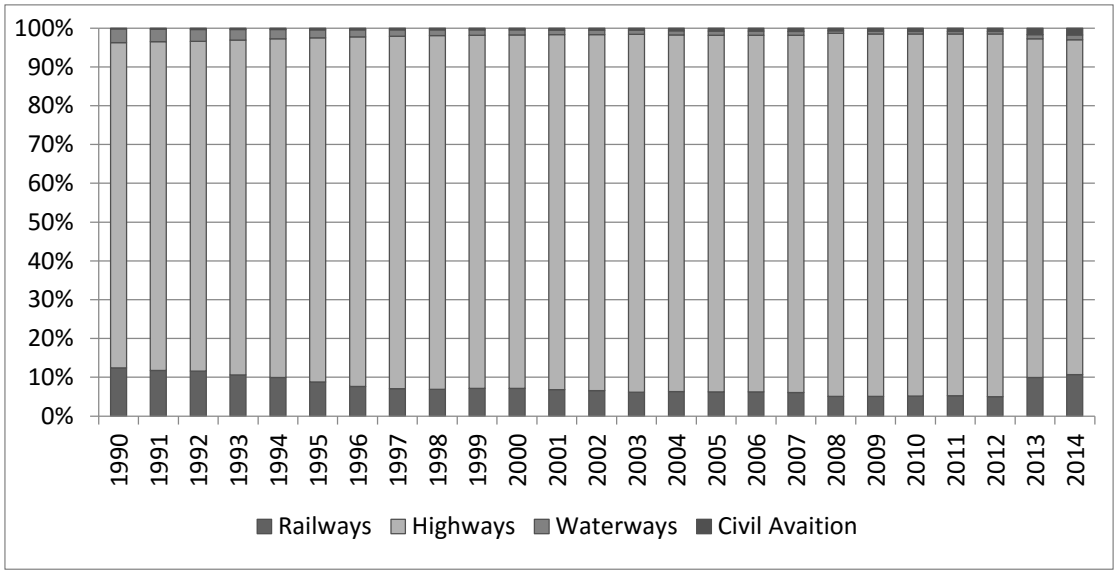
World Bank. (2014). Public-private partnerships：Reference guide version 2.0. Working Paper no. 90384, World Bank and PPIAF.

Xue L. & Fang W. (2015). Rail plus property development in China: The pilot case of Shenzhen. Working Paper. World Resources Institute. (in Chinese)

Yang X. & Lee J. (2008). *People's Republic of China Toll Roads Corporatization Strategy: Toward Better Governance*. Manila: Asian Development Bank.

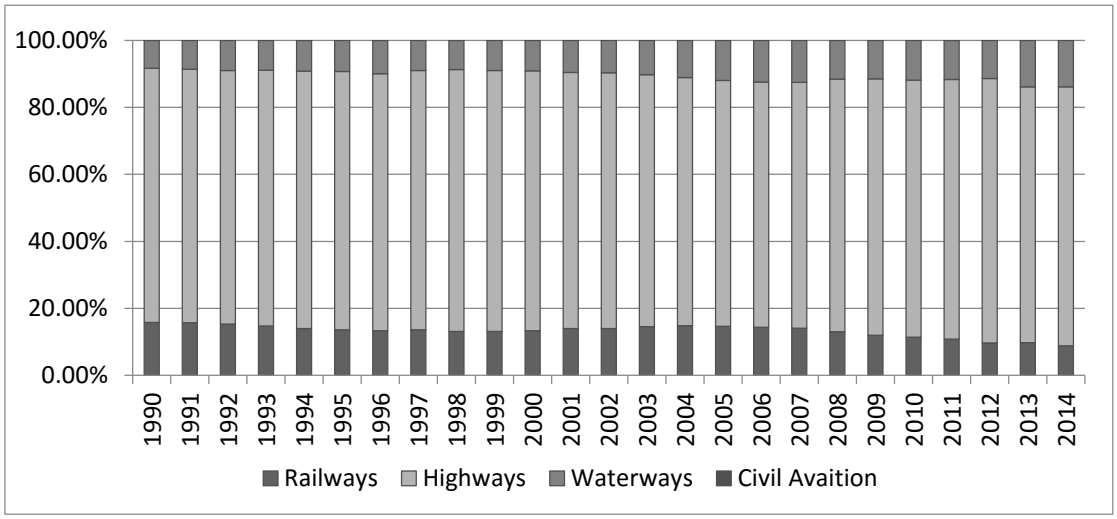
Zhang S. & Kahn M. E. (2013). China's bullet trains facilitate market integration and mitigate the cost of megacity growth. *PNAS,* **110** (14), 1248–1253.

Figure 1. Share of Passenger Traffic by Mode



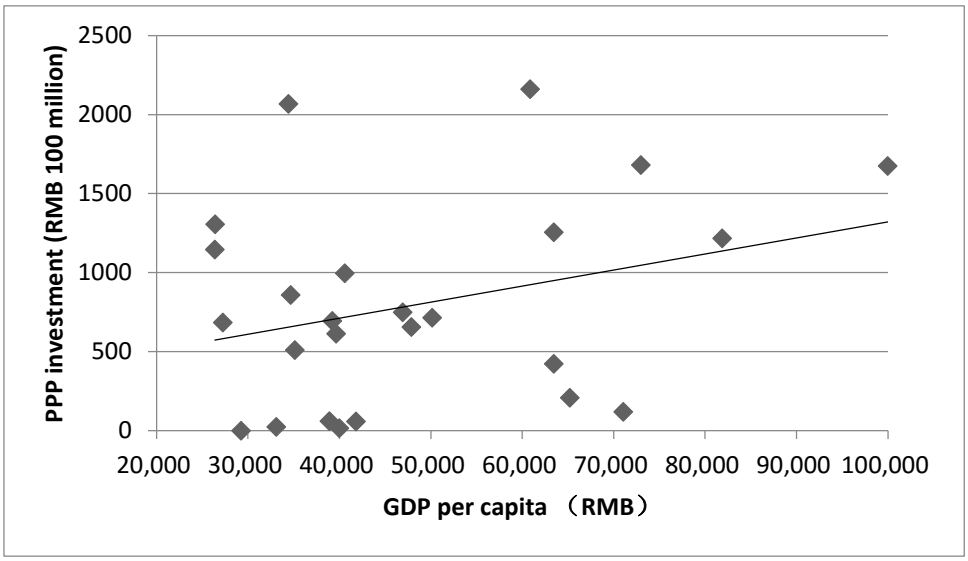
Data Source: China Statistical Yearbook.

Figure 2. Share of Freight Traffic by Mode



Data Source: China Statistical Yearbook.

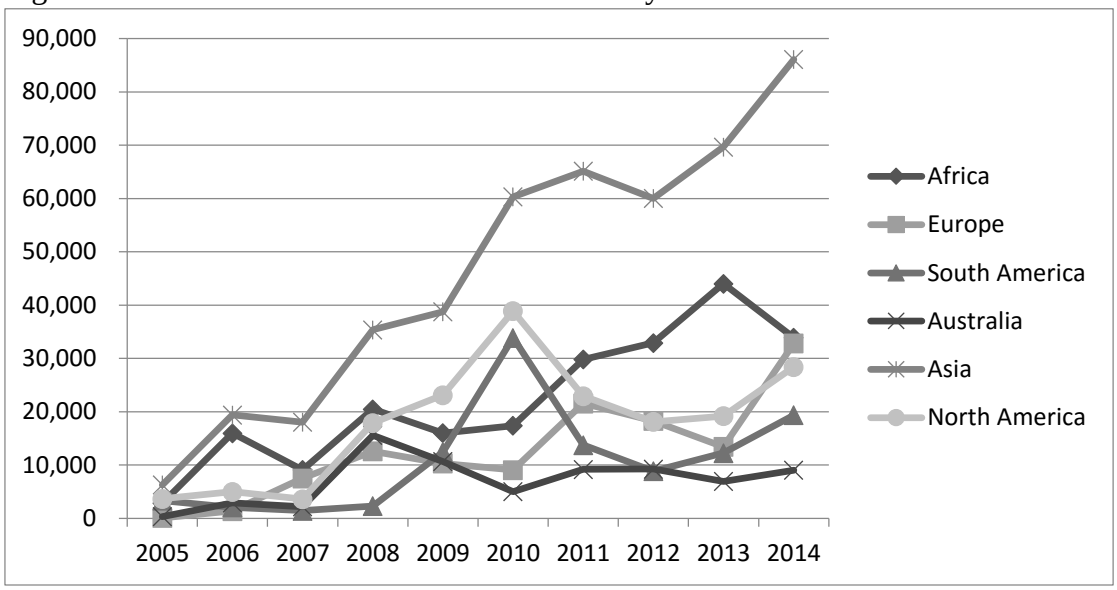
Figure 3. PPP Investment and GDP per Capita



Data source: PPP investment data are from the PPP Project Library http://tzs.ndrc.gov.cn/zttp/PPPxmk/; GDP per capita data are from National Statistical Yearbook (2014).

.

Figure 4. China's Outward FDI in Infrastructure by Continent



Data Source: http://www.aei.org/china-global-investment-tracker/.

Figure 5. Indicative Map of the Land Silk Road and the Maritime Silk Road

Data source: Ernst & Young (2015).