The Development of the Chinese Transportation Infrastructure: A Case of Highway Development

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"The development of China's expressway network over the last fifteen years is remarkable and on a par to the development of the interstate highway system in the US fifty years ago. This development has generated impressive reductions in transport costs and travel times, enhancing the competitiveness of Chinese markets."

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INTRODUCTON

Economists have long envisaged that China would be a major economic power in the 21st century. China along with India accounts for 18 percent of the global economy (on purchasing power parity basis) and 40 percent of the global working age population. During the past decade, China's economy grew on average at ten percent per annum, and China's share of world trade increased from one percent in early 1990s to six percent in 2004. China's industrial production also increased at an annual rate of 17 percent in 2004.[1] Going forward, the continued economic growth of China will continue to impact other countries as well as provide impacts within China. Long term impacts of this growth will likely result in spillover effects in countries surrounding China as well as other countries in the Pacific Rim.[2]

In fact, this rapid growth in the Chinese economy has spawned the need for an increase in the demand for reliable highway transportation. Another driver for an increased need for reliable road transportation in China has been significantly influenced by changes in the globalization of economic growth. To accommodate this economic growth, China has made significant progress in the development of a National Trunk Highway System (NTHS), which should total 35,000 km of toll highways and expressways by 2015 as a means to provide reliable highway transportation.

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[1] Ahya, C., A. Xie, A. Agarwal, D. Yam, S. Lam, and M. Sheth. (2004). *India and China: A Special Economic Analysis*. Shanghai: Morgan Stanley.

[2] Ianchovichina, E. and Martin, W. (2003) 'Economic Impacts of China's Accession to the WTO,' WBPR Working Paper No. 3053, World Bank.

Road density in China is still very low in comparison with other countries in the world as measured both in relation to area and population. Despite the low road density, this has been compensated by the high utilization of infrastructure and vehicles, which has affected the improvements in quality for drivers. In fact, there will be an increase in the demand for improvements in transportation services; however, given the adequate capacity and declining quality of service would cause a decline in the quality of transportation services unless the Chinese government increases investments in transportation infrastructure.[3]

The deficiencies of the Chinese highway system have created a bottleneck in their economic development which could have major impacts in the next 10 years. The World Banks estimates that the Chinese highway system will grow at 2.5 percent in the 10 years while the number of vehicles will increase more than 2.5 percent. As mentioned earlier, China's real GDP growth is predicted to be approximately 8 percent over the next ten years. The current highway capacity is not adequate to meet the demands of a growing economy since the current highway system has exceeded its capacity. This excess capacity could have an impact on future economic development unless the highway capacity is increased and increased at a faster rate in order to meet the demands of a growing economy.[4]

In this paper, we look at the effects of the economic implications of the investments by China into the development of a modern highway transportation system in China. Additionally, the balance of this paper is as follows: An examination of the highway development as a means to close economic gaps, indicators of highway development in China, the financing issues of highway development in China, and the development of multimodal transportation and logistics systems.

CLOSING THE ECONOMIC GAPS VIA HIGHWAYS

The Expressway Network of the People's Republic of China is one of the longest in the world, and this network is also known as National Trunk Highway System (NTHS). At the end of 2006, the total length of this system is approximately 45,400 km. In fact, this highway system is the world's second longest only after the United States and a combination of the highway systems in Canada, Germany, and France. In the last four years, about 4,800 km of expressways were added each year on average.[5] In fact, by the end of 2003, 99.6 percent of the townships and 91.9 percent of the administrative villages had access to roads, with 176 towns and 56,963 administrative villages still require connections to this highway system.[6] In early 2005, the Ministry of Transport and Communications announced plans to construct an additional 300,000

[3] This is not the first time that China has engaged in the development of a highway system. The Chinese government developed highway infrastructure in the 1930's as a means to resist the Japanese during World War II. See Hall, R.E. (1937). "Transport Facilities in China's Defense: II. China's Domestic Transport System**."** *Far Eastern Survey*, *6*(22), pp. 253-257 for the details concerning the development of the highway system in the 1930's.

[4] Churchill, A, and C. Thum, (2005). *The World Banks Assistance to China's Transport Sector*. The World Bank Operations Evaluation Department, World Bank.

[5] Li, Lin (2006). Expressways being built at frenetic pace. *SINA English*, available at http://english.sina.com/china/1/2006/0404/71800.html, last accessed on November 21, 2007.

[6] Seneviratne, P.N. (2006). "Road Sector Development in China and India: Trends and Implications." *Transportation Research Record: The Journal of the Transportation Research Board,* p. 15-21.

km of rural roads and 50,000 km of expressways and to provide bus service to all villages in China. With this ambitious development of the highway system in China, China could surpass the United States in the mileage of its highway system.

More than 34,288 km of expressways, 33,522 km of Class I roads, and 231,715 km of Class 2 roads were added to the system between 1992 and 2002, inclusive. In fact, this translates into the development of 18 km of roads per day in China.[7]

The main objective in the development of a comprehensive highway system in China is to reduce the gaps in economic growth between the well developed eastern portions of China with the less populated areas in the western part of China. In 2007, China announced plans to invest 2.3 billion yuan in the next five years to upgrade highways linking border trading areas in Xinjiang Uygur Autonomous Region, west China as a means to facilitate trade with the bordering countries such as Russia, Mongolia, Kazakhstan and Kyrgyzstan.[8] More specifically, the development of a comprehensive highway network will create links with transportation hubs throughout the country as well as to the port cities in order to ship their products overseas.

Additionally table 1 shows the regional variations in the quality of density of the highway.

From table 1, the western region experiences a poor system of highway infrastructure compared to the central and eastern regions. The provinces of Tibet and Qinghai have poor road infrastructure with a road density of 33 km per thousand square kilometers of land. In addition to the lack of highway infrastructure, the highway quality is also poor in the western part of China. There has been a major push for expanding highway infrastructure in the western part of China.

Since China started the National Trunk Highway System (NTHS) in 1992, China took advantage of the macroeconomic slowdown following the Asian financial crisis that began in 1997 to more than double its spending on highways, from US$13 billion in 1997 to US$30 billion per annum. In fact, this massive highway building in the 1990s has increased China's GDP by 2% per annum over the subsequent years. Wei-hua et al. (2007) provided detailed research on China's data of transportation and economic development from the beginning of its reform through the end of 2005. Additionally, research has shown that increases in GDP would influence the development of highway and other transportation infrastructure.[9]

[7] Fan, S and C. Chan-Kan, (2005). "Road Development, Economic Growth, and Poverty Reduction in China." Research Report 138, International Food Policy Research Institute, Washington, DC.
[8] http://portalapp.tdctrade.com/airnewse/index.asp?id=26309, accessed on 24 August 2007.
[9] Wei-hua, W., Guo-li, O. and L. Chen-yang. (2006). Research on the Development Mechanism of China's Highway, a paper presented at the 2006 International Conference on Management Science and Engineering.

Table 1

	Length of Highways (in km)	Road Density (km per 1000 km^2)	Shares in Total Length of Highways (percent) Expressway Class 1 and 2	Below Class 4
North	146,745.00	392.20	19.70	8.5
Beijing	14,359.00	854.30	18.20	2.90
Tianjin	9,696.00	857.70	22.10	5.90
Hebei	63,079.00	332.00	21.40	14.40
Shanxi	59,611.00	382.10	17.90	4.00
Northeast	152,192.00	193.30	17.70	5.30
Liaoning	48,051.00	329.30	27.90	0.60
Jilin	41,095.00	219.30	16.00	6.50
Heilongjiang	63,046.00	138.90	11.00	8.20
East	368,500.00	463.30	20.50	15.50
Shanghai	6,286.00	991.40	30.00	4.20
Jiangsu	60,141.00	586.20	25.60	16.90
Zhejiang	45,646.00	448.40	20.10	6.30
Anhui	67,547.00	483.90	12.80	9.10
Fujian	54,155.00	446.10	11.90	23.90
Jiangxi	60,696.00	363.70	12.70	40.60
Shandong	74,029.00	472.40	35.40	0.20
Central	372,061.00	478.40	16.60	24.30
Henan	71,741.00	429.60	23.80	7.30
Hubei	86,098.00	463.10	14.90	21.80
Hunan	84,808.00	400.40	7.50	54.70
Guangdong	108,538.00	609.80	21.30	10.00
Hainan	20,876.00	596.50	10.10	43.60
Southwest	391,790.00	166.20	5.60	38.10
Chongqing	31,060.00	376.90	12.70	29.40
Sichuan	111,898.00	230.70	10.40	33.90
Guizhou	44,220.00	251.10	5.80	31.00
Yunnan	164,852.00	418.40	1.90	34.70
Tibet	39,760.00	32.60	1.50	79.00
Guangxi	56,297.00	237.80	10.70	25.10
Northwest	277,637.00	65.70	10.50	18.20
Inner Mongolia	72,673.00	61.60	9.20	13.30
Shaanxi	46,564.00	226.50	12.60	12.40
Gansu	40,223.00	88.40	11.50	23.40
Qinghai	24,003.00	33.30	12.80	23.00
Ningxia	11,245.00	170.40	21.40	1.50
Xinjiang	82,929.00	51.80	7.80	24.20

Source: China's National Bureau of Statistics, *Statistical Yearbook of China*, 2003

As stated, the core of their transportation policy is to develop the "national trunk highway system" (NTHS). This 35,000 km network of 12 interprovincial second grades and above highways will link 95 major Chinese cities and 600 million people to Beijing. This highway system would form the Chinese highway system with the goal of linking the smaller roads to the major highway routes. Table 2 provides the major north and south routes in China.

Table 2: The Five Major North and South Routes

From	To	Distance (in km)
Tongjiang, Heilongjiang	Sanya, Hainan	5,200
Beijing	Fuzhou, Fujian	2,500
Beijing	Zhuhai, Guangdong	2,400
Erlianhaote, Inner Mongolia	Hekou, Yunnan	3,600
Chongqing, Sichuan	Zhenjiang, Jiangsu	1,400

Source: Churchill, A, and C. Thum, (2005). *The World Banks Assistance to China's Transport Sector*. The World Bank Operations Evaluation Department, World Bank.

In addition to the north and south routes, the development of the highway system would include the highway system to include the east and west routes. Table 3 summarizes the east-west routes that are under development.

Table 3: The Seven East-West Routes in Chinese Highway System

From	To	Distance (in km)
Dandong, Liaoning	Lhasa, Tibet	4,600
Lianyugang, Jiangsu	Huoerguosi, Xinjiang	4,400
Shanghai	Ruili, Yunnan	4,000
Shanghai	Chengdu, Sichuan	2,500
Hengyang, Hunan	Kunming, Yunnan	2,000
Qingdao, Shandong	Yinchuan, Ningxia	1,600
Suifenhe, Heilongjiang	Manzhouli, Inner Mongolia	1,300

Source: Churchill, A, and C. Thum, (2005). *The World Banks Assistance to China's Transport Sector*. The World Bank Operations Evaluation Department, World Bank.

INDICTATORS OF HIGHWAY DEVELOPMENT IN CHINA

In the 1950s the development of the interstate highway system in the United States resulted in prosperity and change for its people. With the heavy investment in highway construction in China, China is replicating the US experience with highway construction. Many of the people using these roads are typically migrant workers who wish to travel to the urban areas in China for better job opportunities.

The central government's tenth five-year plan released in 2001 envisages an increase in total expenditures for transportation infrastructure to be approximately 15-20% per year with

much of it devoted to highway infrastructure. Table 4 provides the highway mileage which was provided the *General Survey of Roads 2000*.

Highway development continues to grow in China and at the end of 2005, there were 1.9305 million kilometers of roads in China. The breakout of the composition of the national roads can be allocated as follows: national road was 132,674 km, provincial road was 233,783 km, county road was 494,276 km, rural road was 981,430 km, special road was 88,380 km, which accounted for 6.9%, 12.1%, 25.6%, 50.8% and 4.6% of the total roadways in China. Table 4 provides the highway passenger and freight traffic from 1991 through 2004 which are derived from the estimates by the National Bureau of Statistics of the Peoples Republic of China.

The estimates for freight in table 5 reveal quite a dramatic increase in the movement of freight from 1991 through 2004 especially after 1997. The increase in freight coincides with the significant growth of GDP in the Chinese economy. Consequently, in order to accommodate the significant increases in freight movements, there needs to be a reliable highway system to allow for the movement of freight to other parts of the country as well as to ports for shipments to other countries. Freight transportation is calculated in tons while passenger traffic uses the number of people. Movements of freight and passengers provide a quantitative measure to show how well the transportation sector is serving the national economy. More importantly, the amount of freight and passenger movements serves as a tool to plan for improvements in transportation infrastructure which include the construction and/or improvements of highways as a means to get passengers and freight to their final destinations efficiently.

Despite the dramatic increases in freight movements, the logistic costs are 16 percent of the Chinese GDP whereas in the US it is 9 percent of GDP. These costs include transportation, inventory-carrying cost, and the administrative/information technology costs. [10]

In February 2007, the Ministry of Communications revealed that the government will build 1.2 million km of highways which includes the construction of rural roads. The rationale of the government to build these additional rural roads is to connect the rural roads to allow easier access to education, health-care, and commerce for the people living in rural areas. Once the highway system has been completed, this will allow for greater movements of freight and people at a faster speed.[11]

However, for the movements of freight, the trucking sector is highly fragmented with an estimated of 2.5 to 2.7 million truck operators registered to provide for-hire trucking services and 5.1 million trucks and related equipment. Consequently, there appears to be an adequate amount of trucks to move the freight to its shipping centers because of the existence of economies of scale. However, much of the trucks and related equipment is antiquated and would not provide an adequate movement of freight. Thus, the reliability of transporting the goods to its destinations would be deemed unreliable, which would result in higher transportation costs for the shippers.[12]

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[10] Callarman, T.E. and L.G. Sprague. (2007). "All Roads Leading to Beijing." *Far Eastern Economic Review*, 170(5), pp. 57-59.

[11] Ibid

[12] APL Logistics (2003). China's Transport Infrastructure and Logistics.

Table 4: Highway Mileage in 2000 (from the General Survey of Roads, 2000)							
Region	Total	Miles of Highway Surface					Number of Highway Surface
		Subtotal	Top-grade	Second-grade	Medium-grade	Low-grade	Mileage
National total	**1,679,848**	**1,525,830**	**241,447**	**411,856**	**441,557**	**430,970**	**154,017**
Beijing	13,600	13,590	4,343	6,017	1,313	1,918	10
Tianjin	9,622	9,503	7,013	1,992	452	46	119
Hebei	60,691	54,554	16,742	24,996	3,847	8,968	6,137
Shanxi	55,342	53,453	4,163	25,225	8,571	15,494	1,889
Inner Monglia	69,065	60,866	2,911	11,325	13,318	33,312	8,198
Liaoning	46,063	45,801	7,766	17,727	10,755	9,553	262
Jilin	39,389	36,663	10,215	3,231	15,088	8,129	2,726
Heilongjiang	62,853	59,115	7,865	2,706	27,272	21,272	3,738
Shanghai	5,970	5,970	4,481	531	688	271	-
Jiangsu	58,032	55,883	15,484	17,542	17,356	5,502	2,149
Zhejiang	43,548	43,548	13,992	12,717	16,203	635	-
Anhui	65,353	62,938	4,962	23,466	29,757	4,753	2,414
Fujian	53,506	48,675	12,395	10,452	17,038	8,790	4,832
Jiangxi	60,292	59,569	8,409	9,901	21,894	19,366	723
Shandong	70,657	70,206	15,954	40,590	2,515	11,147	451
Henan	66,824	63,193	9,530	38,236	9,327	6,101	3,630
Hubei	85,522	81,687	8,410	17,532	33,482	22,262	3,835
Hunan	66,360	64,589	6,713	13,309	33,356	11,212	1,772
Guangdong	103,153	101,051	35,025	7,409	15,308	43,309	2,101
Guangxi	53,591	52,793	4,487	13,513	18,943	15,850	797
Hainan	20,665	10,882	1,662	1,840	347	7,033	9,784
Chongqing	30,354	30,178	6,198	1,250	19,135	3,595	176
Sichuan	108,529	99,591	16,933	18,457	36,632	27,569	8,938
Guizhou	33,948	33,948	1,664	5,953	22,235	4,096	-
Yunnan	163,604	129,455	4,302	14,674	31,484	78,995	34,148
Tibet	35,538	17,254	364	1,397	1,103	14,390	18,284
Shannxi	44,225	30,839	3,639	17,194	5,433	4,572	13,386
Gansu	39,382	33,112	730	14,870	5,700	11,813	6,270
Qinghai	22,697	19,122	963	5,127	2,957	10,076	3,575
Ningxia	10,600	10,434	558	5,193	3,099	1,584	166
Xinjiang	80,875	67,366	3,574	27,485	16,948	19,359	13,509
Production and Construction Group	23,153	18,207	65	4,996	7,103	6,044	4,946

Table 5: Highway Passenger and Freight Traffic, 1991-2004[1]

	Passenger Traffic (10,000 persons)	Passenger Kilometers (10,000 per km)	Freight Traffic (10,000 tons)	Freight Ton-kilometers (10,000 tons per km)
1991	150,248	2,498,117	25,430	1,181,376
1992	142,089	2,422,747	26,796	1,221,989
1993	135,556	1,941,098	30,167	1,286,684
1994	128,921	1,799,516	31,340	1,309,140
1995	120,345	1,615,089	29,100	1,249,150
1996	116,716	1,542,116	28,940	1,199,090
1997	116,280	1,441,704	27,700	1,216,500
1998	115,483	1,429,848	36,000	1,742,600
1999	114,900	1,424,673	35,000	1,847,000
2000	110,400	1,465,716	34,400	1,818,200
2001	109,100	1,523,654	30,000	1,773,500
2002	105,400	1,574,680	28,900	1,773,100
2003	98,800	1,484,700	30,400	1,816,400
2004	101,200	1,538,300	34,500	2,042,900

Source: http://www.allcountries.org/china_statistics/appendix_1_12_railway_and_highway_passenger.html
Note: The freight data for highways are based on for-hire trucking companies

In addition to the antiquated trucks and related equipment, the for-hire trucking sector is not integrated seamlessly among the provinces. That is, freight movements between the Chinese provinces are limited because of the highly bureaucratic and restrictive licensing system which makes it difficult to allow for shipments of freight across provinces. Typically, as a truckload of goods reaches the end of a province, the operator would need to empty the freight from one truck and loaded onto another one at provincial borders. Such changes are time consuming; provide greater transportation costs for the shippers; and damages to the freight increases. In fact, there are often restrictions that exist between cities and rural areas in the same province since some cities would impose their own restrictions on freight movements into and out of the city.[13]

[13] In the United States and Europe, there is a national less than truckload (LTL) services network which has allowed for greater flexibility in the movement of freight. Without the development of this LTL system, freight movements become more difficult and more expensive. Less-than-truckload is a for-hire service offered by trucking companies that only need a small shipment of goods delivered. In contrast, a shipper that uses all space of a truck would be a full truck load. In contrast, a less-than-truckload shipment is delivered with shipments of other shippers and is usually not delivered directly to a destination as full truckloads

LINKAGES OF TRANSPORTATION AND ECONOMIC DEVELOPMENT

In policy-making, an examination of the relationships between transportation and economic development is common, especially in the developing world. A burgeoning literature exists concerning the linkage between the transportation and economic development and the examination of these complex interactions between transportation investment and economic development is not entirely clear. If policy-makers are able to grasp these relationships, they are responding to the more demanding task of using these estimates to help make better policy and allocative decisions with respect to these investments.

There is no dearth in the economic literature concerning the effects of public expenditures on development of the economy. Numerous empirical analyses have attempted to estimate the output elasticity of public capital. The topic is important in evaluating the efficiency of fiscal spending versus private investment. The earlier analyses often generated large estimates of the output elasticity of public capital stock, sometimes even higher than private capital.[14]

There has been research linking economic development and transportation, namely highway development and a reduction in poverty. Additionally, the development of transportation infrastructure in rail, water, and river corridors has led to positive economic development in a province. In fact, those provinces in China which have a well-developed highway system and allows for access to the eastern part of the country, these provinces experience higher economic growth giving the people in the province additional prosperity. [15]

INFRASTRUCTURE FINANCING IN CHINESE HIGHWAY SYSTEM

In the United States, the Highway Trust Fund serves as the major driver for the development of transportation infrastructure, namely surface transportation such as highways, railroads, and transit systems. The funding sources for the Highway Trust Fund are comprised of tax revenue derived from excise taxes on highway motor fuel and truck-related taxes on truck tires, sales of trucks and trailers, and heavy vehicle use. On the contrary, the central government of China does not rely on the revenue raised from the gas tax, but relies on other forms of financing of highway projects.

The Chinese government has inquired about the introduction of a fuel tax as a means to increase revenue for highway construction. However, traditionally, transport fuel taxation has not been a revenue source in China, and when a few years earlier a proposal was made for its introduction as an alternative revenue source, it was not endorsed by the Chinese government.

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[14] Aschauer, D.A. (1989)." Is public expenditure productive?" *Journal of Monetary Economics 23*(2): 177- 200 and Munnell, A. H. (1990) Why has productivity growth declined? Productivity and public investment. *New England Economic Review*: 3-22. In fact, Aschauer (1989) and Munnell (1990) estimated that the output elasticity with respect to public capital was 0.39 and 0.37, respectively.

[15] Wei-hua, W., Guo-li, O. and L. Chen-yang. (2006). Research on the Development Mechanism of China's Highway, a paper presented at the 2006 International Conference on Management Science and Engineering; and Fan, S and C. Chan-Kan, (2005). "Road Development, Economic Growth, and Poverty Reduction in China." Research Report 138, International Food Policy Research Institute, Washington, DC.

The Chinese government believed that there were many policy issues that could not be resolved: how much of the revenue would go to the national level and the provinces; how much revenue would need to be raised; and possible additional charges for trucks by axle to recover costs of damages to roads not covered by the fuel tax.[16]

The central government has adopted off-budget sources to fund its highway expansion and maintenance programs. The two sources of funding highway construction projects are the Road Maintenance Fee (RMF) collected by the individual provinces and the Vehicle Purchase Fee (VPF) which is collected at the national level. In fact, the RMF and the VPF provide 70 percent of highway funding in China with the remaining funds derived from private financing, which includes an infusion of foreign capital. However, policy-makers have criticized RMF as an inefficient way of funding of highway projects because it does not relate road use to the costs of maintenance and construction. Despite these criticisms, the RMF has still provided a major source of funds for its highway projects.[17] Additionally, these financing options do not provide complete financing to build the expansive highway system in China in 2002. The RMF is inefficient, administratively expensive to administer, easy to evade, and does not generate the necessary revenue to cover highway construction costs. In fact, only 60 percent of the actual revenue of the RMF is used for road maintenance while the remainder of these funds is used for highway construction.[18]

Table 6 provides the breakdown of the highway funding by sources.

Table 6: Highway Funding by Sources (in percent)

	Central Government			Local Government				
Year	**Total**	**(1)**	**(2)**	**Total**	**(3)**	**(4)**	**(5)**	**Foreign Capital**
1998	7.10	6.6	0.5	87.8	36.0	5.3	46.5	5.1
1999	6.70	5.9	0.8	89.7	36.3	4.9	48.6	3.6
2000	7.30	6.6	0.7	88.8	36.0	4.4	48.5	3.9
2001	12.0	8.9	3.1	85.1	40.7	3.6	40.9	2.9
Average	**8.3**	**7.0**	**1.3**	**87.9**	**37.3**	**4.6**	**46.1**	**3.8**

Source: *China Highway Transport Statistics*, various years

Notes: Numbers in parentheses represent the following variables: (1) ministry special funds; (2) central fiscal special funds; (3) domestic loads; (4) local fiscal funds; (5) self-raised funds and other funds.

Between 1998 and 2001 local governments have contributed the most highway funding for these investments (87.9 percent) followed by the central government (8.3 percent) and the use

[16] In fact, the central government has passed a mandate in 1998 that there needs to be a gas/fuel tax but there is no implementation plan for gas/fuel tax. Given that the fuel prices in China are rather low, the central government has not determined the amount of the tax to be implemented and how to allocate this revenue to the provinces for highway transportation projects.

[17] Churchill, A, and C. Thum, (2005). *The World Banks Assistance to China's Transport Sector*. The World Bank Operations Evaluation Department, World Bank.

[18] Nogales, A. (2004). "China's Recent and Planned Transportation Investments." *The China Business Review.* p 26-26.

of foreign capital (3.8 percent). Despite the high amounts of contributions by the local governments, economic inequality does exist among the provinces of China in terms of revenue generated. That is, local government revenue is highly dependant on local economic activity and the political ability of the local governments to negotiate higher funding from the central government.[19] Because of these provincial disparities, the central government launched major highway construction projects in the central and western provinces in China. Additionally, the central government reallocated funds for highway construction from the eastern provinces of China to the central and western parts of China. Consequently, highway investment by the central government in eastern China declined from 54.8 percent in 1998 to 45.2 percent in 2001 whereas the central and western provinces received greater funds for highway investments. [20]

From table 5, it reveals that there is some infusion of foreign capital by private sector firms in the development of the highway construction projects throughout China. The extent of this infusion is greater than other countries throughout the world. In fact, since the mid 1990s there have been a multitude of joint ventures between the foreign and private Chinese developers in the development of highway projects. As a result, 14 provinces have raised an additional $9 billion from these private sources. Also these private investments have used asset securitization as a substitute for long-term debt financing which raised an additional $2 billion by 2001 for highway construction projects throughout China. Though private financing has attracted many foreign investors, it has contributed approximately 10 percent of China's total commitment to new highway construction since the early 1980s.[21]

The most notable feature concerning the financing of the highway system in China has been the infusion of private funding. The participation of private firms into the development have led to the following factors in the early years of highway development such as (1) emerging domestic markets, (2) unclear central government policy on public and private financing, (3) an evolving regulatory framework, (4) lack of transparency, (5) weak enforcement of contracts, and (6) defaults on the loans and bonds. Given some of the latter negative attributes, the situation has improved in China since many of these private highway firms were publically listed with the central government.[22]

MULTIMODAL TRANSPORTATION AND LOGISTICS

As the Chinese economy becomes increasingly interlinked in international trade, goods are being shipped over longer distances, and shipping and logistics costs will become important in the costs of the goods. In order to minimize these costs, there needs to be a seamless transfer of components, finished products, and bulk commodities between ships, railcars, airplanes, and truck. Consequently, multimodal transportation and logistics plays a major role in the transport

[19] Demurger, S. (2001). "Infrastructure Development and Economic Growth: An Explanation for Regional Disparities in China?" *Journal of Comparative Economics* 29, pp. 95–117.
[20] Ibid.
[21] Nogales, A. (2004). "China's Recent and Planned Transportation Investments." *The China Business Review.* Pp 26-26.
[22] Seneviratne, P.N. (2006). "Road Sector Development in China and India: Trends and Implications." *Transportation Research Record: The Journal of the Transportation Research Board,* p. 15-21.

of freight by shippers, and one of the main drivers for a developed multimodal transportation system would be the development of an advanced highway system. Currently, the development of an advanced multimodal system has been lagging because China maintains a hierarchical culture that resists crossing over jurisdictional boundaries. Because of this resistance, it becomes difficult to develop an effective multimodal transportation system since this system would require the cooperation between the providers of freight transportation, railways, and water transportation. However, this cooperation is nonexistent because each of these modes of transportation is operated by a different ministry in the central government. Consequently, the ratio of logistic costs to GDP in China is estimated to be 16.7 percent whereas in the United States it is estimated to be about 9.5.[23] For China, the lengthy transactions, high interest charges, and inefficient transportation systems have contributed to these higher logistic costs. Some research has shown that toll costs play a major role in the higher logistics costs. In fact, toll costs constitute between 20 and 40 percent of total transportation costs which often depends on the truck coming in or out of the province.[24] However, tremendous improvements in the transportation infrastructure in the costal provinces have allowed for improvements in logistic costs, but the inland provinces are still lagging.

However, the establishment of intermodal transfer hubs and smaller facilities involves identifiable direct and indirect costs and benefits - financial, environmental, and social. The direct benefits would be lower shipping costs for the Chinese shippers that ship these goods. Because of the development of modern multimodal transportation system could result in increased profitability, increased market share, and increased employment. Additionally, indirect benefits could also be derived from a comprehensive multimodal transportation system. These indirect benefits could include increased business to suppliers of those firms who received the direct benefits when those firms increase production and/or market share, as well as expanded employment among those suppliers. Induced benefits could also arise from the increased sales by various Chinese businesses to employees of those firms who experience direct benefits and from their suppliers. Further development of intermodal transportation facilities can allow for more effective transportation of goods from the various provinces to the ports which can result in lower shipping costs as well as saving time in shipping.

More specifically, the development of the highway system has reduced the travel time for a truck from 55 hours to 25 hours for the Beijing to Hong Kong route and the Shanghai to Beijing route from 31 hours to 14 hours. In fact, DHL operations in China have allowed DHL to reduce its transport time from a Beijing warehouse to other markets throughout the country. As a result, firms in other nations would be able to store fewer inventories since the reduction in shipping times allows for a more frequent replenishment of its inventory. [25]

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[23] Ibid

[24] Dai, J. (2005). "China Road Transport Enterprise Survey 2004." Logistic Institute Asia Pacific Singapore. Georgia Institute of Technology. School of Industrial and Systems Engineering, Atlanta, GA. Also Raghuram, G. and J Shah (2003). "Roadmap for Logistics Excellence: Need to Break the Unholy Equilibrium." Presented at the CH Logistics Convention. Chennai, India.

[25] Meredith, W. "When the Silk Road Gets Paved." Forbes.com, September 20, 2004. Available at www.forbes.com/business/global/2004/0920/029.html, last accessed on November 21, 2007.

CONCLUSION

By having investments in transportation projects would provide the effects of having lower costs and increasing the mobility of freight and passengers. One of the inevitable consequences of an improved highway system would be the migration of people from the rural areas to the urban areas. Consequently, China has begun the transformation from a rural economy to an urban economy, but this transformation does take time and requires persistence. China has more than doubled its road length in the past 20 years, and this highway system is the second longest system in the world. Given the expectations of an growing economy in the next decade, this will create a greater demand for its products. In order to meet this increasing demand for their products, the central government will need to invest more in the development of highways to allow an easier flow of freight and passengers. Additionally, economy wide impacts of these investments will provide less travel time for freight and passengers, and the returns from these highway investments have exceeded the social rate of returns. As shown in table 1, some western provinces in China have plenty of low quality of roads. As a remedy, the central government needs to provide additional investments in highway infrastructure in the western provinces in order to allow greater movements of passengers and freight to the other provinces.

Given its massive investments in highways in recent years and continued interest in expanding its highway system, the Chinese highway system could become the longest system in the world. With the expectation that the Chinese economy will continue to growth in the next decade, a modern, highway system will be required to move its freight and allow easier movements for passengers. Consequently, there needs to be additional investment in the highway infrastructure in order to support the increased demands for freight movements and movement of people.