北京交通大学
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The Financial and Economic Assessment of China's High Speed Rail Investments

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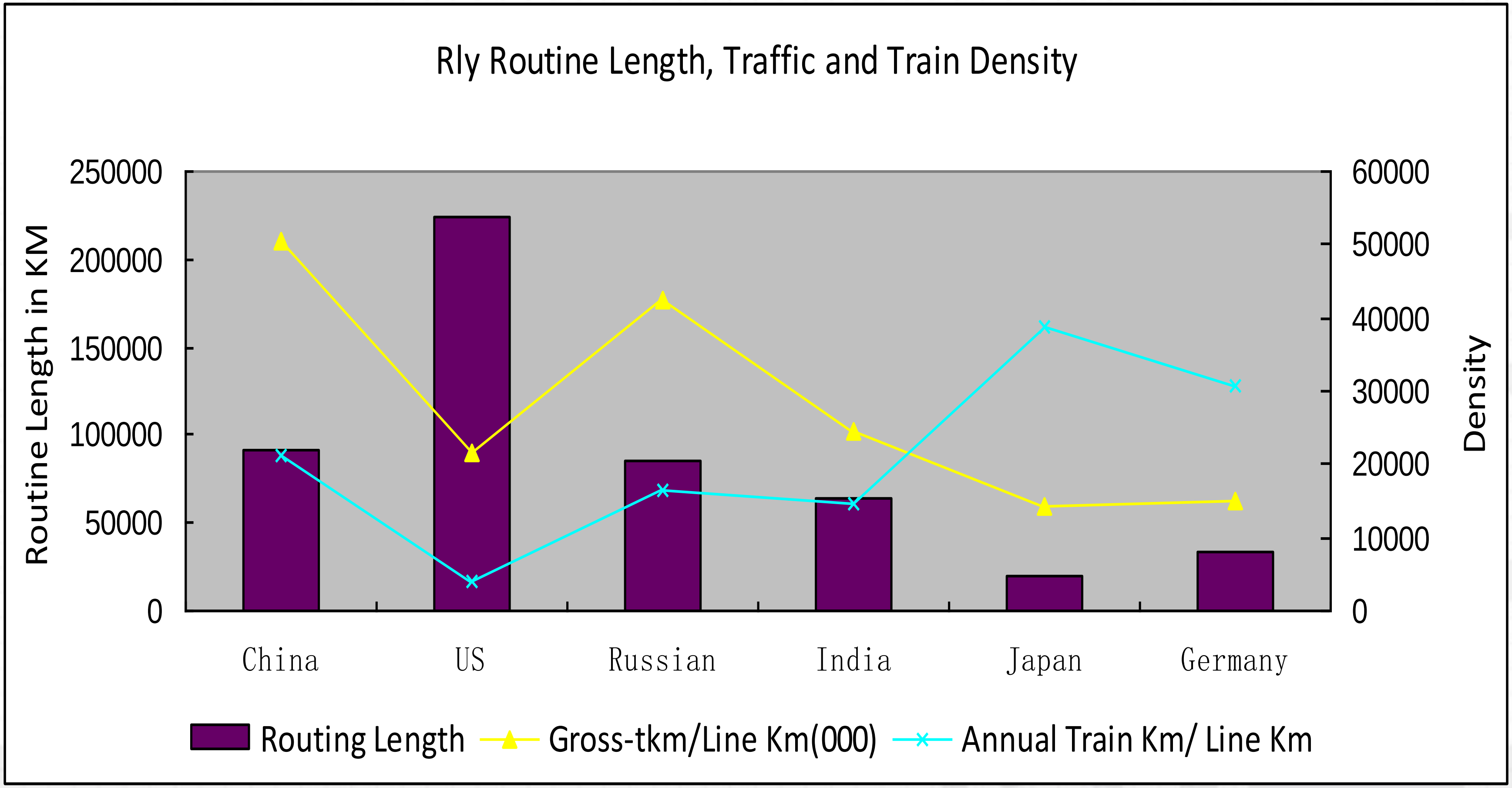
1. INTRODUCTION

- The background of building HSR in China: lack of capacity
- The key role of HSR plan in China’s Rapid Railway Development Plan
- HSR construction and its implementation by 2012

International Comparison on Routing Km vs. Traffic and Train Density



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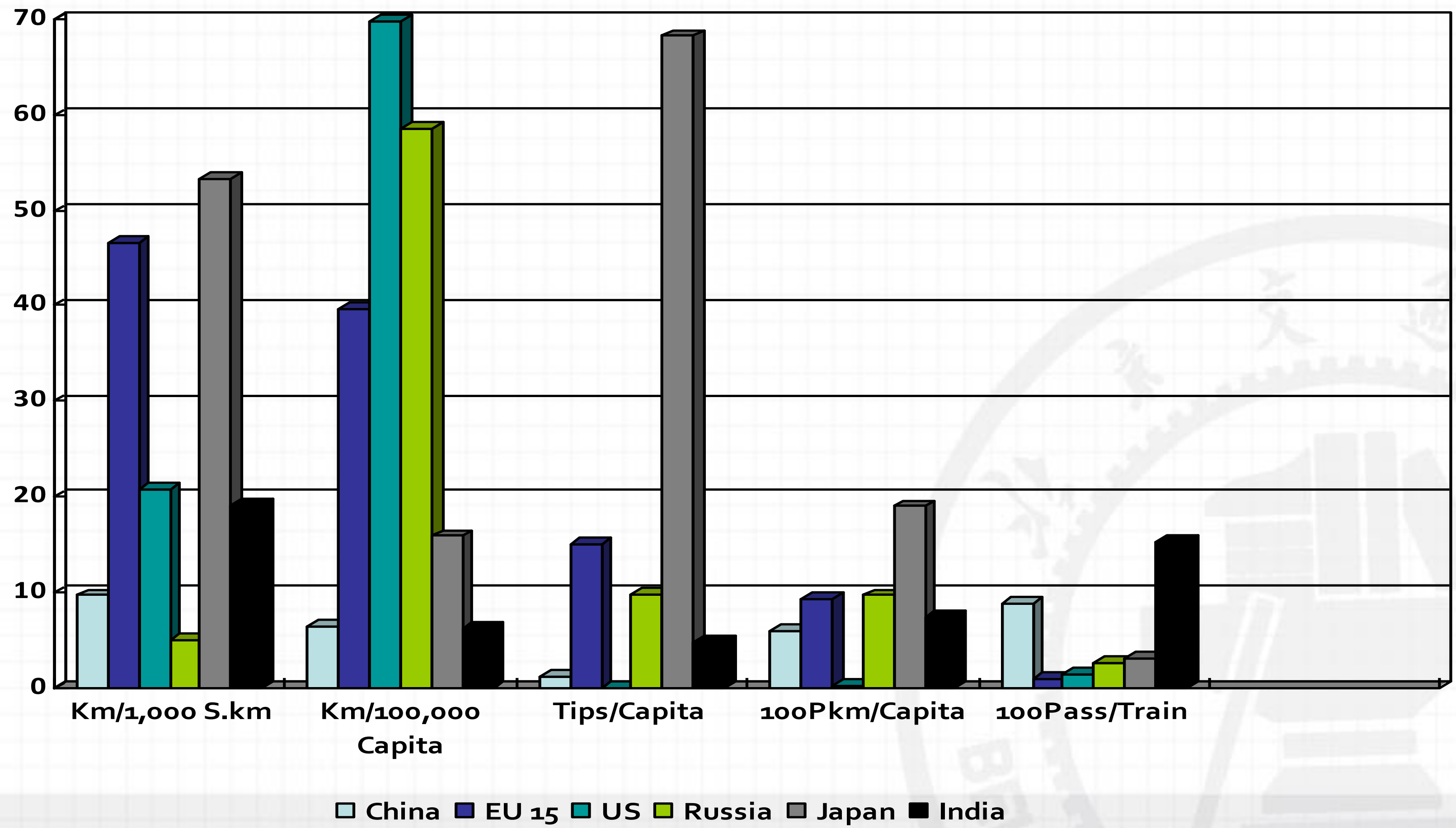
Network Density, Average Annual Rail Trips and Pass-Km per Capita



Rail Congestion during Chinese New Year

中国春运50年 回家艰辛路 (2/35)

为第一个分享 的人吧！ 203 条评论 即时资讯：以色列呼吁美国不要中断对埃及资金援助

1954年，铁道部首次明确春运為春节前后一个月，春节旅客输送办公室昼夜值班。当时日均客流为73万人次，高峰客流90万人次。在将近50年之后的2012年，为期40天的春运即将到达运力最高峰，此间将有31.58亿人次的人口流动，创历史新高。

2013年01月21日 08:10 图片来源：财经网 关键字： 中国 春运 50年

中国春运50年 回家艰辛路 (1/35)

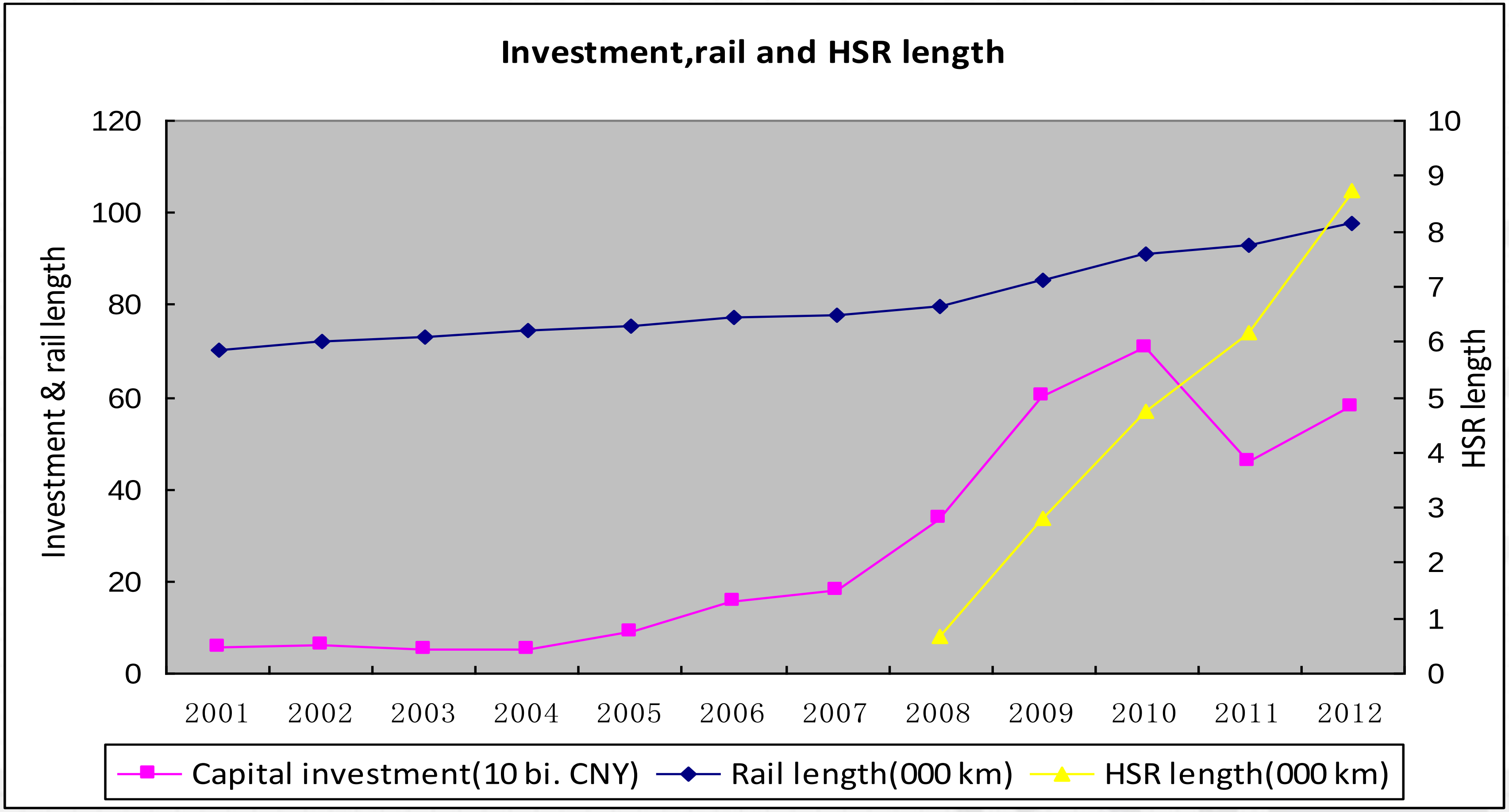
为第一个分享 的人吧！ 203 条评论 即时资讯：李双江之子案新律师：媒体不能因看不惯“星

2013年春运大幕即将拉开，重要的是如何搞定春节回家的票。从20世纪50年代初不多的人流开始，到了改革开放的时代，经济发展加速，随着收入的增加，中国的旅游者逐年增加，从2000年春运时又有了“黄金周”的旅游客流汇入。探亲流、学生流、民工流、旅游流这四股巨大的人流，每年春节前后的一个多月时间里，20多亿人次汇成的极为巨大的人流在960万平方公里的大地上涌动，蔚为大观，世界仅见。让我们一起回顾历史上的“春运”。

Mid-and Long-term Railway Network Program in China

Source:

Dramatic increases of rail capital investment & HSR length since 2005



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HSRs network plan and its implementation in China by 2012

2. THE COST OF BUILDING HSR INFRASTRUCTURE AND ITS COMPOSITION IN CHINA

Estimated unit construction cost for 250 km/h HSL

HS Line	Design speed (kmph)	Length (km)	Estimated unit construction cost (m euro /km)
Hefei-Nanjing	250	156	6.03
Qingdao-Jinan	250	393	6.27
Shijiazhuang-Taiyuan	250	190	14.48
Coastal HSL	250	650	7.24
Chengdu-Dujiangyan	250	67	18.10
Changchun-Jilin	250	96	10.81
Hainan East Circle	250	308	8.69
Wuhan-Yichang	250	293	9.78
Average construction cost of the HSL with 250kph			8.84

Estimated unit construction cost for 350 km/h HSL

HS Line	Design speed (kmph)	Length (km)	Estimated unit construction cost (m euro /km)
Beijing-Tianjin	350	120	20.51
Wuhan-Guangzhou	350	1068	15.69
Zhengzhou-Xi'an	350	456	12.07
Shanghai-Hangzhou	350	154	22.93
Guangzhou-Shenzhen	350	104	27.57
Zhengzhou-Wuhan	350	536	15.66
Harbin-Dalian	350	921	13.30
Beijing-Shanghai	≥350	1318	19.31
Average construction cost of the HSL with 350kph			16.50

The cost difference between 250km/h & 350km/h

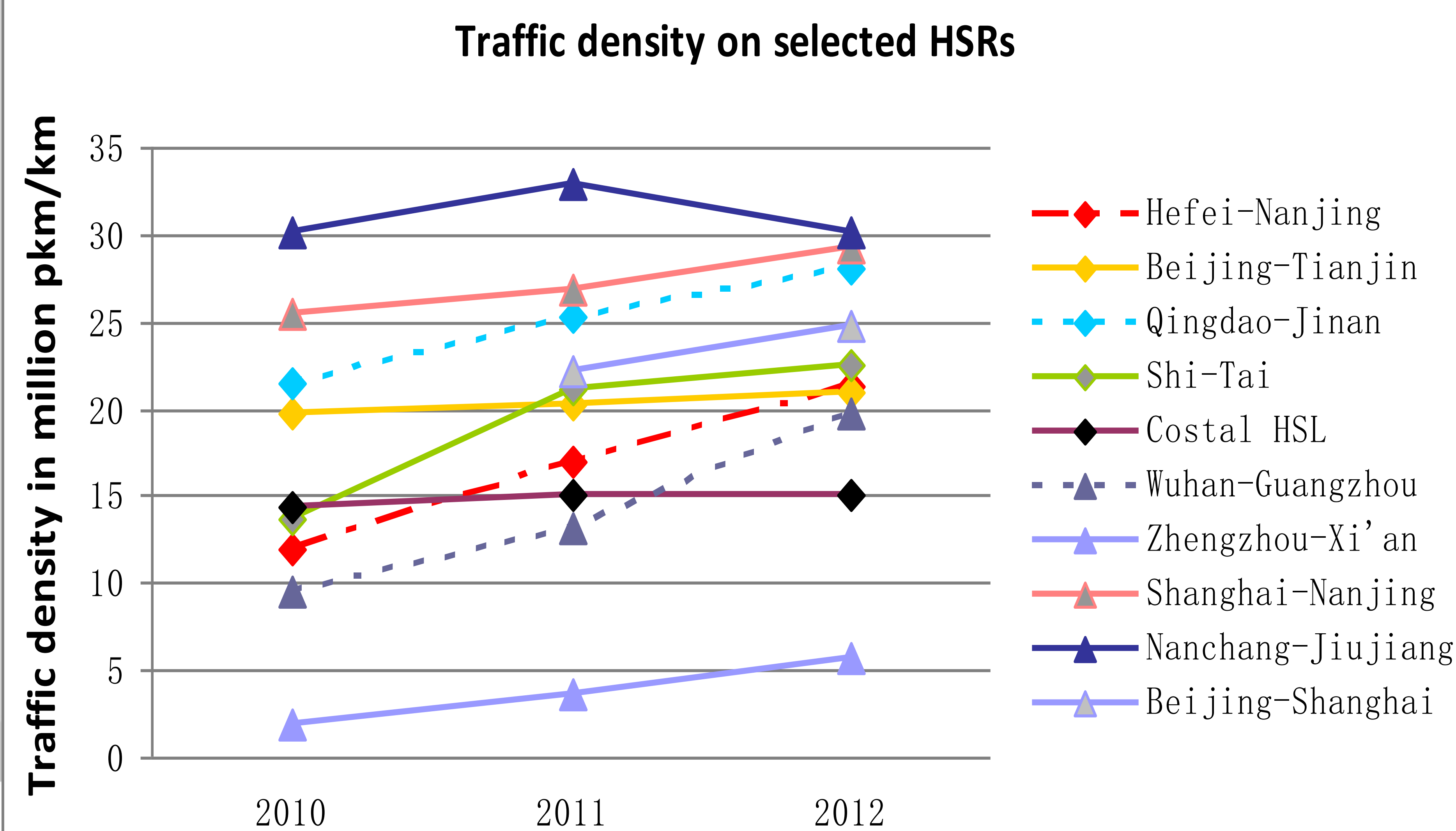
- The average unit cost of 350 km/h was about 90% higher than that of 250 km/h.
- The major reason is because it has to be elevated to accommodate the common use of slab tracks.
- The average ratios of the bridges and tunnels length to the route length was 74% for the HSR with design speed of 350 km/h and it raised as high as 90% for some specific projects.

THE HSL COST COMPOSITION in China

- Includes the infrastructure, superstructure and land costs.
- The average cost ratio of the infrastructure and superstructure are respectively around 60% and 20%, of which the bridges and tunnels are over 45% of the total cost.
- In general, the cost of HSL varies enormously, between 8.00 and 30.00 million Euros

3. THE INITIAL OPERATIONAL PERFORMANCE OF HSR IN CHINA

Estimation of HSR traffic density from 2010-2012



The tariff level and estimated load factors of HSR lines

HS Lines	*Tariff of 1st class of HST (euro/pkm)*	*Tariff of 2nd class of HST (euro/pkm)*	*Tariff of 2nd class of fast CT (euro/pkm)*	*Tariff of 2nd class of slow CT (euro/pkm)*	*Estimated load factor (%)*	
					HST	*CT*
Average level of the HST and CT running on 250kph lines	*0.045*	*0.037*	*0.019*	*0.009*	*65*	*93*
Average level of the HST running on 350kph or over lines	*0.082*	*0.054*			*55*	

4. FINANCIAL ASSESSMENT OF CHINA’s HSR INVESTMENT

A preliminary analysis with very limited public data

- 50%-70% of HSL investment was from market borrowing.
- Very large traffic volumes are needed to support the high financial, depreciation, and operating and maintenance costs
- For most of the operating HSRs, the initial financial performance was poor when compared with the ex-ante appraisals.

Estimate financial results of 4 HSL projects (m. CNY)

Item	2009	2010	2011	2012
Beijing-Tianjin	-702.59	-612.59	-661.16	-639.32
Wuhan-Guangzhou		-3255.00	-2045.65	-1003.04
Zhengzhou-Xi'an		-2192.92	-1990.40	-1762.56
Jian-Qingdao		3.92	192.83	333.42

The break-even traffic density of HSRs

	Tokaido Shinkansen*	Paris-Lyon TGV*	Beijing-Shanghai HSL	Wuhan-Guangzhou HSL	Qingdao-Jinan HSL	Beijing-Tianjin HSL	Zhengzhou-Xi'an HSL	China HSL (with 350 kph) in average
Tariff (Euro/pkm) in 2010	0.195	0.121	0.051	0.056	0.037	0.058	0.058	0.056
Traffic density (m pkm/km) in 2010	80	20	25	14	25	20	4	
Annual revenues per Km (m Euro/Km)	15.6	2.42	1.275	0.784	0.925	1.16	0.232	
Unit construction cost (m Euros /km)	34.00	15.20	19.31	15.69	6.27	20.51	12.07	15.68
I/O ratio per Km **	0.4589	**0.1592**	0.0660	0.0500	**0.1475**	0.0566	0.0192	
Initial financial performance	Full recovery of investment within 8 years	FIRR= 15%	Loss	Loss	Break-even	Loss	Loss	Break-even
Break-even traffic density corresponding to I/O ratio=0.145 (m pkm/km)	25.28	18.22	**54.90**	**40.63**	24.57	51.28	30.18	**40.60**

**: refers to traffic density* Tariff/unit construction cost

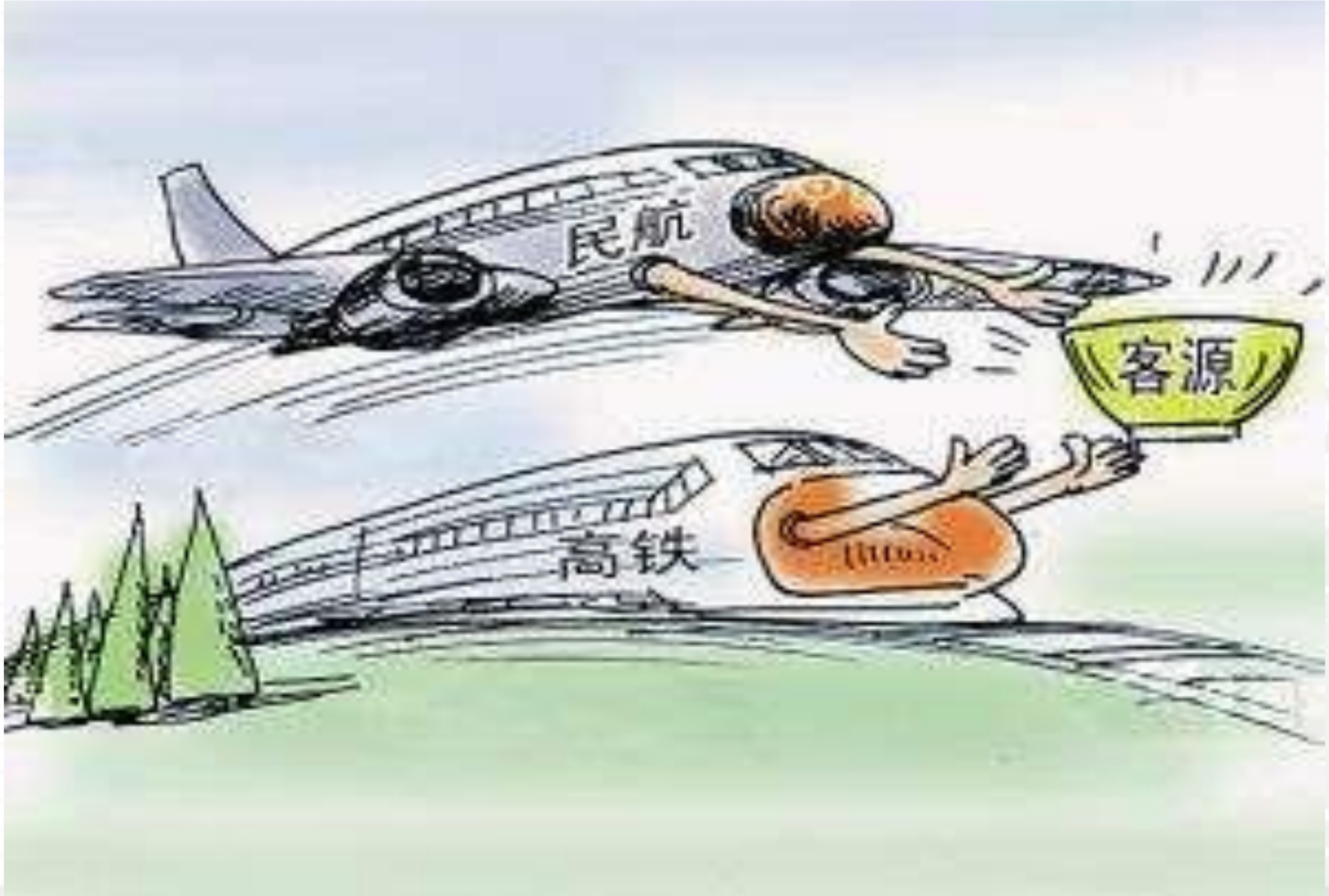
5. ECONOMIC ASSESSMENT OF CHINA's HSR INVESTMENTS

5.1 Mode split ,the competition between HSR & air
5.2 Time savings
5.3 The break even traffic to justify the investment of a HSL in terms of time savings
5.4 Additional capacity and its benefits
5.5 Reduced externalities from other modes
5.6 Wider economic impact
5.7 Some trial ex-post cost-benefit analysis of HSR projects

5.1 Estimate traffic composition of 3 HSRs

Item	*Wuhan-Guangzhou*	*Beijing-Tianjin*	*Jinan-Qingdao*
Diverted from conventional lines	*52%*	*55.39%*	*93.61%*
Diverted from aircraft	*6%*	*n.r.*	*n.r.*
Generated or shifted from road	*42%*	*44.61%*	*6.39%*
inc. road	*n.a*	*11.09%*	*n.a*
inc. generated	*n.a*	*33.53%*	*n.a*

5.1 The competition between HSR & air

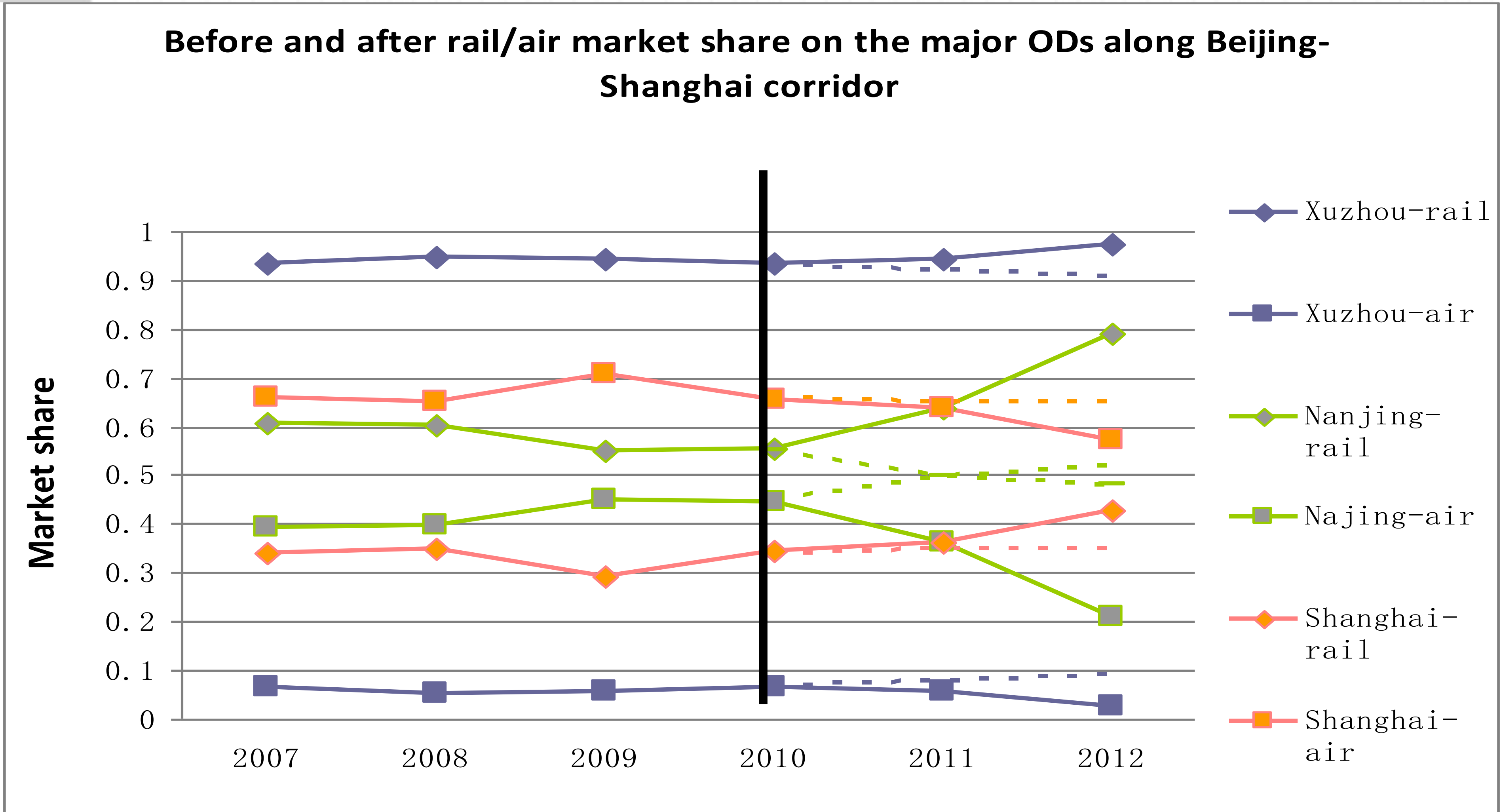


5.1 The competition between HSR & air

Rail/air share in Wuhan-Guangzhou transport OD pairs

	Before (2009)	After (2010)	Change
Aircraft	7.01%	2.86%	-4.16%
Conventional Train	92.99%	55.92%	-37.06%
HS Train	0.00%	41.22%	41.22%
Total	100.00%	100.00%	

5.1 The competition between HSR & air



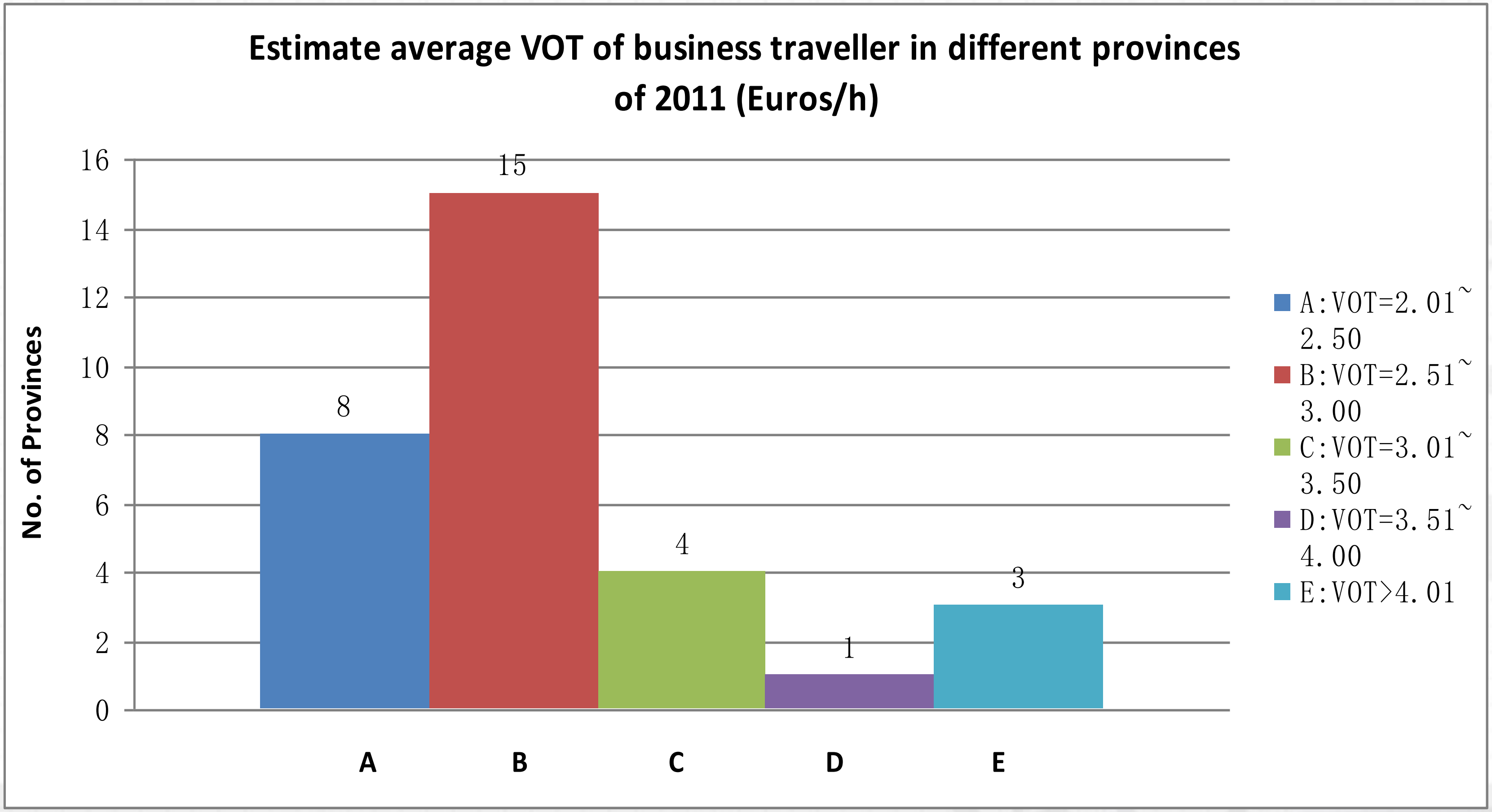
5.1 Change of rail/air market share caused by Beijing-Shanghai HSR

Airport	Rail distance to Beijing	Rail journey time to Beijing	Expected Impact to air before	Market Share %				Actual impact to air after
				Before (2010)		After (2012)		
				Rail	Air	Rail	Air	
Jinan	406 km	1.63h	-36%	91%	9%	98%	2%	-78%
Xuzhou	692km	2.85h	-67%	93%	7%	98%	2%	-64%
Nanjing	1023km	4.10h	-4%	55%	45%	79%	21%	-53%
Wuxi	1210km	4.90h	-2%	57%	43%	70%	30%	-31%
Shanghai	1318km	5.53h	-2%	34%	66%	43%	57%	-13%

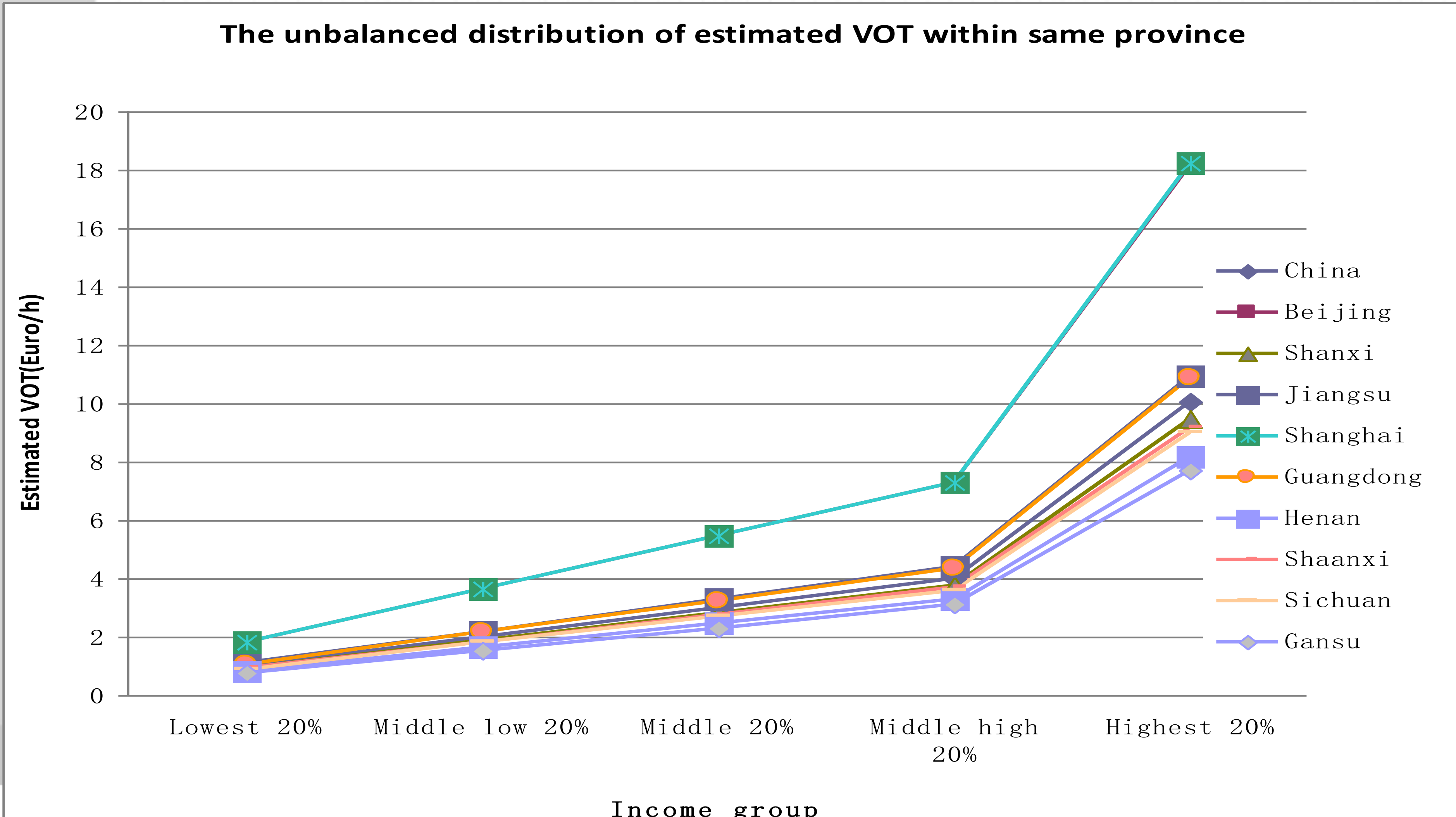
5.1 The competition between HSR & air

- In China HSR tends to have a market share of about 80% when rail journey times are within 4 hours or travel distance around 1,000km, which is significant higher or longer than those of the EU and Japan.
- This can be explained by the HSR’s rather cheaper price and higher frequency when compared with the air and also the heavy airport delay that happened so frequently in recent years.

5.2.1 Estimation of VOT in China



5.2.1 The distribution of VOT in China



5.2. 2 Estimation of the time savings per pass.

For a 500 km journey (Euros)	*Time savings per trip*	*Average VOT*	*Value of time saved per trip*
The operational speed of HS train with a max design speed of 250km/h at national average level	*0.88*	*2.27*	*1.99*
The operational speed of HS train with a max design speed of 350km/h at national average level	*1.79*	*2.27*	*4.05*
Beijing-Shanghai HS Line	*1.58*	*2.84*	*4.49*
Wuhan-Guangzhou HS Line	*1.68*	*2.09*	*3.51*
Zhengzhou-Xian HS Line	*1.69*	*1.97*	*3.34*

Q_i

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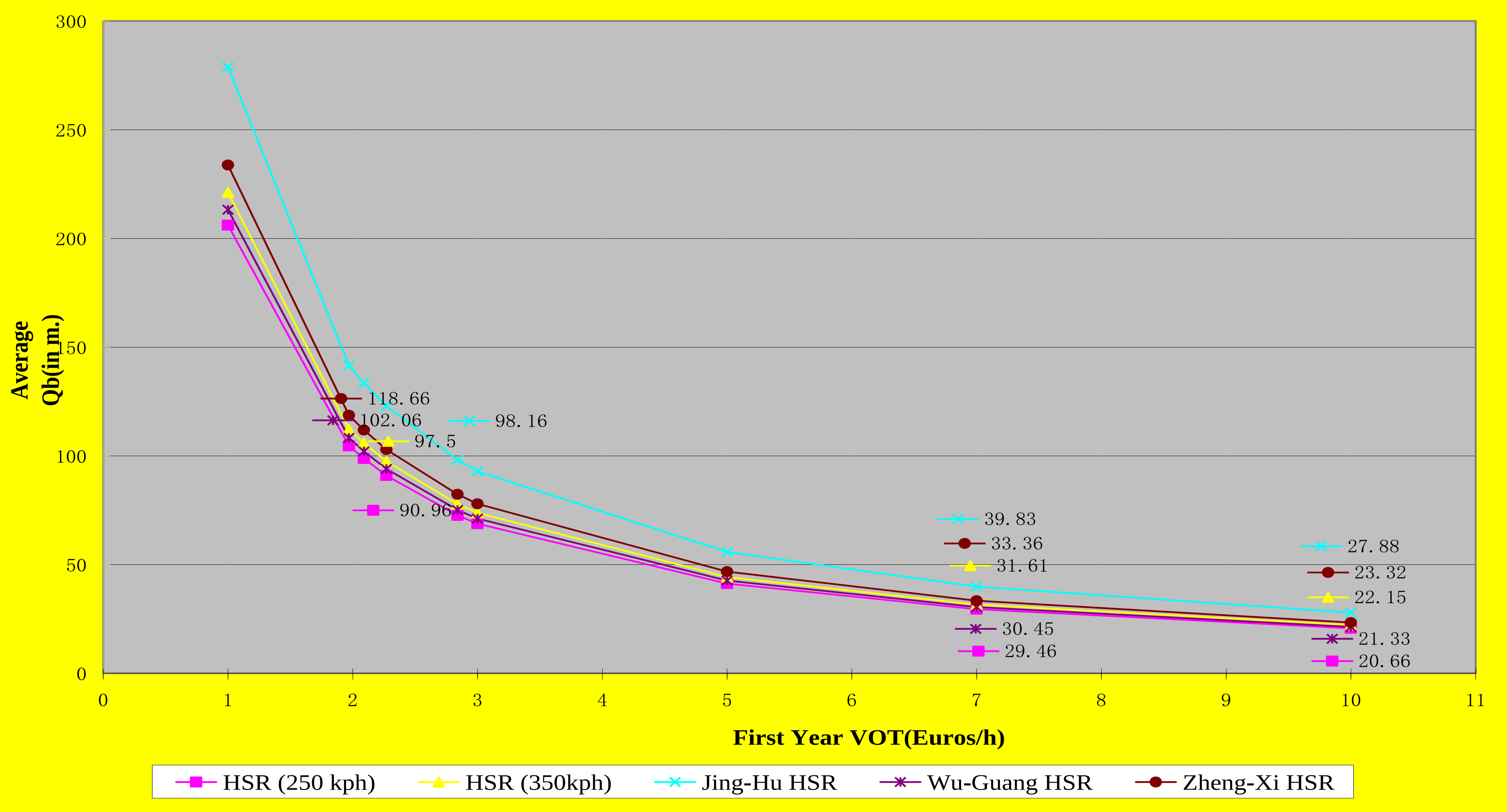
5.3 The break even traffic to justify the investment of a HSL in terms of time savings

$$B = \sum_{i=1}^{T} \frac{Q_i * \Delta t * VOT_i}{(1+\gamma)^{i-1}} - I_C$$

$$Q_{i+1} = Q_i * (1+\alpha_i)$$

$$VOT_{i+1} = VOT_i * (1+\theta_i)$$

Estimation of breakeven traffic for HSLs in China



5.4 Additional capacity and its benefits

- Many passengers of conventional trains refused to change to the passengers of the HSR with 350 km/h, mainly due to the high level of tariff and its lower axle load limitation prohibits the conventional passenger trains to run on it.
- Accordingly, a large number of conventional trains have to be kept running on the existing lines.
- So it is difficult to free up substantial capacity for freight trains on most of the existing lines.
- For the HSRs in operation, the additional revenue cargo volume that can be actually achieved in recent years is quite low, between one third and one tenth of that expected
- One of the problems is that high speed lines have only been built on some sections, and bottlenecks remain elsewhere on the main freight routes.

5.5 Reduced externalities from other modes

Energy consumption by train and air on a specific corridor in 2010

	Intercity train	HST (1000 km)	Air (900km)
Maximum speed	160	350	700
Seating capacity	1200	600	180
Load factor	90%	50%	81%
KWH per gross ton km	0.016	0.043	n.a
KWH per 100 passenger km	1.63	5.59	n.a
MJ per passenger km		0.61	1.28

Source: Wu, Cui and etc., 2011

5.5 Reduced externalities from other modes

- Given the composition of the HS traffic mainly from CT and new generation, the energy savings seem to be very limited.
- The introduction of HSR cannot lead to a substantial environmental advantage and where there is only limited diversion from air, it will undoubtedly lead to an increase in energy consumption.
- So the objective to reduce negative externalities will not happen unless HST can raise its load factor substantially and shift huge traffic from the other modes, especially from potential future car traffic.

5.6. Wider economic impact

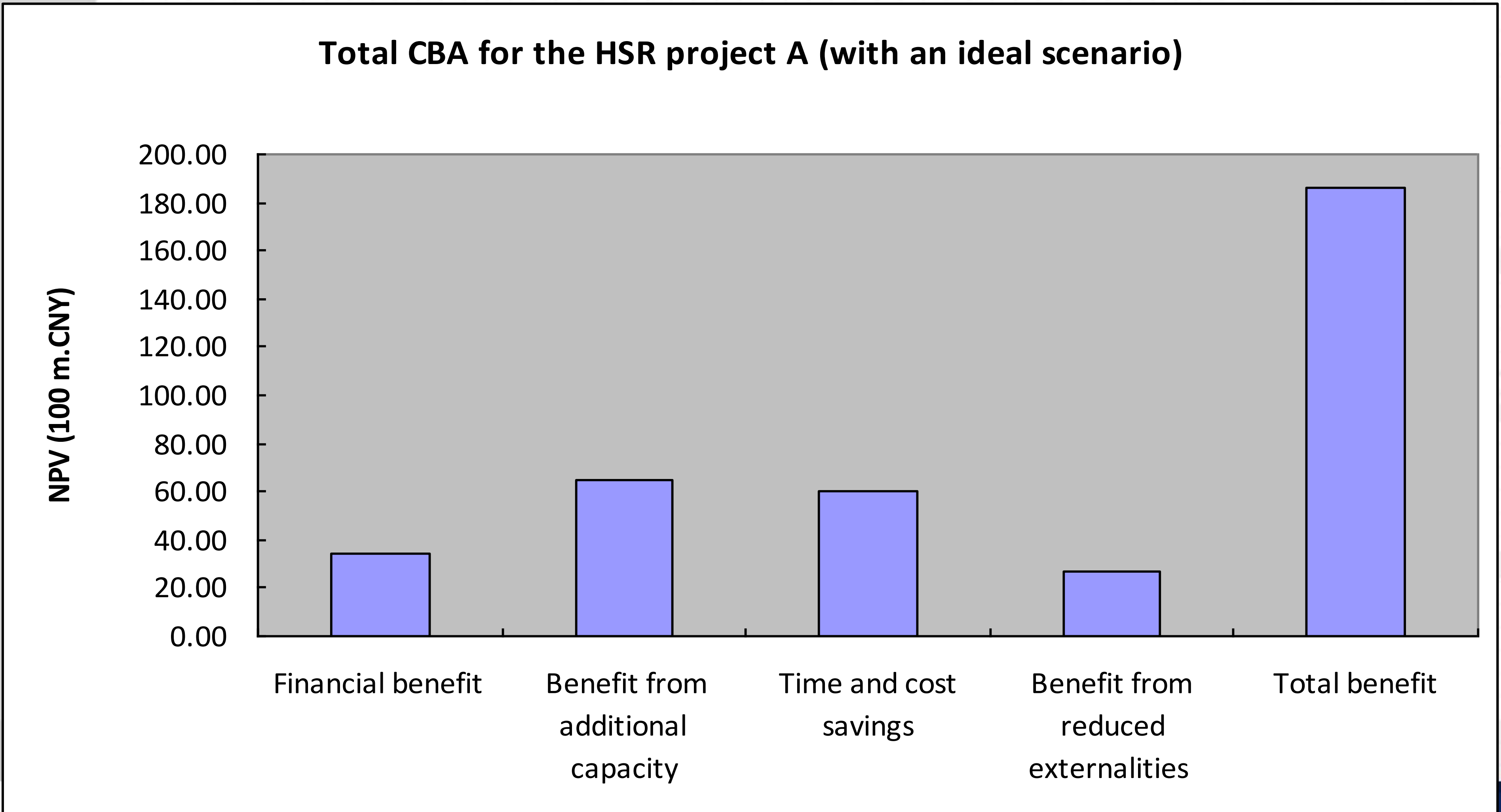
- The wider economic impact of HSR in China could be greater than in the EU.
- Officials from Dezhou city and Xuzhou city claimed that the land price around their stations of Beijing-Shanghai HSR rose more than 20 times after the operation of HSR. Further, as it has happened in the EU, there is also a negative impact of HSR on regional economic development.
- However, it is still difficult to quantify it at this moment not only due to their short time operation, but also because of the difficulty in separating the agglomeration economies induced by HSR from other reasons.

5.7. Some trial ex-post CBA of HSR projects

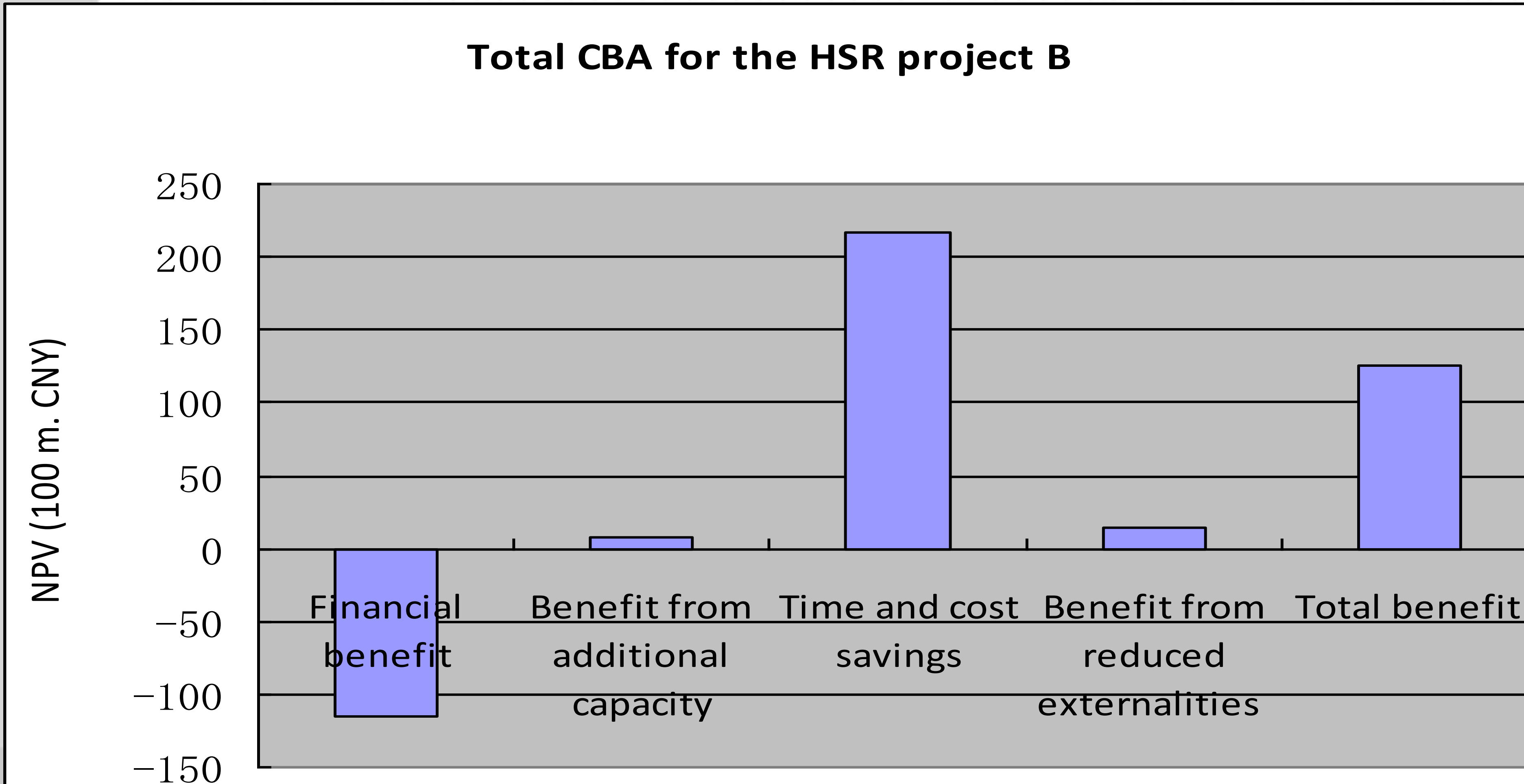
		Project A	***Project B***	***Project C***
FIRR	*Ex ante*	*≥6%*	*≥6%*	*≥6%*
	Ex post	*6.00%*	*positive, but less than 3%*	*negative*
EIRR	*Ex ante*	*≥20%*	*≥20%*	*≥20%*
	Ex post	*10.90%*	*10.00%*	*8.50%*

In China the official discount rate for financial evaluation has been 3% since 2006, while that for economic evaluation is 8%. The rail project evaluation period has been 25 years since 2006

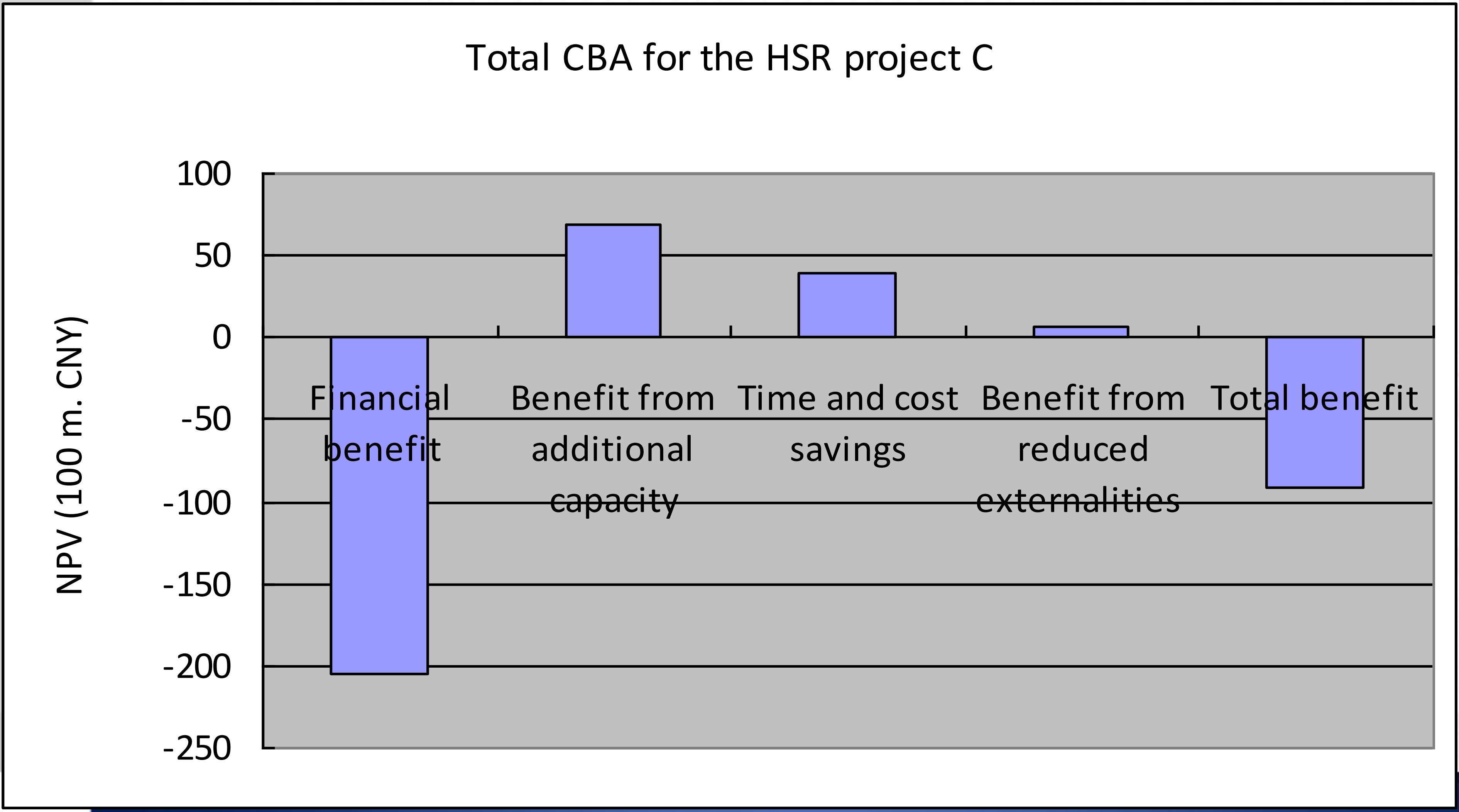
5.7 A trial ex-post CBA of a HSR project A



5.7 A trial ex-post CBA of a HSR project B



5.7 A trial ex-post CBA of a HSR project C



6. SOME TENTATIVE CONCLUSIONS

- A comprehensive appraisal should be undertaken for investing in a HSR project.
- The initial financial and economic performance of HSR in China indicates that deployment of HSR throughout the country to high technical standards is unlikely to be justified, esp for most of the HSLs built in the middle and west areas.
- The commercial breakeven traffic density in China for the 350 km/h HSL is about 40-50 million passenger trips per annum, while that for 250 km/h HSL is about 25-30 million. The construction cost and the level of debt funding are the most important variables in determining the breakeven volume.

- For a positive social cost-benefit ratio in China, solely in terms of time savings, it would require of the order of 100m passengers per annum justifying HSR. However, the additional volume of traffic needed to justify will be 28m passengers per annum in the case where a new advanced conventional will otherwise be built, so that it is only the incremental cost of high speed that has to be compared with the value of time savings.
- HSR in China seems to be more successful at competing with air than in the rest of the world.

- The introduction of HSR in China is unlikely to have significant environmental benefits unless load factors can be raised substantially and large volumes of traffic can be shifted from other modes in the future
- There is an urgent need to design and adopt a package of new HSR policies in China, both for improving the operational, financial and economic efficiencies of the existing HSR lines and for re-evaluating the HSR projects that are under construction or still in the planning stage.

- For HSR lines in the western part of China additional significant subsidy from central and regional governments will be needed not only for construction of infrastructure but also for high speed train operations.
- Network effects and evaluation of the wider economic benefits of HSR are important issues to be addressed for the future planning of HSR in China.

Thank you！ थैंक यू !

Q & A?