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The effects of the high-speed railway on urban development: International experience and potential implications for China

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Abstract

The unfolding high-speed railway (HSR) network is expected to have a great impact on Chinese cities. This paper discusses the international experience of the direct and indirect development effects of the HSR network on cities at the regional, urban and station-area level. It then discusses the potential development implications and planning challenges for China by translating the international experience into a Chinese context. Finally, future topics for research are identified.

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Keywords: Effects of high-speed rail; Urban development China; Planning challenges; Research challenges

Contents

1. Introduction	2
2. Direct effects.	4
2.1. Reduced travel time	4
2.2. Impact on the modal share of railways in the transport market	4
2.3. Towards an integrated transport system	7
2.3.1. Aircraft: from competition to cooperation	7
2.3.2. Integration with traditional railway systems and express buses.	7
2.3.3. Integration between HSR and urban transport networks	8
2.3.4. The HSR station: a connector	9
3. Indirect effects: regional level	10
3.1. A greater development gap between the connected and the unconnected.	10
3.2. Redistribution and relocation along the HSR corridor	14
3.3. A reconstruction of the urban-regional system	17
3.3.1. Commuter HSR and a new metropolitan process	17
3.3.2. Long distance HSR and an integrated functional region	17

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4.	Indirect effects: urban level.	18
4.1.	A catalyst for the restructuring of urban systems	18
4.1.1.	A catalyst for the restructuring of the urban spatial structure.	18
4.1.2.	An opportunity for the urban economy	19
4.2.	A synergy between HSR and urban dynamics	19
5.	Indirect effects: station-area level.	21
5.1.	How to define an HSR station area.	21
5.2.	The general function of a station area.	23
5.3.	Property development in the station area.	24
5.4.	Urban quality of the station area	24
5.5.	The development of station areas: a complex process	25
6.	The international experience of effects of the high speed railway on urban development: summary of findings.	26
7.	Potential implications and planning challenges for China	27
7.1.	The potential implications and planning challenges of direct effects of HSR	27
7.1.1.	Generation of HSR traffic	27
7.1.2.	Realization of a modal shift.	30
7.1.3.	Development of an integrated transport system	31
7.2.	The potential implications and planning challenges of indirect effects of HSR on the regional level.	33
7.2.1.	Enlarging the gap between the connected and not connected: population growth and economic activity	33
7.2.2.	Redistribution along the HSR line: tourism, business and the knowledge economy.	33
7.2.3.	The HSR as a factor in the reconstruction of the Chinese urban-regional system	34
7.3.	The potential implications and planning challenges of indirect effects of HSR on the urban level	36
7.3.1.	A catalyst for reconstructing the Chinese urban system.	36
7.3.2.	HSR and the need for synergy with the strategy of urban transformation	39
7.4.	The potential implications and planning challenges of indirect effects of HSR on the station-area level	41
7.4.1.	A balance between node and place.	41
7.4.2.	Coping with rising land values and real estate rents in the area around the station.	42
7.4.3.	Quality of place of the station area: urban design and beyond	42
7.4.4.	A complex station area development process: the limits of a physical planning tradition in China.	43
7.5.	Potential implications in China of HSR's effects on urban development: summary of findings.	43
8.	A final note on research challenges	47
	References	49

1. Introduction

High-speed rail (HSR) is expected to have a great impact on Chinese cities. China's emerging HSR network, at 11028 km, is already the biggest in the world (data as of December 2013: <http://www.nra.gov.cn/zggstlzt/>). This vast network drastically reduces travel times between major cities. It also binds cities together as integrated urban-regional areas and acts as a catalyst for reshaping their urban systems. Although China's construction of HSR shares common elements with similar, longer-standing projects in Western Europe, Japan, Korea and Taiwan, the unique magnitude and pace of modern Chinese urbanization, as well as the strategies adopted to manage it, present some notable differences.

Improving or at least not further depressing the quality of life in cities in the face of rapid, uncontrolled urbanization has become the key challenge of spatial development in China. Across the country, the

urbanization level grew from 36.22% in 2000 to 49.68% in 2010 (6th Census of Population in China, 2010). Meanwhile, the urban built-up area has expanded from 21,847.64 km² in 2000 to 40,533.8 km² in 2010, an increase of 85.5% (Wang et al., 2012). The resident population living in cities has increased from 455 million in 2000 to 665 million in 2010 (6th Census of Population in China, 2010), or an increase of 46.15% in ten years. This rapid, extensive urbanization, coinciding with the country's economic rise over the past 30 years, has created huge challenges, including the depletion of scarce land resources, disruption of natural environments, air pollution, traffic congestion, poor living and poor public health conditions. However, it is believed that rapid and extensive urbanization is set to continue. By 2015, the urbanization level is expected to rise 5% with respect to 2010 (12th Five-Year Plan, 2011), meaning that even more people would crowd into the cities and that the built-up area would be larger still.

Meanwhile, improving the quality of urbanization in all its ecological and social dimensions has been given high priority in the 12th Five-Year Plan, which is the most important current national policy document. The HSR is a major infrastructure that is expected to significantly affect urban development. Insight into these impacts, and of ways of influencing them, is crucial for any plan aiming to direct the development of a city or region. Accordingly, this paper looks at the role of HSR in this special phase of China's rapid and extensive urbanization, and the opportunities and threats it poses in improving the quality of urbanization.

At the national level, even though there is no official national spatial strategy, some clear directions for the spatial development of China have been set. The development direction has transformed from focusing on the East Coast in an unbalanced way at the beginning of the reforming and opening-up in the 1980s to a more balanced development between inlands and the East Coast in order to reduce the ever-growing development gap between the two (Li, 2012). The strategy can be seen reflected in for instance the policies of "The Development of Chinese Western Regions" (CPGPRC, 2000), or "Rising of Central China" (CPGPRC, 2006)". The issue is raised of whether the high-speed railway can support the national spatial strategy of the coordinated and balanced development across the country.

This largely implicit national spatial strategy has been more explicitly implemented by many spatial plans of megacity regions. The Chinese central government has approved many megacity region plans since the year 2000, especially following the 2008 financial crisis, with the aim to push the development of different areas in China. These plans set out the spatial strategies for improving the connection between different cities in the megacity regions, coordinating industrial development between them, and reinforcing their competitive position. This paper discusses the role of HSR in these megacity region strategies and how it can support them.

On an urban level, spatial transformation has become the most important strategy of many cities. After the rapid and extensive development of the last 30 years, more and more cities face the challenges of what has been called the "urban disease", which includes urban sprawl, a poorly built physical environment, traffic congestion and the loss of urban and environmental quality, especially for the megacities of Beijing, Shanghai and Guangzhou. In order to solve this "urban disease" through spatial transformation, many practices have been implemented such as adopting a so-called polycentric urban system, developing new towns, and

encouraging the deployment of public transport. The interrelationships between high-speed railway and spatial structure are considered as a critical factor in the development of cities. This paper will highlight the role of HSR in the urban spatial transformation strategy and how to respond the opportunities it presents at a local level.

The development of the areas that surround HSR railway stations has become a heated topic of discussion in China. The strategy for the station area is to combine the development of the station with that of a new city centre or new town. HSR is considered to be an important condition in the development of station areas; this paper considers the role HSR will play in that development.

All of these issues make it important to pay attention to the potential effects of HSR on urban development in China. Although there are some discussions about this topic based on the international experience and there is a recent publication pointing out the challenges stemming from HSR development (Chen, 2012), there is still no systematic discussion relating to actual urban development effects abroad, potential effects in China and ensuing planning and research challenges. This paper aims to fill this gap. Accordingly, we must first assess the impact of HSR abroad and then discuss the Chinese context.

Due to the very recent nature of HSR and urban development in China, little evidence exists of its actual impact on cities. This observation provides the rationale for our approach and the structure of the paper: first looking for evidence of actual impacts in contexts where enough time has passed to observe them, and then reflecting on potential impacts in China, based on the specific characteristics of the Chinese context, and, when available, on emergent evidence.

The paper addresses the following sets of questions:

1. What are the urban development effects of HSR? What are the experiences of other countries?
2. How should planners respond to the expected effects of HSR in China, given the specificities of the local context? What can China learn from the experiences of other countries?
3. What are important areas for further research for China?

The first set of questions is answered through a literature review covering the urban development effects of HSR in Japan (Shinkansen), France (TGV), Spain (AVE), Germany (ICE) and other countries. In the literature, there are usually two different perspectives in

discussing the urban development effects of HSR. The first perspective distinguishes between direct, indirect and external effects. Direct effects are the direct costs and benefits of HSR for passengers (travel costs, reduced travel times) and HSR builders and operators (construction and operating costs, ticket revenues). Indirect effects are the costs and benefits for actors in the economic system that do not use, build or operate the HSR themselves. External effects are costs and benefits for which no evident economic value can be assigned, such as effects on the natural environment or on the quality of life. The second perspective discussed in the literature classifies HSR's effects into those at national, regional, city and station levels, according to their spatial scope. These two perspectives are not mutually exclusive. Direct, indirect and external effects can be shown at each spatial level and the effects at each spatial level include both direct and indirect components.

In order to shed light on the effects of HSR on urban development, this paper adopts a combined perspective. It focuses on the direct and indirect effects of HSR on urban development (external effects, while important, are still not reflected in enough consolidated findings in the literature). The direct (transport) effects constitute a relatively well-defined domain, but one cutting across different spatial levels; it therefore seems appropriate to discuss these effects separately, and by combining the different spatial levels. On the contrary, indirect effects are both more difficult to isolate and more focused on a particular spatial level, and so the discussion of indirect effects will be organized along spatial levels. There are few studies focusing on the national level, hence they have been integrated into the regional level, which is also more directly relevant considering the urban development focus of this paper.

The literature review addresses the direct transport effects (Section 2) and indirect effects of HSR at a regional level (Section 3); urban level (Section 4); and at a local/station area level (Section 5). It is important to note here that this literature review framework is chiefly a way of organizing the material, and does not aim to provide explanations itself, for instance by suggesting causal relationships. Combining these insights with those specific to the Chinese context, in Section 7, we will answer the second question by discussing the potential urban development implications and planning challenges of HSR for China. Finally, answering the third research question, in Section 8, this paper points out the main HSR-related topics deserving future research in a Chinese context.

2. Direct effects

2.1. Reduced travel time

Reduced travel time is one of the most important effects of HSR, which often helps it win political and public support. Journey times on high-speed lines are drastically lower than those of conventional railways. An illustration of this can be seen in Japan which inaugurated its Shinkansen high-speed service in 1964. Over the first 11.5 years of operation, it is estimated that 977 million journeys were made on the network, saving passengers a total of 2246 million hours over the use of conventional trains (Sanuki, 1980). Enormous time savings can also be seen in France, Germany, Italy, Sweden, Spain, South Korea and Taiwan (see Table 1). Fast travel time has become an important reason for people to choose HSR as a transport mode. In Italy, for instance, 71.2% of HSR users along the Rome–Naples corridor declare that their main reason for choosing HSR is the reduced travel time (Cascetta, Papola, Pagliara, & Marzano, 2011).

2.2. Impact on the modal share of railways in the transport market

Every new mode of transport impacts the distribution of modal shares in the transport market. HSR is no exception. With the advantage of high frequency, shorter travel times, a comfortable travelling environment and “centre-to-centre” connections, HSR has a tremendous opportunity to win market share from other transport modes in certain contexts, mainly depending on the time travel gains relative to other modes.

The gain to passengers, in terms of time savings, varies according to the distance of the journey (Hall, 2009; Pepy & Leboeuf, 2005; Pepy & Perren, 2006). For trips less than 150 km, HSR has little advantage over conventional trains or cars, which give greater flexibility and easier door-to-door connectivity. For distances between 150 km and 400 km, passengers reach their end destination faster with HSR than by driving on a highway. Between 400 km and 800 km, HSR is the fastest mode for personal travelling, beating both air and road travel in terms of door-to-door journey times. Beyond 800 km, air travel is faster (Pepy & Leboeuf, 2005; Pepy & Perren, 2006). Japanese and European experiences suggest that HSR should obtain 80–90% of traffic in the distance range between 150 km and 500 km, and capture 50% up to about 800 km. The competitive range could potentially extend to 1500 km

Table 1

Travel times: HSR versus conventional railways.

Country/line		Journey time: conventional railway	Journey time: HSR	Change	Distance (km)	Year opened	Source
Japan	Tokyo–Shin Osaka	6 h 30'	4 h'	–38.33%	515	1964	Sands (1993)
	Shin Osaka–Hakata	8 h 30'	4 h 40'	–45.10%	554	1972/1975	
France	Paris–Lyon	–	2 h 20'	–	427	1981/1983	Bonnafeous (1987)
Germany	Frankfurt–Cologne	2 h 13'	59'	–55.64%	177	2002	Ahlfeldt and Feddersen, (2010)
Italy	Rome–Naples	1 h 45'	1 h 5'	–38.10%	213	2005	Cascetta et al. (2011)
Spain	Madrid–Seville	5 h 55'	2 h 30'	–57.45%	535	1992	De Rus and Inglada, (1997)
Sweden	Stockholm–Eskilstuna	1 h 40'	1 h	–40.00%	115	1997	Fröidh (2005)
South Korea	Seoul–Busan	4 h 10'	2 h 40'	–36.00%	441.7	2004	Chang and Lee, (2008)
	Seoul–Mokpo	4 h 40'	2 h 58'	–36.43%	414.1	2004	
Taiwan	Taipei–Zuoying (Kaohsiung)	4 h 50'	1 h 34'	–67.59%	345	2007	Yung-Hsiang (2010)

at the maximum practicable present speed of 350 km/h (Hall, 2009).

There are many before-and-after-opening quantitative field surveys of shifts in modal share for different HSR lines (see Table 2 for an overview). Such shifts involve both traffic substitution (from other modes to HSR) and new traffic generation (trips that were previously not taken). Looking at the cross-country comparison of modal share of HSR for similar distances, it is clear that the volume of traffic substituted to and generated by HSR is highly country-specific. Take Spain's AVE as an example. The modal share of rail on the Madrid to Seville corridor after two years of operation (including AVE and traditional rail) rose from 14% to 51%, while the market share of aviation decreased from 40% to 13%; road journeys (bus and car) dropped from 44% to 36% (Givoni, 2006). Of those who chose HSR, some 32% switched from air, 25% from car, 14% from existing rail services and 26% were passengers whose journeys were triggered by the presence of the HSR (Vickerman, 1997). Similarly, in France and Japan, the volume of traffic generated was far greater than would be expected in an average context. For example, on France's Paris–Lyon line, passenger numbers reached 19.2 million in 1985 – an increase of 7 million relative to 1980, higher than the forecast increase of 5.9 million. Of this, 49% was newly generated traffic. Likewise, in Japan, passenger numbers exceeded forecasts by 20% in the first year of operation of the Sanyo line (Osaka–Hakata).

By contrast, passenger numbers fell short of expectations in Germany, Taiwan, and South Korea (Chang & Lee, 2008; Vickerman, 1997; Yung-Hsiang,

2010). In the first five years of operation of Germany's ICE, according to the estimation of Deutsche Bahn, ICE traffic accounted for 28% of long-distance passenger revenues. Some 12% of this HSR traffic came from former road and air passengers. All figures were lower than expected (Vickerman, 1997). In Taiwan, the amount of passengers of HSR in the year 2010 was, after three years of operation, only 50.5% of the amount originally forecast (101,000 trips per day, while the original forecast was for a daily ridership of 200,000). Similarly, in South Korea, the amount of passengers on the KTX's Seoul–Busan line in the year 2004 was only 46% of the amount originally forecast (Chang & Lee, 2008).

According to the authors cited, several country-specific reasons explain the differences in the modal share of HSR across the countries studied. In the case of Germany, the spatial and urban structure may explain the lower-than-anticipated use of HSR. Compared with France, the German urban system does not have a great mono-centric focus, and urban centres are relatively close to each other. Furthermore, there is an extensive inter-urban highway infrastructure which is free to drive on, whereas motorists in France must pay costly tolls. This may explain why HSR passenger numbers in France have been higher than in Germany. In the case of Taiwan, business travel demand was lower than forecast mainly due to manufacturing companies moving to Southeast Asia and the Chinese mainland in the intervening period (Yung-Hsiang, 2010). Also, poor integration between different transport modes is seen by this author as a reason for the weak performance of HSR in Taiwan. As is the case in many other countries, it

Table 2

Change of transport mode market shares after the introduction of HSR.

HSR systems (nation/line)	Mode split after the starting of the operation of HSR	Source
Sanyo Shinkansen line	By the first year of opening, in 1975, passenger numbers had increased as much as 40% compared with 1971. - 55% transferring from the narrow-gauge lines - 30% from other modes of transport (including 23% from airlines) - the stimulus of new travel accounted for 6% - the remaining 9% increase was of an unknown origin	Okabe (1980)
TGV Sud Est line	Growth in train users came from: - 33% air travel - 18% automobile travel - 49% newly induced traffic	Bonnafoous (1987)
ICE network	In the first five years of operation of ICE, passenger numbers more than doubled; ICE traffic accounted for 28% of Deutsche Bahn's long-distance passenger revenues. 12% of this traffic was diverted from road and air.	Vickerman (1997)
AVE Madrid-Seville	After two years of operation, rail's share of the market grew from 14% to 51%; air decreased from 40% to 13%; and bus and car share decreased from 44% to 36%. Some 32% of HSR travellers were former air passengers; 25% former car passengers; 14% were diverted from conventional railway; and 26% were the result of newly generated traffic.	Givoni (2006), Vickerman (1997)
Svealand line	The rail service's market share increased from 6% to about 30% for regional trips. New rail passenger growth came from: - 30% the former SJ bus service - 25% regional public transport authority's former bus service -15% from car travellers - 30% from new travellers	Fröidh (2005)
Rome- Naples	Between the years 2005 to 2007 the share of train and car changed from 49% and 51% to 55% and 45%, respectively: - 22.3% of weekday HSR train users represent a newly-generated demand (12.5% generated by new trips, 9.8% generated by an increase of trip frequency) - 7.8% demand was subtracted from car travel - 0.6% demand was subtracted from air and bus travel - 69.2% demand was subtracted from IC (Intercity) and EC (Eurostar) conventional trains	Cascetta et al. (2011)
Gyeongbu line	Before the opening of KTX, the South Korean HSR, from April 2003 to March 2004, the market share of automobile, express bus, air and conventional rail was 12.1%, 7.8%, 42.2% and 38.0%, respectively. After the initiation of KTX, the high-speed service captured 50.4% of the entire transport market, while the express bus, air and conventional rail had their share reduced to 9.4%, 4.7%, 25.0% and 10.5%, respectively, in the period from April 2004 to March 2005.	Chang and Lee (2008)
Honam line	Before KTX opened, from April 2003 to March 2004, the market share of automobile, express bus, air and conventional rail was 59.1%, 14.3%, 3.1% and 23.5%, respectively. After the initiation of the high-speed operation, KTX captured 21.1% of the entire transport market, while the express bus, air and conventional rail had their share reduced to 53.8%, 14.9%, 1.1%, and 9.0%, respectively, in the period from April 2004 to March 2005.	
Taipei – Kaohsiung	HSR entered service in April 2007 and had a 25.03% in share of the market that month. One year later, it had a 49.64% share of the market. 8% of demand was new after HSR entered the intercity transportation market: Between April 2005 and April 2008, market share of other modes changed on the Taipei-Kaohsiung line as follows: - The intercity bus service decreased from 35.29% to 22.28% - Conventional rail went down from 7.76% to 2.50% - Air travel decreased from 28.73% to 4.97% - Car travel dropped from 28.22% to 20.61%	Yung-Hsiang (2010)

appears that developing an integrated transport system is crucial to the performance of the HSR. This point will be expanded upon next.

2.3. Towards an integrated transport system

Developing an integrated system is not only beneficial to the system itself but also to passengers and the regions served by the lines. It is important to remember that HSR is only one element of a total transport system in an urban area and that it should contribute to bringing passengers “door-to-door” in the vast majority of trips reaching beyond the access points of HSR. A properly integrated transport system, where HSR is complemented by other modes, can avoid disorderly competition, encourage a sensible distribution of occupancy and stimulate cooperation among operators. It is also worth remembering that the impact of HSR may not only be beneficial to the cities it connects, but also to the cities in surrounding regions. In order to achieve this, it is desirable that an urban region be linked to a network of HSR lines, with regional services operating in harmony with HSR through seamless connections and timetable-matching. Done in this way, an integrated transport system can improve the spatial penetration of HSR, putting it within reach of more passengers. The following sections will discuss in more detail the relationships with different modes with which HSR can integrate.

2.3.1. Aircraft: from competition to cooperation

HSR competes with air travel in medium to long distances. Hall (1991) has made some assumptions comparing the time differences between HSR and air travel in terms of door-to-door journeys. In a city-centre-to-city-centre HSR journey, travellers are assumed to be able to reach the train station in 15 min and then the train in another five minutes; at the other end, 15 min are allowed to reach the final destination. For air, the model is based on a 45 min journey to the airport and another 60 min for check-in and waiting time; at the other end, five minutes are calculated to exit the terminal and another 45 min to arrive at the final destination. The total access and waiting time is thus modelled at 35 min by rail and 155 min by air. On this basis, the break-even distance between HSR and air is 530 km for a 200 km/h high-speed train or 960 km for a 300 km/h high-speed service (Hall, 1991).

Evidence also suggests that HSR competes strongly with air travel on many shorter-distance links between major metropolitan areas (see also Table 2). In France, between the years 1980 and 1985, the total number of

journeys on the 450 km Paris–Lyon route went up by 56%. Per train, the number of passengers rose by 151% while the number per aeroplane declined by 46% on average (van den Berg & Pol, 1998). In Japan, when the Shinkansen Hikari trains began full-scale operation in 1967, the passenger volume of Nagoya Airport was reduced from fifth to 19th position among 88 national airports; passenger volumes shrank by 75% and took seven years to return to their pre-Shinkansen level (Sanuki, 1980).

Even though HSR is a competitor to the aeroplane, it can also provide fast, comfortable access to the airport and enlarge the service area of airports that are connected with the HSR network. Airports can benefit from HSR’s complementary service and develop higher-level services such as intercontinental flights. A typical example is the airport of Lyon-Satolas, which is the third-largest in France. Since the Paris–Lyon HSR began in 1981, the volume of passengers using the airport in Lyon–Satolas fell at first; however, because a HSR terminus was built there, the airport went on to benefit from improved accessibility to an enlarged radius of 400 km, which contributed to the launch of intercontinental flights there. By 1996, international traffic had surpassed the 50% mark at Lyon-Satolas for the first time. This example clearly illustrates how HSR and air travel can complement each other: better access by HSR increases the development prospects of international flights, and a growing number of such flights make it more attractive to locate HSR stations in airports (Thompson, 1995; van den Berg & Pol, 1998).

There are two scenarios in which the integration of HSR and air travel can take place. One way is to create a direct HSR line to an airport (as in Paris, Lyon, Frankfurt or Amsterdam), or even offering a seamless rail–air journey possibility as is the case the case in Germany where Deutsche Bahn teams up with Lufthansa to offer code share ticketing and shared baggage handling (Grimme, 2006), or with the partnership between Thalys and KLM in Schiphol, Amsterdam’s airport. The other scenario for integrating HSR and air travel is through a public transport link (metro, regional railway or express bus) to connect the two modes such as between airports and HSR stations in Lille Europe, Brussels South, Madrid Atocha or London St. Pancras. In Table 3, we can see that several HSR stations in Europe have good connections to airports through public transport and car links

2.3.2. Integration with traditional railway systems and express buses

HSR relies on integration with the traditional railway system, express buses and related modes. In Japan, the

Table 3

Examples of connections between HSR stations and airports.

HSR station	Airport	Transport time by train from station	Connection time (h)	Via	Travel time by car (off-peak times)
Lille Europe	Paris Charles de Gaulle	0:49	1	Direct	1:50
	Lille Airport	0:29	1.67	Lille Flanders	0:16
Brussels South	Brussels National Airport	0:21	4	Direct	0:19
	Paris Charles de Gaulle (F)	1:51	2	Direct/Paris North	2:35
London St. Pancras	London Heathrow	0:56/0:45	8	Direct (4)/Paddington (4)	0:41

Source: de Jong (2007).

great success of Shinkansen is largely attributable to the reinforcement and improvement in the service of the narrow-gauge lines that feed into the high-speed service. Similarly, when the Shinkansen was extended to the southern city of Hakata, the number of buses operating between Hiroshima and Hamada to connect with the Shinkansen was increased and high-speed ferry boats from Mihara to Shikoku Island were introduced. These initiatives reinforced and complemented the high-speed train service (Okabe, 1980). It is a similar picture in the southern Italian region of Campania, where the HSR stations are part of an integrated transport strategy. The new HSR station of Naples connects seamlessly with regional rail services operated by two different private companies. The HSR station is also integrated with the regional metro system (Cascetta & Pagliara, 2008).

Taiwan's HSR story provides a contrasting example; here the decision was taken to locate many HSR stations on the outskirts of the cities away from traditional railway stations in the city centres. Only four of the eight HSR stations in operation (Taipei, Banciao, Zuoying and Taichung) share services with conventional railway systems. The frequency of traditional railway also does not fulfil passengers' requirements due to poor timetable matching; this is one of the reasons for the poor performance of HSR in Taiwan in terms of passenger numbers (Yung-Hsiang, 2010). Due to the legacy of poor integration that this created, the Taiwanese government is now aiming to strengthen the links between the HSR and traditional trains. However, it faces major civil engineering (in centrally located stations) and technical and operational (in peripherally located stations) challenges in doing so.

Integration with traditional railway systems and express buses is very important, but not easy to achieve. Firstly, planners have to confront technical issues, such as different track gauges, electrification voltages and signalling systems (Hall, 2009). Secondly, there are

operational challenges such as timetable-matching and integrated ticketing. Thirdly, there is a civil engineering and financial challenge in creating additional capacity in prime city centre locations. Underground construction solutions are often required; however, governments may not be keen on the extra cost and disruption that tunnelling can provoke. On the other hand, peripheral locations need to connect new stations and old stations. This poses a different integration problem and the challenge of finding the extra funding to invest in new public transport infrastructure.

2.3.3. Integration between HSR and urban transport networks

As a transport mode, HSR rarely provides a door-to-door service between cities. Thus, integration with the urban transport system including public transport and car parking at each end of the journey is crucial. Adaptations to the urban transport system are nearly always required and the level and feasibility of these adaptations depends, chiefly, on the location of the station, whether it is central or peripheral (van den Berg & Pol, 1998).

For central locations, public transport connections are typically better; however, car accessibility is usually poorer. According to many analysts, no matter how much planners would like to see people travel by public transport, good car accessibility to the HSR stations can be a decisive factor, especially for business travellers who place a premium on comfort and short travel time (de Jong, 2007). With respect to car accessibility, two elements can be distinguished: road connections and, especially, parking facilities adjacent to HSR stations. Despite the realities of urban traffic policy (encouraging public transport, limited car parking spaces, efforts to discourage the use of cars), it does seem necessary and desirable to provide selective car access to centrally positioned HSR stations. Selective car access can be achieved by introducing or intensifying the price

mechanism on access roads and/or parking facilities near the HSR station. Another way to achieve selective car access is to lay out dedicated access roads to so-called “destination car terminals” such as multi-story car parks (as at the HSR station of Liège in Belgium). Promotion of taxi transport can also help to keep the HSR station internally accessible for traveller groups that place a value on speed and direct door-to-door connectivity. Taxis offer individual accessibility without the need for additional (long-term) parking spaces (van den Berg & Pol, 1998).

By contrast, peripheral locations are characterized by easier car accessibility and worse public transport accessibility. At these locations, public transport integration is typically focused on the connection between the HSR station and the city centre, rather than on orbital links. Poor public transport connections are a reason why HSR does not always live up to expectations in terms of passenger volume or development impacts at these stations (see also Section 3). Take the Gifu-Hashima station in Japan, for example. Since this HSR station opened almost 30 years ago, relatively little development has happened at the station or its immediate surroundings. One of the main reasons for this failure is that the urban public transport service to the city centre has not been improved (Sands, 1993). In France, an example of poor integration between the

HSR station and the city centre is at Avignon, where, due to financial problems, there is only a shuttle bus to connect the station with the city centre. The bus is affected by road traffic, leading to delays or connection disruptions during rush hours. This lack of interconnectivity has impacted the development potential of the station area (Todorovich, Daniel Schned, and Lane, 2011).

2.3.4. The HSR station: a connector

Ideally, different transport modes should integrate at HSR stations. The physical organization of Euralille, the HSR station at the heart of the city of Lille, in France, literally visualizes this ambition (see Fig. 1). While in other instances this ambition may be less visible, it is equally important. The railway station is a node which supports the transfer between modes, even if this connection cannot be completed in the railway station for reasons such as transport organisation, or capacity. It is a “connector” (Van der Spek, 2003) which joins up various forms of transport and all kinds of functions related to travelling.

The ideal state in HSR stations is for seamless transfer. It should be safe, reliable, fast, hassle-free, comfortable and pleasant, thus meeting travellers’ demands. The design of the connector should reduce “transfer resistance”; the station area should be

Fig. 1. Euralille, integrating HSR, traditional rail, local public transport and road infrastructure at the heart of the city.
Source: Euralille

spatially defined by all possible transfer routes connecting the different transport modes. The area need not have a uniform shape – the space will depend on the situation of the stops and may extend to multiple levels to include indoor and outdoor space, as well as public and private space (Peek & Louw, 2007). To enable these transfers and meet the needs of passengers, a railway station must provide the following: secure access, loading and standing for vehicles of all modes to stop or be parked; clear spatial orientation for passengers moving between transport services; waiting areas and information that supports passengers who are making connections; and related services such as ticketing and lost-and-found offices (Zemp, Stauffacher, Lang, & Scholz, 2011).

Tapiador, Burckhart, and Martí-Henneberg (2009) use a concept of inter-modality as measured by the distance between modal stops (such as bus stops, regional train stops, car parks, bicycle racks and taxi ranks) and the time required for a traveller to transfer from one mode to another, taking into account all possible combinations. This is applied through empirical research of 27 HSR stations in Europe. The empirical work shows that the Swiss system provides an example of good practice. The transfer system there is promoted by the following features: punctual and high density trains, bus and coach services; consistent departure and arrival platforms; timetables that optimise combinations between different modes of transport; good access to the station for private cars and taxis; and safe storage areas for bicycles. Combined, these features help provide a good door-to-door service for commuters and other travellers. At the other end of the scale, the Toledo HSR station in Spain is recognized as a case of poor planning for inter-modality. Car access was penalized as the new system included an increase in the cost of car parking near the station. The result was increased traffic congestion in neighbouring areas. Furthermore, the regional bus station is half a mile from the HSR and connecting local bus services are infrequent (Tapiador et al., 2009).

So far, we have discussed the direct effects of HSR, focusing on the transport effects. In the next section we will examine the indirect effects, which are of particular interest to economists, urban geographers and urban planners.

3. Indirect effects: regional level

At a regional level, HSR changes the absolute and relative accessibility of different cities. This can increase mobility opportunities, enabling businesspeople and

tourists to travel longer distances. Through changes in the relative accessibility of centres, HSR also influences the choice of location for individuals (housing, place of work) and for firms (office sites), leading to a regional spatial redistribution.

A great deal of research both with empirical and model-based approaches has been done to investigate HSR's spatial development effects at regional level. Most studies focus on the disparity between regions that are connected to HSR and those that are not. They also examine the distribution of cities along HSR lines within the region and how this structure changes after the introduction of HSR. This research will be discussed in this section.

3.1. A greater development gap between the connected and the unconnected

Research points out the relationship between regional economic and social development and connection to the HSR. In Japan, for example, Okabe (1980), Kamada (1980), Sanuki (1980), Hirota (1984), Nakamura and Ueda (1989), Amano and Nakagawa (1990), Sands (1993) and others have extensively investigated the Shinkansen regional development effects. In France, Bonnafeous (1987), Pidea (1991), Plassard (1989) and Nyfer (1999), among others, focused on the impact of TGV. There is also more recent evidence from Spain, South Korea and the UK. The picture, in terms of cause/effect relationships is, however, more complex. In Japan, for example, data shows a close link between GDP and ridership of the Shinkansen; the government there believes that transport infrastructure spurs economic growth, but showing a simple cause/effect relationship has proven difficult (Smith, 2003). In France's TGV Atlantique, substantial growth has taken place at Le Mans, Nantes and Vendome after connection to HSR. However, these were cities where local conditions were also buoyant (Banister & Berechman, 2000).

Several studies show that the disparity between connected and unconnected cities and regions tends to become larger as HSR may create new location advantages for the connected cities and regions, but also disadvantages for cities and regions not served by the new networks (Vickerman, Spiekermann, & Wegener, 1999). These disparities can be captured by looking at the economic performance of businesses in information, communications and entertainment (van den Berg & Pol, 1998) that can be expected to be sensitive to HSR access. These include developments in business services, urban tourism, and congress and fair activities (see Table 4). Research has compared

Table 4
Development effects of HSR on the regional scale.

HSR systems	Development effects	Source
<i>Population</i>		
	Station locations on the HSR route showed marginally-higher than average population growth.	Amano and Nakagawa (1990)
Tokaido line	Cities with a Shinkansen station experienced growth rates that were 22% higher than cities without an HSR station.	Hirota (1984)
	Three of six prefectures (provinces) that have one or more Shinkansen station grew more than the national average. For those without any HSR station, some grew below the national average and some even shrunk.	Nakamura and Ueda (1989)
Tohoku Line	Cities close to the HSR grew in population by 32%. Cities in the same region, but located further away from the HSR line, saw no population growth.	Obermaier and Black (2000)
Madrid- Seville	The disparities from 1991 to 2001 become larger than from 1981 to 1991 between connected and non-connected cities. Along the HSR line, there are two large cities, Ciudad Real and Puertollano. Ciudad Real successfully attracted population and housing investment from inside and outside the province, while Puertollano showed a completely different pattern. Its population grew at a rate of only 4.29% from 1981 to 2007; this rate in Ciudad Real was 38.9%. The development of Ciudad Real is considered to have happened at the expense of the latter.	Preston and Wall (2008) Garmendia et al. (2008), Garmendia, de Ureña, and Coronado (2011)
HS1	Ashford, the city connected to the HSR, the population received an uplift of 11% in the 1990s compared with the Southeast of England as a whole.	Preston and Wall (2008)
Inter City 125/225	Within 1 h of London, both HSR and non-HSR towns showed large increases in population, in contrast to the reduction of population in London. Among the towns within 2 h of London, all main non-HSR towns, interestingly, experienced a noticeable increase except for three towns. However, the percentage of population increase was smaller than in towns within 1 h of London. Even more surprisingly, HSR towns demonstrated a population decline or a slower increase than the national average, except for York and Cardiff. For towns over 2 h away from London, populations decreased, except in Swansea.	Chen and Hall (2011)
<i>Employment and labour force</i>		
Tokaido line	16–34% higher employment growth in cities with HSR stations (in the retail, industrial, construction and wholesale sectors).	Hirota (1984)
	Employment growth at station locations of 1.8% versus 1.3% in non-station locations	Amano and Nakagawa (1990)
Joetsu and Tohoku line	Employment in the retail sector rose by 0.4% and by 2.8% due to the combined effects of expressways and HSR, respectively. Employment in the IT sector was up 22% for the combined HSR/expressway effect. Employment reduced by 3.6% in cities without expressways or HSR,	Nakamura and Ueda (1989)
Sanyo line	Both terminal stations and intermediate stations showed significant growth in the food and accommodation sectors.	Brotchie (1991), Hirota (1984), Okabe (1980)
	Specific employment sector impacts, such as retailing, were small and declined with distance from the stations.	
HS1	Ashford's employment received an uplift of 6% in the 1990s compared with the average growth in the Southeast of England as a whole.	Preston and Wall (2008)
Inter City 125/225	Among HSR towns within 1-h travel time of London, financial services, information technology (IT) and other business services were represented more heavily than other services. For towns within 2 h travel time, the picture was more mixed. Bristol had dominant economic activities in finance, IT and other business services, while Leeds experienced a shift from public administration, education and health services towards finance, IT and other business services. But York, Cardiff, Newport and Swansea were characterized by high employment in public administration, education and health sectors. For those HSR towns over 2 h away from London, representation was strongest in public administration, education and health services between the period of 1995 and 2006, except for Edinburgh and Darlington. On the other hand, the service industry in non-HSR towns, in general, showed higher percentages of employment in public administration, education and health services.	Chen and Hall (2011)

Table 4 (Continued)

HSR systems	Development effects	Source
	Regarding employment in the knowledge economy, HSR towns within 1 h of London appeared strong, while towns within a 2-h radius also performed above average, strongest in knowledge-intensive services, except for Doncaster. For HSR towns over 2 h from London, the only available data (Newcastle) showed less-than-average performance. For non-HSR towns within 1 h of London, only Cambridge exceeded the national average figures for both high and medium technology and knowledge-intensive services. Among the non-HSR towns within 2 h of London, Bournemouth, Southampton and Norwich proved quite knowledge-intensive, especially for knowledge-intensive services; although, this resulted from local policies aimed at promoting knowledge-intensive activities.	
Atlantic lines	As a result of the TGV, employees who were not able to work in Paris because of the high cost of living now have the possibility to do so. Paris benefits from the enlarged (labour) market resulting from the TGV while Le Mans, a city located along the HSR line, experienced decreases in employment.	Nyfer (1999), Rietveld et al. (2001)
<i>Economic activities: tourism</i>		
Paris–Lyon (1983)	Underwent two contradictory changes: there were fewer overnight stays, but there were also new travel packages for users of the TGV. Winter tourism did not seem to be affected by the TGV.	Bonnafeous (1987)
Atlantic HSR (1989)	In Le Mans, a city connected to the Atlantic HSR, several tourism development projects occurred, particularly in business tourism. Conventions and trade shows drew in national and international clients, whereas before, they had only operated on a regional scale. Hotel stays increased, but there was a decrease in the average number of nights stayed, contributing to the decline of this city's hotels, which were already in difficult times. In Tours, a city located in the Loire valley, tourism activities experienced a large increase when the HSR was implemented. The impact is undoubtedly visible when considering the growth of visitors from Paris. However the impact on international tourist attendance was weaker, this may be due to the interest in visiting the famous — Châteaux de la Loire, which are spread in the region and not directly served by the HSR.	Masson and Petiot (2009)
Paris–Marseille (2001)	The southern region benefited from an increase in short-stay travel (extended weekend- getaways) and from an increase in travel from specific markets (i.e. young adults, seniors, high-income professionals and international travellers).	Masson and Petiot (2009)
Sanyo Shinkansen line	Visitor numbers to the three prefectures along the HSR (Hiroshima, Yamaguchi and Fukuoka) increased by 7.9%, 1.3%, and 11.8%, respectively, while for the outer regions, nearly half had a decrease in visitors (Shimane, −6.5%; Oha, −0.4%; Miyazaki, −2.8%). Moreover, some cities along the Shinkansen line saw a big drop in the number of visitors because inter-city trains do not stop there anymore. One example is Onomichi. In 1964, the city had as many as 1,764,000 visitors; this dropped to 1,605,000 in 1975, the year the Shinkansen opened. Overnight stays did not go up proportionately for intermediate cities.	Okabe (1980)
<i>Economic activities: business and knowledge-intensive economy</i>		
Tokaido line	The Shinkansen had a major impact on the distribution of administrative, financial and other controlling functions. As a general trend, it can be said that, in the Tokaido region, the controlling influence of Tokyo and Osaka is becoming stronger, while that of the Nagoya, Kyoto, Osaka and Kobe areas, sometimes called the middle capitals, is weakening.	Kamada (1980), Sanuki (1980)
Paris–Lyon	Business travel increased by 56%, while leisure travel was up 112%. Evidence does not suggest that the Paris-Lyon line resulted in firms moving from Lyon to Paris; instead, the opposite trend was observed. Branch offices of Parisian firms were set up along the HSR line, particularly those in the high-tech sector in the region Rhône-Alpes. It seems that the presence of a HSR station played a role in the regional location choice of firms, although the research also suggests that this was not decisive factor. The line caused relocation effects within the regions of cities that have a HSR railway station. Lyon, for instance, was able to attract many firms from competing cities like Grenoble and Geneva.	Pieda (1991) Bonnafeous (1987), Sands (1993), Rietveld et al. (2001) Nyfer (1999), Rietveld, Bruinsma, Delft, and Ubbels (2001)

Table 4 (Continued)

HSR systems	Development effects	Source
Paris–Lille	Lille attracted several international accounting firms and major offices of some national banks. The large conference centre built shortly after the arrival of HSR is enjoying strong business; plans to enlarge it are underway.	Ureña, Menerault, and Garmendia (2009)
Madrid–Barcelona	Zaragoza, a medium-sized city between Madrid and Barcelona, staged the 2008 International Expo and has been selected to stage the international Floralia show in 2014.	Preston and Wall (2008)
HS1	There had been greater growth in the number of new businesses in Ashford than elsewhere. Generally, HSR services appear to have reinforced the trend in local economies towards the knowledge economy. Within 1 h of London, both HSR and non-HSR towns have demonstrated strength in private and knowledge-intensive activities. However, in non-HSR towns, the office developments might be, to a large extent, attributed to routine public services or private back-offices rather than knowledge-intensive types of activity. Within 2 h of London, HSR towns have reversed their previous decline. Some cities were given economic advantages as critical transport hubs for HSR services from London. This, to some degree, alleviated London's excessive domination of certain economic activities; however, some of the cities in the North of England continued to be path-dependent on heavy industry. Non-HSR cities showed business profiles that were highly public sector-oriented. Beyond the 2 h radius, HSR effects appear weaker and also contrasting.	Chen and Hall (2011)
InterCity 125/225	As a result of the HSR, Montabaur and Limburg, two small cities served by the line, experienced a 2.7% upward shift in economic activity compared with the rest of the region, and this trend was not reversed during the subsequent years. The service helped the two cities attract new residents, which increased the local employment pools and consumer markets, and eventually attracted new businesses that helped to drive the towns' growth.	Ahlfeldt and Feddersen (2010)
Frankfurt–Cologne	As a result of the HSR, Montabaur and Limburg, two small cities served by the line, experienced a 2.7% upward shift in economic activity compared with the rest of the region, and this trend was not reversed during the subsequent years. The service helped the two cities attract new residents, which increased the local employment pools and consumer markets, and eventually attracted new businesses which helped to drive the towns' growth.	Ahlfeldt and Feddersen (2010)
<i>Economic activities: wholesale and retail</i>		
Sanyo Shinkansen line	In retail and wholesale activity, the Shinkansen seems not to have affected output greatly. Although there were increases in retail and wholesale activity in only two HSR cities (Ogori and Tokuyama) there was a rise in retail sales of more than 10% in the year following the 1975 opening of the Sanyo line. In addition, wholesale activities became increasingly concentrated in the existing centres	Sands (1993)
HS1	The decline in retail occupancy rates was less in Ashford than elsewhere in the region	Preston and Wall (2008)

empirical evidence of cities' performances with HSR and without HSR, which had been used as a control group, in order to study the effects of HSR in countries like Japan, France, Spain and the UK. For example, in 1991, Brotchie researched the social and economic impact of the Japanese Shinkansen by comparing population growth, employment and economic activity in cities that had an HSR station versus those that did not (Brotchie, 1991). The results showed that the cities connected with the Shinkansen performed better on average, especially for employment in information-based industries. In a more recent example from the UK, Chen and Hall (2011) investigated six London-based long distance railway lines – all of them over 150 km, of

which two are HSR and four are non-HSR in order to compare performance of the local economy and knowledge-intensive development in cities served by the different lines. They classified the effects of HSR into three influential zones, namely cities within 1 h of London, within 2 h, or greater than 2 h. Cities connected to HSR within 1 h of London saw a strong impact on private and knowledge-intensive activities and seemed to gain from the spillover effects of value-added activities from London. By contrast, in cities not connected with HSR, urban development remained focused on local service activities and a solid knowledge economy did not develop. Of the cities within 2 h travelling time from London and connected to HSR,

some of reversed their past declines; these cities were given economic advantages as transport hubs with HSR services from London. On the contrary, cities not served by HSR were characterized by high unemployment, low office rents and highly public-oriented services. Beyond the 2-h ring, HSR effects appeared weaker and also contrasting (Chen & Hall, 2011).

Nevertheless, the link between HSR connection and retail and commercial activity is not so clear. For instance, even though there was an increase in retail and commercial activities in cities with a Shinkansen station (Preston & Wall, 2008), only two cities with stations saw a rise in retail sales of more than 10% in the year following the 1975 opening of the Sanyo Line (Okabe, 1980; Sands, 1993). The research indicates that the face-to-face demands of knowledge intensive sectors such as business services, R&D, education and so on rose significantly in the knowledge based economy; the HSR, which is primarily a passenger train, reduced the cost of face-to-face meetings having a significant impact on these sectors; however few people would travel for retail and wholesale purposes.

While these studies may identify clear patterns of correlation between HSR and development, they are much less convincing when it comes to the direction of causation. Does HSR drive growth or is it that cities that are already growing (or cities with greater conditions for growth) attract HSR?

The model-based studies based in the fields of transport economics and spatial economics also support these findings. These models consider different kinds of accessibility as a key condition for development, and HSR as a factor in changing accessibility levels. At the European level, the effects of HSR on accessibility patterns have been measured with different kinds of indicators. These include weighted average-distance indicators (Gutiérrez, 1996) (Fig. 2), a gravity-type indicator (Bruinsma & Rietveld, 1993) and a daily accessibility indicator (Spiekermann & Wegener, 1996). The results have shown that as planned a European HSR network will increase the accessibility imbalances between the main cities and their hinterlands. In particular, the position of the cities in the north-western part of Europe will be reinforced, while the continental countryside will become relatively less accessible. In Japan, Murayama (1994) studied the transformation of the urban system paying special attention to changes in the railway accessibility of cities. This research highlights the transformation of the spatial structure brought about by the emergence of the Shinkansen in the 1960s. The Shinkansen cities gained the highest location advantage, while non-Shinkansen

cities in remote regions became even more peripheral. Such studies have also been carried out on specific stretches of HSR lines. For example, Gutiérrez (2001) studied the accessibility effects of the HSR line from Madrid to France via Barcelona. The HSR was predicted to increase accessibility differences because, in Spain, the larger agglomerations tend to benefit most from the infrastructure on a national scale (Gutiérrez, 2001).

While non-HSR regions could thus face challenges in their prospects for economic development and transformation, they will not necessarily lose out as long as they can improve their inter-regional and intra-regional accessibility by other means of transport. For example, in France, the three sub-regions of Cambresis, Sambre-Avesnois and Berck-Montreui were not connected to the French HSR network. Of these, Berck-Montreui, showed continuous employment growth above the national average and became an increasingly popular destination for migration; the other two performed far below average. A key factor behind this was the development of the A16 highway, significantly improving the connection of the region with Paris (Chen & Hall, 2012).

3.2. *Redistribution and relocation along the HSR corridor*

Among the cities along HSR corridors, there has been a redistribution of social, economic and spatial elements. This has been shown by both empirical indicators such as population growth, employment levels, real estate market values, GVA (Gross Value Added), GDHI (Gross Disposable Household Income), and theoretical indicators such as different kinds of accessibility indicators (Gutiérrez, 1996), a supply-driven model (Sasaki, Ohashi, & Ando, 1997), and Krugman's core-periphery model (Masson & Petiot, 2009). Major cities along HSR corridors have gained development opportunities by being connected to the HSR. As well as improving the hinterland's accessibility for those who live in the city, the HSR also makes the major city more accessible for those who live outside the city. Reduced travel time due to the HSR enables dominant cities to become more competitive and enlarge their area of influence. Consumers and purchasers of business services from other regions can reach the city more easily than before the opening of the HSR. Gutiérrez (1996) predicted that major cities like London and Paris would become the chief beneficiaries after development of the European HSR network by measuring the accessibility change.

Fig. 2. Absolute and relative changes in accessibility to the main economic activity centres 1993–2010.
Source: Gutiérrez (1996)

Both empirical and theoretical studies point to a more complex situation for intermediate cities. The advent of HSR has filled the high-speed connection gap in certain distance ranges that was caused by aircraft, traditionally a point-to-point link between larger cities. HSR's potential to integrate cities within regions may be underestimated (Blum, Gerçek, & Viegas, 1992; Ross, 1994; Ureña, Menerault, & Garmendia, 2009). Indeed, some research has argued that in countries like France, the impact on secondary cities is greater than the impact on larger central cities (Cervero & Bernick, 1996). HSR connectivity helps overcome intermediate cities' traditional isolation, improving their location advantages. The new opportunity for commuting to or conducting business in the larger central cities helps

attract certain types of metropolitan business activity to the intermediate cities. These include meetings of metropolitan professionals, mid-level business, technical consultancy firms and urban tourism (the staging of congresses, scientific meetings, seminars and so on) (Ureña et al., 2009).

On the other hand, there is a risk that railway operators focus primarily on achieving high speeds, concentrating on profitable traffic between the largest urban centres while bypassing smaller and less profitable places (Hall, 2009). This could cause “backwash effects” – a connection to the HSR network can even result in economic activities being drained away from intermediate cities and a negative overall impact (van den Berg & Pol, 1998). Examples of intermediate

“middle capitals” that are weakening after connection to HSR include Nagoya, along the Tokyo–Osaka line in Japan (Kamada, 1980), and Le Creusot, along the Paris–Lyon route in France.

Murakami and Cervero (2010) compared the population and labour markets within 5 km of the Shinkansen stations on the Tokaido line. Since 1992, the operating company has been running faster trains that do not stop at five intermediate stations: Odawara, Shizuoka, Hamamatsu, Gifu-Hashima and Maibara. As destinations, these intermediate stops have become less attractive for business passengers and less profitable for the privatized Shinkansen company. They have generally lost both manufacturing and service-based activities within 5 km of the HSR stations (Murakami & Cervero, 2010). Masson and Petiot (2009) used Krugman’s core-periphery model to predict the impact of a proposed HSR link between Spain and France on tourism activity in Perpignan, France. The prediction was that Perpignan’s vitality as a tourist centre would face the risk of decline because of the threat of the major city Barcelona.

In light of the ambivalent impacts sketched above, a key question seems to be which kind of intermediate cities and secondary cities (destination cities, but lower in the urban hierarchy) can benefit from HSR. Three criteria have been found to determine an HSR service’s potential impact on intermediate and secondary cities: city size, network location and distance from central cities. All three criteria combine to determine the development potential of a city (Stanke, 2009).

The first criterion, the size of a city and its metropolitan area, has been identified as a critical factor in how HSR service affects the development of that city. de Jong (2007) posits a relationship between the attractiveness of HSR stations (office rentals in station areas are used as indicators) and the factors which could influence the attractiveness of a HSR station. This research found that the economic size of the region, such as population and Gross Domestic Product (GDP), is one of the most important factors which will influence the city’s attractiveness. This may explain why Ashford (population: 110,000), gained relatively little new development despite it being on the Eurostar line (Preston, Wall, & Larbie, 2006) or why Lyon, which has a smaller population and economy than other urbanized European regions, cannot compare with metropolises such as Milan or Barcelona in spite of its excellent HSR connections (Thompson, 1995).

The second criterion, network location, is identified as a critical factor for intermediate cities. This location does not only rely on the HSR network. This is

important, as demonstrated by the example of Lille, located on the crossroads of the triangle of Paris, London and Brussels – a network location which has boosted the city’s economy. However, other transport modes also contribute. A recent Delphi Survey among international experts states that the location of an intermediate HSR city at a transportation node with strong connections to other regional and inter-regional networks was listed as the most important prerequisite for its future development (Loukaitou-sideris, Cuff, Higgins, & Linovski, 2012). Chen and Hall (2011) studied the Manchester and Lille sub-regions and showed that the simultaneous development of the intra-regional transport network and a HSR hub strategy are crucial for spill-over effects from the arrival of HSR. The massively increased rail frequencies between Manchester and its sub-regions, including Central Lancashire, Merseyside, Greater Manchester North and Pennine Lancashire, reflected the wider attraction of a revived centre. However additional Manchester–London services reduced track capacity available for other operators and, to some degree, limited other operators’ services. The expectation is that this unsolved intra-regional system will not sustain the momentum of local economic development. On the contrary in Lille, the regional government further attempted to improve its intra-regional network by connecting peripheral coastal areas to Lille through the regional TGV service (TERGV) and progressively expanded the service range of TERGV. These differences are clues to explaining the fact that most sub-regions in Manchester have experienced continued decline, whereas the Lille region, albeit slowly has been transforming positively (Chen & Hall, 2012).

The third criterion, the distance from central cities, is greatly impacted by the travel time between an intermediate or secondary city and the central city (usually the capital city). According to Harmon (2006), three travel time bands exist: commuting market (1 h or less), primary market (1.5–2.5 h) and longer-distance market (over 2.5 h). Firstly, within the commuting market, high income earners can take advantage of high-speed trains for daily commuting. Secondly, within the primary market, the time band enables travellers to make a return trip within one day with time for short activities (business meetings, leisure visits). This is particularly important for business travel, increasing the dynamism of business activity, provided that the local economic context is favourable. Thirdly, within the longer-distance market, the high-speed services have expanded the potential for short breaks and weekend getaways. Social changes mean that all groups are taking more short trips, but rail travel has

grown especially for middle-aged couples with a comfortable income. In each time band, the competitive position of the respective housing, business services and leisure facilities relative to the central city will determine the development course.

3.3. A reconstruction of the urban-regional system

When considering the impact on the regions connected or not connected to the HSR and the redistribution of activities along the HSR corridor, it is important to examine the regional structure. The HSR plays a different role as a commuting mode and as a long-distance transport mode. We will discuss them separately in the next sections.

3.3.1. Commuter HSR and a new metropolitan process

At first, HSR was thought of as an alternative to air transport, connecting large cities 400–600 km apart. Yet, with many intermediate stations being brought within a feasible commuting time of the larger cities, HSR can also become part of the commuter infrastructure. In the process of a metropolitan sprawl, households and economic activities have the potential to relocate and move outwards. Meanwhile, the introduction of HSR can improve the connection between small cities in the periphery and the city centre. This type of HSR connection facilitates or reinforces the attractiveness of these small cities or suburban areas and bonds them more tightly with the metropolitan core. People can commute to the metropolis from faraway places (Ureña et al., 2010). In the process, some metropolitan activities may relocate and take on a suburban role compared to the traditional role, which is more polarized towards serving its surrounding region. This leads to a new metropolitan process.

Typical examples of this are Ciudad Real (Madrid) and Ashford (London) (Garmendia, de Ureña, Ribalaya, Leal, and Coronado, 2008; Preston & Wall, 2008). Ciudad Real (65,703 inhabitants in the year 2003) is a small city located on the HSR line of Madrid-Seville. Before the HSR, the accessibility of Ciudad Real was very poor and commuting and participation in the metropolitan processes of Madrid was almost non-existent. It experienced little population growth in the past, and only 10.9% of the regional population was concentrated there in 1981. After the opening of the AVE in 1992, the accessibility of Ciudad Real improved immensely. Journey times to the centre of Madrid were reduced to just 51 minutes. This attracted people who were not originally from the city or the province to live

in Ciudad Real, travelling daily or weekly to Madrid. One survey found that 39% and 33% of the daily and weekly commuters, respectively, were born outside the province of Ciudad Real (Garmendia et al., 2008). Meanwhile, the proportion of the region's population living in Ciudad Real had increased to 13.8% by 2004.

This evidence shows that the HSR can help isolated cities to attract housing investment from within the province (30% in the case of Ciudad Real) as well as from outside the province (9%). The HSR has helped the city increase its spatial polarizing capacity. The same story happened in Ashford, 88 km from London. After the opening of Ashford International in 1996, journey times to London were reduced from 70 to 37 min. This led to an estimated 85% increase in the accessibility of continental destinations. Compared with the Southeast as a whole, the population went up by 11% and employment by 6%. Since 1996, property prices in Ashford have risen 26.5%, compared with 23.2% in the rest of the region. Vacancy rates for properties in Ashford dropped from 13% in 1998/99 to 8% in 2004/05. By contrast, vacancy rates in Southeast England as a whole, increased from 7% to 9%. The trend is that Ashford is becoming a potential commuting centre of London (Preston & Wall, 2008).

Evidence confirms that the construction of HSR can have the effect of increasing population in cities served by the high-speed corridors. It also shows, however, that HSR can contribute to the urban sprawl process. At least in some cases, the HSR can also facilitate the development of these small cities or suburban areas as specialized sub-centres of the metropolitan area with high-level office developments so that people do not need to commute to the metropolis. For instance, the evidence of the impact of the UK's InterCity 125/225 rail corridor suggests that the cities connected to the HSR in a commuting distance (within 1 h of London) show spill-over effects of high-value-added activities from London (Chen & Hall, 2011).

3.3.2. Long distance HSR and an integrated functional region

Most HSR is built for inter-metropolitan transport. The HSR connects two or more metropolitan areas, linked together via a chain of cities by means of a high-speed train. This may have the effect of creating an extended functional region – an integrated corridor economy. Blum, Haynes, and Karlsson (1997) examine economic integration along a corridor in the short and medium term (based on empirical evidence) and long term (based on model studies). In the short term, the HSR will not only integrate the goods and services

market, but also labour, commercial, inter-personal and leisure activities. In the medium term, a HSR will lead to some relocation of households and firms along its corridor. This includes relocation from the capital to medium/small-sized cities and from medium/small-sized cities to the capital, as has happened on routes such as Paris–Lyon. For further evidence see Table 4.

Looking at the long-term perspective with the aid of dynamic model, Blum et al. (1997), conclude that within certain transport corridors, HSR could lead to a completely new location pattern with larger travel volumes and a major change in travel patterns. After the establishment of a new HSR connection, one could expect a non-linear reaction. Its full force will not be felt until sometime after the new line has opened up. Related to this, Haynes (1997) used spatial interaction models and empirical evidence to explain that HSR can facilitate the effectiveness of regional labour markets. It can reduce information decay over distance, or the cost of market adjustment, thus making labour migration easier.

4. Indirect effects: urban level

4.1. A catalyst for the restructuring of urban systems

At an urban level, HSR is a catalyst for the restructuring and reshaping of urban systems. This section will discuss the extensive research which has been carried out on this spatial and economic restructuring.

4.1.1. A catalyst for the restructuring of the urban spatial structure

According to the particular locations of a HSR stations in a city, Hall (2009) identified three kinds of urban impacts of HSR depending on the location of the station. The first is when the station is located beside or within the traditional Central Business District (CBD). This improves or reinforces the CBD's attraction as a place for commercial investment. This is true in stations such as Lille Europe, Brussels South, Rotterdam Central, King's Cross-St Pancras in London and Charmartin (St. Martin) in Madrid. A second type of station is usually located on the edge of cities, adjacent to, but separated from, the major urban centres. This can help develop complementary sub-centres. For example, the new station at Kassel-Wilhelmshöhe in Germany has created a sub-centre, but has not displaced the original mediaeval location of the city centre. Other typical examples are New Osaka, Lyon Part Dieu and Stratford in London. The third type of station is different in concept, but equally ambitious. This is the use of a new station as the basis for a new commercial “edge city” on the urban periphery such as Shin-Yokohama in the Kanagawa prefecture in Japan, Ebbsfleet railway station (a park-and-ride station) outside London, the new HSR station in Avignon, France and Amsterdam South (Hall, 2009). All of them are shown in Table 5.

The latter two types of station locations can alter the centre of gravity of a city's core and spur redevelopment of underutilized areas in the urban periphery (Todorovich et al., 2011). Meanwhile, they also promote the

Table 5
Models and examples of three kinds of HSR station location (based on Hall, 2009).

	Type one: located beside or within the traditional CBD	Type two: located on the edge of cities	Type three: located in Edge City
Model
Examples	Lille Europe, Brussels South; Rotterdam Central; London King's Cross-St Pancras; Madrid Charmartin (St. Martin)	London Stratford, Kassel-Wilhelmshöhe new station; New Osaka station; Lyon Part Dieu station	Shin-Yokohama station; London Ebbsfleet railway station; Amsterdam Zuidas, Avignon new HSR station

transformation of the mono-centric city into a poly-centric urban region. This, by definition, means the development of more urban centres and more nodes connecting the urban pattern and the infrastructure networks together (Priemus, 2008). Comparing the latter two types, the first offers the greater potential for urban revitalization, but the degree to which the benefits of HSR are realized also remains dependent on the current urban physical and economic circumstances. Nevertheless, there remain major challenges: to manage the competitive dynamics between the old and new station areas and centres and to integrate the new development into the existing urban fabric. In the following section, ways in which these challenges can be dealt with are discussed and illustrated.

4.1.2. An opportunity for the urban economy

HSR gives an opportunity for economic expansion in the cities connected to the line. Pol (2002, p. 24) outlined the urban economic impact of the advent of the HSR as follows (see also van den Berg & Pol, 1998): “The connection of a city to the HSR network can be seen as an external impulse to an urban region. It reduces the Generalized Transport Costs (GTC). The relevant region for individuals is also extended with the same GTC level. And more remote locations can be reached. Their welfare potential will therefore increase: within the relevant region, more welfare elements will be available.” Pol (2002, p. 25) distinguishes two sorts of cities that connect with the HSR network: “cities in transition” from an industrial to a services-based economy and already established “international service cities”. HSR’s impact on economic growth is different for these two kinds of cities. Within the broader planning frameworks provided by TENS (Trans-European Networks) and European Spatial Organization Plans, a catalyzing role is played for cities in transition such as Antwerp, Brno, Cologne, Dortmund, Liège, Lille, Lyon, Marseille, Nantes, Naples, Strasbourg and Turin. In such cities, the improvements in external accessibility brought about by the advent of the HSR may help to enhance economic potential and location factors to get a higher position in the international or national urban hierarchy. But the city needs to meet some preconditions for economic growth and renewal; otherwise, the improved external accessibility may also lead to unwanted side effects (Pol, 2002). These are, most importantly, the loss of activities towards cities higher in the national and continental hierarchy and now expanding their catchment areas because of HSR. In particular, a facilitating role is played for the established international service cities

such as Amsterdam, Berlin, Munich, Brussels, Geneva, Rome and Utrecht. Such cities normally already have a relatively high economic potential and attractive location factors for new companies such as well-educated residents, consolidated business clusters, or attractive legal and fiscal regimes. With HSR, these cities will be further enhanced by their improved external accessibility (Pol, 2002).

4.2. A synergy between HSR and urban dynamics

It is important that HSR be developed in synergy with urban dynamics, whether within the context of “cities in transition” or “international service cities”; that is to say a condition in which urban development and HSR development reinforce each other. Urban development and transport infrastructure development are both highly interdependent and path dependent. For instance, the urban development patterns of London and Paris have been strongly marked by the construction of extensive metro systems at an early stage that maintained accessibility to the city centre and then intensified the interaction between city centre, suburbs and the region. These urban development patterns have, in turn, determined the conditions for the performance of existing and new transportation systems. Much research has pointed out these two-way relationships between different types of main transport infrastructure and different urban forms (Muller, 2004). As for the HSR, it is thus worthwhile to analyze the existing urban pattern, including additions and extensions already planned and the existing infrastructure networks. Once the analysis has been carried out, the existing nodes need to be highlighted and classified (Priemus, 2008). Against this background, the role of the HSR station as one of the most important new infrastructure nodes in the urban dynamic will vary according to the specific situations of cities and station areas. Many case studies discuss this issue; the cases can be divided into two types. One is the HSR station that is used to promote urban development (e.g. Lille Europe) and the other is that where an HSR is attracted by the presence of station area development, and then reinforces its centrality (e.g. Amsterdam Zuidas, which is located in the south of Amsterdam near the city’s motorway ring-road). This paper chooses a typical example of each group to illustrate the synergy between HSR and urban dynamics (see also Table 6).

Many researchers have studied the case of Lille Europe (Bertolini & Spit, 1998; Bertolini, 2000; Bruyelle, 1994; Newman & Thornley, 1995; Trip, 2008b). Lille is an old industrial city. Prior to the arrival

Table 6
Synergy between HSR and urban development.

	From HSR to urban development	From urban development to HSR
Typical example	Lille Europe	Amsterdam Zuidas
Population	166,000	743,000
City level	Industrial city in northern France.	The centre of business and culture in the Netherlands.
Location on the HSR network	At the crossroads of Paris–Brussels, Paris–London and London–Brussels - Traditional manufacturing in decline - Transferring to service industries and high-tech manufacturing. High unemployment, severe spatial disparities. Rediscovering the urban value of neighbourhoods. Improving the development dynamics of the city centre.	The nexus of Amsterdam–Paris and Amsterdam–Cologne. The region's three economic pillars are the managerial, distribution and the creative economy, all favourably linked to the rising global economy. Most residential development through the 1990s occurred outside the borders of Amsterdam, especially in the East and South. From mono-centric to poly-centric.
HSR's impact on the transformation		HSR has reinforced the role of Amsterdam in international business networks, changed the traditional mono-centric structure of Amsterdam and reshaped the urbanity in the region. Outside of the inner-city, in the middle of a new regional <u>axis</u> Office, residential and other facilities.
Location	At the edge of old city centre	
Function of the area around the station	Offices, services, shops, culture, housing, public facilities and open space.	
Synergy with surrounding locations	Complementary-spatially, visually, and functionally.	Complementary – the old centre has been given more space to develop tourism and smaller-scale enterprises.
Development effects of the station area	Huge gains in business, commercial, cultural and residential spheres.	Amsterdam Zuidas has become the top business location in the Netherlands.

Source: Authors.

of HSR, it had a university and was an historical centre. However, in the 1960s and 1970s, the city faced the traditional industrial decline as employment in textile industries began to slip away. Worsening economic conditions created high unemployment, especially for young people, and a widening degree of social and spatial segregation was created (Moulaert, 2001).

The urban transformation agenda that followed was to develop an economy based on service and high-tech industries, reduce unemployment, integrate young people in urban society, rediscover the urban value of neighbourhoods and improve the dynamic of the city centre.

As with many other cities in France, the HSR in Lille has been regarded as an opportunity to boost the economy. At a station development level, at first, SNCF, the French state rail operator, did not agree to put the station in the city centre, arguing that it was too expensive and would result in a less direct route, meaning a loss of time between the larger cities connected to the TGV. Thanks to the strong lobbying by Lille's mayor, however, the station was located on the fringe of the old city centre, close to the old station of

Lille-Flanders. This turned out to be a very successful location choice for the revitalization of the city centre. A diversified programme to attract the service and leisure economy was carried out, consisting of offices, services, shops, cultural establishments, public facilities, housing, and high-quality open space, all arranged around the station area. Importantly, the function of the station area was made complementary to the existing centre, so that it did not compete with (Bertolini, 2000; Bertolini & Spit, 1998), for example, the commercial area around the station focused on younger clients, whereas the city centre focused on older ones.

Efforts were also made to integrate spatially the HSR station and the old city centre, such as the Le Corbusier viaduct, which connects the inner city and the Euralille shopping centre with the station and districts beyond. The metro system was also extended to serve the HSR station. Between the train platforms and the station square, a glass wall was constructed – the aim being to visualize the relationship between the TGV and the city (Trip, 2008b). It seems that both the city and the station area have gained from this central location. The strategy of urban transformation to cater for the service economy

has largely been achieved. The position of Lille as a regional service centre has been strengthened, and the commercial centre of Lille as a whole has reinforced its role among metropolitan consumers with its influence even being felt across the Belgian border. The area around the station has also gained new facilities like offices, entertainment and cultural venues as well as congress and exhibition facilities.

Amsterdam Zuidas is an example of an already dynamic station area attracting the HSR, and has been the object of several studies (Bertolini & Spit, 1998; Bruinsma, 2009; Salet & Majoor, 2005). In the past, the urban growth of Amsterdam was internationally regarded as prototypical expansion of the “monocentric city”. Since the seminal Amsterdam Extension Plan in 1933, all local structural plans have been based on the philosophy of accommodating the economic forces in the centre of the city. In the 1990s, however, the region of Amsterdam happened to experience rapid growth connected with the rise of the global economy. This affected all the three major economic pillars of the region consisting of the managerial, the distributional and the creative economic clusters. These economic forces reshaped the existing urban space, creating a need for new economic spaces. The banks and business service economies shifted from their old inner-city locations to the edge of the city which linked into other developments in the wider regional space. Most residential development through the 1990s occurred outside the borders of Amsterdam in the new town of Almere and in Haarlemmermeer, a prosperous commuter zone (Salet & Majoor, 2005). With these changes, Amsterdam Zuidas found itself at the nexus of a new regional axis. Accessibility was excellent; both the city centre and Schiphol Airport were reachable within 10 min by car and public transport, the access to the residential new towns was also good. The infrastructure was already there or would be improved in the future. A new metro line, the North–South line, connecting the area with central station and the historic city centre was scheduled to be completed in the medium-term. In the year 1997, initial plans were drawn up for the HSR to stop at Amsterdam Zuidas and the area around the station was marked out by the national government as a key project, elevating the role of Zuidas within the region. At first, the development plan mainly focused upon attracting international head offices in business services (Bruinsma, 2009; Salet & Majoor, 2005). After the first strategic plan for Zuidas however, the city of Amsterdam repositioned itself to become an outspoken proponent of a high- quality mixed-use development of the area, which led to a revised plan. When complete,

the area is projected to be a centre of diverse urban activities including residential, cultural, commercial and business, while the existing city centre will maintain its role in the region. Interestingly, with the Zuidas project now in development, the inner-city economy of Amsterdam is witnessing strong growth in new, small-scale enterprises causing an increase in employment. The tourist industry in the historic core is also flourishing. And so it appears that the old city and the new station areas each gain from this project. Amsterdam Zuidas reinforces the role of Amsterdam as an international business centre. It is also changing the traditional monocentric structure of the city and reshaping the urbanity of the region, where the historic city centre has a different but nonetheless key role. The area around the station has already achieved the goal of becoming a top business location. The Zuidas and Schiphol business centres are the only two large-scale business locations in the Netherlands. Zuidas however, is still not fully developed; if current plans are fully realized, the area will also become a diverse urban centre.

If we compare the two approaches of Lille and Amsterdam (for a comparative synthesis, see Table 6), we see that they have many similar aspects, even though the cities’ size, economic potential and social environments are very different. Their developments share the common aim of achieving synergy between the HSR and the urban dynamics. In terms of station location, both are consistent with the city’s overall strategic direction of urban development. Lille Europe and Amsterdam Zuidas are developed in coherence with the development of other locations in the city. This complementary strategy avoids zero-sum competition between the old and the new, and can also reinforce the dynamism and competitiveness of the city as a whole.

5. Indirect effects: station-area level

In the last two sections, we discussed HSR’s indirect effects at regional and urban levels. On a regional level, we focused on the redistribution of development among cities. On a city level, we focused on the relationship between HSR stations and urban development. In this section, we will focus on the immediate station area.

5.1. How to define an HSR station area

There is no universal definition of a HSR station area; however, defining the station area according to the zone of influence and development perimeter is one common method. Schütz (1998, cited in Pol, 2002)

Table 7
Accessibility to HSR node of different types of developments.

	Primary development zone	Secondary development zone	Tertiary development zone
Accessibility to and from the HSR station	Direct 5–10 min on foot or by seamless transport	Indirect <15 min, by complementary transport modes (including travel and transfer time)	Indirect >15 min, by complementary transport modes (including travel and transfer time)
Location potential	Location for high-grade (inter)national functions	Secondary location for high-grade functions. Specialised functions related to specific location (cluster)	Variety of functions depending on specific location factors
Building density	Very high	High	Depends on specific situation
Development dynamic	Very high	High	Modest

Source: Schütz (1998).

distinguishes three development zones in which the accessibility of a HSR stop has various kinds of influence. There are primary, secondary and tertiary development zones, which are, respectively, a zone that is within five to ten minutes reach of the station, a zone that can be reached within 15 min from the HSR station by complementary transport modes and a zone that is more than 15 min travel time from the HSR station (see Table 7).

The greatest effects of the advent of the HSR can be expected in the primary zone. The maximum amount of travel time can be saved in this zone because, in principle, the traveller does not need to use complementary transport. Also, because of its proximity to the HSR network, this area profits directly from its improved status as a location. High-grade office and

residential functions can be established, and relatively high increases in land and real estate values can be expected. As a result, high and dense construction becomes attractive in this area. There can also be some high-grade functional areas in the secondary zones, but the gains in property value and the building density will be lower there. Stakeholders, therefore, may be somewhat less inclined to invest in these zones, though they may still do so at a later stage. Even tertiary development zones may profit from improved accessibility, but these zones are unlikely to see any development effects directly related to the advent of the HSR. The three zones are represented in Fig. 3.

In general, the primary development zone can be regarded as the immediate station area; the area directly surrounding Euralille for example, (see Fig. 1) roughly

Fig. 3. Accessibility to the HSR node of different types of development zones.

Source: Schütz (1998)

corresponds to this. It is usually measured by an ideally circular area radiating from the railway station that is considered walking distance (i.e. 500 m or a 10-min walk). However, when discussing the HSR station area, several studies also use the actual development perimeter combined with the spatial transformation plan contours and administrative boundaries. The most “pure” station areas can be seen as the overlap between the development perimeter and the primary development zone.

5.2. The general function of a station area

HSR station areas have some of the same general functions as common railway station areas. There is a great deal of literature on the general models used in defining station areas (for an overview see Table 8). These models can be divided into two types: one type is based on the characteristics of railway station areas as seen from a combined transport and land use perspective (Bertolini, 1996; Peek & Louw, 2008; Wulfhorst, 2003); the other type is based on the different functions of station areas. Notable examples of the latter include Juchelka's (2002)

three functions from the perspective of the potential for urban development, and the perspective of Zemp et al. (2011) which outlines five functions from a multi-stakeholder perspective including both users (local residents and transport system users) and experts (operators, planners, regulators, etc.).

The node-place model is an often-used conceptual framework for analyzing station areas (Bertolini, 1996, 1999; Chorus & Bertolini, 2011; Peek & Louw, 2008; Reusser, Loukopoulos, Stauffacher, & Scholz, 2008). According to this view (Bertolini, 1996), “on one hand, a station area is a (potential) connection to several of the material and immaterial flows that create value in the current ‘informational’ (Castells, 1989) mode of development. On the other hand, a station area is an area of the city that is both permanently and temporarily inhabited; it has a dense and diverse conglomeration of uses and forms accumulated through time that may or may not share in the life of the node.” Both synergy and conflict can emerge between the two, between the node and the place; realizing the former and managing the latter is a key planning challenge (Bertolini, 1996).

Table 8

The general function of a HSR station.

Source	Definition
<i>Defined station areas based on transport land use features</i>	
Bertolini (1996)	Station as node and place Node: a (potential) connection to several of the material and immaterial flows that create value in the current —informational (Castells, 1989) mode of development. Place: an area of the city that is permanently and temporarily inhabited; a dense and diverse conglomeration of uses and forms accumulated through time that may or may not share in the life of the node.
Wulfhorst (2003)	The interactions between land use in station surroundings, use of station buildings, transport interconnection quality and rail transport demand.
Peek and Louw (2008)	Combination of four disciplinary approaches: Connector: a built environment connecting the various transportation modes. Transportation node: a node characterized by its hierarchical position within the transportation networks it is linked to. Meeting place: a modern marketplace where people are confronted with urban life in all its multiplicity. Urban centre: provides a scarce resource of land that accommodates dense and mixed-use developments.
<i>Defined station areas based on functions</i>	
Zemp et al. (2011)	Five functions of railway stations from a multi-stakeholder perspective: Linking the station's catchment area with the transport network. Supporting transfers between modes of transport. Facilitating commercial use of real estate. Providing public space. Contributing to the identity of the surrounding area.
Juchelka (2002)	Three functions from the perspective of the potential for urban development Primary function: interconnecting multiple transport modes. Secondary function: commercial, leisure and cultural areas for medium-sized stations. Tertiary function: an important city centre or centre of commerce for large stations.

As far as the synergy is concerned, improving the transport provision in a location (its node value) will create the potential for intensification and diversification of land uses in a location (its place value). In turn, improving the place value will create transport demand and the development potential for the node value. In this way, the node-place framework not only illustrates the characteristics of railway station areas, but also the potential for their development. The balance of node and place features can be seen as a key mechanism in the development of a station area (Bertolini, 1999; Reusser et al., 2008). This has both quantitative and qualitative dimensions, as discussed below.

5.3. *Property development in the station area*

There is evidence to show that HSR has a great effect on the property values of land around the station. For example, in Le Mans, France, the number of transactions of raw land and building sites around the station doubled in the three years following the station opening; land prices doubled from \$82.07 to \$164.14 (\$1 = 5.66 French Francs in that period) per square foot in four years and apartment prices rose from \$9.52 to \$18.06 per square foot in three years. In Nantes, rentals in the station area were subject to a 20% premium above equivalent space in other areas of the city (Sands, 1993). However, reasons why property values change are complex and not simply related to the presence of a HSR station.

Andersson, Shyr, and Fu (2010) estimated the impact of the Taiwan HSR station on residential property in the Tainan metropolitan area; the main conclusion of the study was that HSR accessibility had only a negligible effect of on residential property prices in the region. This case reflects expensive HSR fares in combination with the inaccessible location of the HSR station (Andersson et al., 2010). High property values can have ambivalent effects. In recognition of the potential high value of property development around station areas, land speculation may occur. Property developers can hoard land, or only develop certain types of property, which in the long run may push up land values and negatively influence the development of the whole station area. Examples of the negative influence of land speculation on surrounding areas of HSR stations include the Gifu-Hashima station in Japan (Sands, 1993) and the Brussels South station in Belgium (Albrechts & Coppens, 2003).

Apart from comparing property prices before and after the HSR, there is some research comparing different station areas, with the aim of finding out which

factors will most influence the property development in station areas. de Jong (2007) listed a series of factors which will influence office prices in a station area. In his comparison of eight HSR stations in northwest Europe, he found the most important factor is the regional economy. The image of the location is another main factor that attracts offices to high-profile locations. In terms of accessibility, regional rail accessibility and good car accessibility are the most important types. Mixed use development in station areas and having stations embedded in the urban fabric are the next important criteria. Public support, good national accessibility, international accessibility and “clustering” will then contribute to the determination of office prices. In another study, Gargiulo and De Ciutiis (2009) compared 10 HSR stations in France, England and Italy and concluded that the function of the city (its position in world city systems), the location of the railway station (centre or peripheral) and other conditions, such as the physical and functional conditions of the respective station areas, affect the property values in station areas.

5.4. *Urban quality of the station area*

HSR has played a key role in creating new city images and stimulating economic development; however, HSR station areas are not only potential business centres, but also potential public spaces. This raises the issue of the impact of HSR on the urban quality of station areas, and which aspects of quality of place are included and supported by various actors when redeveloping station areas. While urban quality is important, it is influenced by many aspects, many of which are difficult to define and measure.

Trip (2008a) distinguishes two approaches of defining urban quality in HSR station areas. The first is a more urban design-oriented approach which relates urban quality directly to the revenues of the project. The second approach is a more elusive set of factors on a city level, related to the general social/economic performance of the city, including the level of cultural, recreational and educational facilities, environmental quality, safety and so on (Trip, 2008a). The two approaches have many inter-related elements. In case studies of Lille Europe, Amsterdam Zuidas and Rotterdam Central, based on project plans and interviews with key actors in the redevelopment of station areas, Trip (2008a) identifies four main categories of urban quality in station areas: urban structure; architecture of a modern and international image; functional diversity; and the quality of public space (Table 9). All of them are based on the idea of traditional urban streets as the model of urban life.

Table 9

Main elements of urban quality contained in the Amsterdam Zuidas and Rotterdam Central projects.

	Amsterdam Zuidas	Rotterdam Central
Urban structure	Relatively fine-grained grid Relatively narrow streets High density	Small scale compared with surrounding area High density
Architecture	Internationally renowned architects High quality design and materials in buildings and public space	Internationally renowned architects High quality design and materials in buildings and public space Maintenance
Functional diversity	Equal shares of office and residential functions Large amount of amenities Public functions in streets rather than malls Dependence on infrastructural tunnel (dock) High-end profile Dispute on levels of social housing Co-location of matching functions	Initial focus on increase of the share of residential function; later focus more on offices Relatively few new amenities Mixone concept Public functions in streets, also by means of adjustment of existing buildings High-end functions emphasized less
Public space	Different functions in various squares (sitting, eating) Open-air art Tolerance of different social – scene Amenities as meeting places	Focus on station square Comfort for pedestrians

Source: Trip (2008a).

This is a concept of a mixed urban environment, where different scales and scenes meet each other in the whole station area rather than only inside the station building, as in a shopping mall.

However, Trip (2008a) asks whether the urban quality of a HSR station is only concerned with what is there? Or is it also linked to the density and diversity of people, that is, to who is there and what is going on? Importantly, HSR, itself, is not primarily mentioned by Trip as a factor of quality of place. HSR is an added feature, not an essential pre-condition for the project's success in this respect. Some station projects, such as Rotterdam Central and, especially, Lille Europe, are, in effect, just induced by the HSR, while the deeper motivation of the project lies largely in the local urban and policy context (Trip, 2008a).

5.5. The development of station areas: a complex process

Having a plan is one thing, but actually developing a quality HSR station area is a complex process. The characteristic dilemmas of railway station area redevelopment include spatial, temporal, functional, financial and management issues (Bertolini, 1998). How to organize different actors in different contexts is crucial for successful development of a station area. Although this paper is mainly concerned with the development

effects of HSR stations and not the development process, it is important to stress that the decision-making process, in combination with the actual implementation process of development, always takes a long period, engages many actors and entails many risks, and will, thus, influence the development effects of HSR stations. These actors include the national, regional and local governments; investors; developers; and citizens. Each group of actors has its own responsibilities and demands. For instance, in the Netherlands, institutional complexity heavily affected the development context of HSR station areas, with as many as four ministries in the central government involved, as well as many other actors at other levels (Majoer & Schuiling, 2008). To illustrate this institutional complexity, V&W, the Ministry of Transport, Public Works and Water Management, advocated and funded only moderate-sized and efficient 'basic' stations, while VROM, the Ministry of Housing, Spatial Planning and the Environment, strove for high-quality station environments. Dutch Rail (NS) operated the rail network and was still a publicly-owned company based on private law, while ProRail – a separate, public organization under the auspices of V&W – was

responsible for construction, maintenance and management of the rail infrastructure. For their part, the municipalities were responsible for creating the master plan. They received subsidies, set up partnerships with the private sector and signed implementation agreements with the central government. In addition they were responsible for managing the interaction with a vast array of local interests, from businesses to citizens.

Other countries show similar institutional challenges (Bertolini & Spit, 1998). Adding to the complexity, large projects like HSR station development involve huge public and private sector risks (Ministry of Housing, Spatial Planning and the Environment, 2000, cited in Priemus, 2006). These include uncertainty as to costs and time needed for developing plans and land resources; potential problems with construction of the actual buildings; uncertainty on future market demand; and potential legal complications and the risk of political changes. Usually, special project-oriented modes of governance, with close ties between public and private actors associated with spatial planning, have been considered a worthwhile approach (Moulaert, Rodríguez, & Swyngedouw, 2003). However the complexity of development of station areas presents a stern challenge. Institutional innovation, while not a main area of concern of this paper, thus seems exceedingly important.

6. The international experience of effects of the high speed railway on urban development: summary of findings

To conclude this part of the paper, and before moving on to discuss the Chinese context, we shall summarize the impact of HSR on urban development as discussed in Sections 2–5 (see also Table 14). Twenty years ago, Banister and Hall (1993) cherished HSR as a harbinger of a second railway age, a prophecy which seems to have come true as HSR has been pursued by many countries and regions. The technical features of HSR, with its ability to link directly city centre to city centre at high speed, have led to drastically reduced travel times, and have reduced the environmental impact of long-distance journeys. All of this, in combination with a burgeoning knowledge economy, with its increasing demands for face-to-face interaction, and a leisure economy, with its search for new destinations and experiences, means that HSR has had a marked effect on urban development.

The complex factors underlying the process of developing HSR, and related impacts that go beyond HSR are now better understood. As far as the direct

transport effects of HSR, discussed in Section 2, a consensus has been reached about the need to see HSR as part of an integrated transport system. Although HSR has been the single outstanding new factor in transport development in many regions, it is still just one among many transport modes. In most countries, slower trains and other transport modes continue to dominate the market. Many examples of successful and less successful practices offer proof of the importance of integration between HSR and other modes of transport, both public and private, as a key factor in the traffic growth of HSR. Examples of integration include air–rail connectivity, links with local public transport, availability of parking, or seamless transfer between modes in stations.

As discussed in Section 3, the spatial redistribution of urban development opportunities is the main topic of indirect effects of HSR at the regional level. Based on empirical comparisons of economic–social indicators before and after or with and without HSR, as well as on model measurements of accessibility changes induced by HSR, many researchers have shown that the gap between the cities connected to and not connected to HSR is enlarged. Along the HSR lines, central cities seem to get most of the opportunities, while the dynamics in smaller cities shows more complexity, importantly depending on city size, network location and distance from central cities. Smaller cities along an HSR line often develop into commuter centres of central cities. Some cases also suggest that smaller cities within commuting distance of central cities might show spill-over effects of high-value-added activities from central cities. However, studies remain uncertain about the direction of causation: is it HSR determining growth or is it growth (or cities with better conditions for growth) attracting HSR? On this basis, it seems fair to conclude that HSR is, in the best case, a catalyst rather than a determinant of growth.

A similar picture emerges at the urban level, as discussed in Section 4. Here HSR has shown itself to be a catalyst for the restructuring of urban systems. HSR has been recognized as an important factor in boosting the local economies of many cities, but in cities with poor conditions for economic development the risk of backwash effects (economic activity being drained away) has also been noted. In many instances, HSR stations have proven conducive to the regeneration of old city centres, or for developing new centres, depending on the location of the station. The examples of Euralille and Amsterdam Zuidas suggest that the fine-tuning between HSR and urban dynamics is a crucial factor for the city and station area in benefiting from HSR.

A key mechanism of station area development, discussed in Section 5, is the balance between node and place features. Even though this field of forces has recognizable effects on property prices and urban quality of the station area, it is just one factor among several characteristics of the local context. The latter also include the size and trends of the regional economy, the regional and local accessibility features of the station area, and the physical and functional conditions of the immediate surroundings of the station. All of these have an impact on the development of the station area. Furthermore, the institutional complexity, and the related complexity of the decision-making and development implementation processes, must also be taken into account and dealt with.

Even though for the sake of clarity we discussed the effects on urban development on different levels separately, the actual effects are multilevel. Effects at all levels interact with and influence each other. On the ground, the effects on the urban level cannot be isolated from the effects at station area level. The redistribution of development opportunities at the regional level both sets conditions for and is affected by effects at the urban and station area level. A multilevel perspective seems thus an important condition for understanding the complexity of HSR effects on urban development. This is something to keep in mind when discussing the potential effects of HSR on the development of Chinese cities. Also important is the observation that the urban development effects of HSR show a great sensitivity to the characteristics of the different contexts. The debates and controversies around HSR can only be fully understood when the specific national and regional contexts are taken into account. For example, the very different context of urban development in the USA – including lower population densities, suburban dispersion, functional and cultural domination of car travel – means that the effects of HSR are likely to unfold differently there from the cases discussed in the previous sections (Ryder, 2012). When discussing the potential effects of HSR on urban development in China, we also must take into account the specific features of Chinese urban development and its broader context, and its similarities and differences from the cases analyzed in the literature so far.

7. Potential implications and planning challenges for China

The Mid-to-Long Term Railway Development Plan (published in 2004, revised in 2008) is a milestone of the development of HSR in China (see Fig. 4).

According to this plan, there are two kinds of HSR lines. The first is a long-distance type of HSR line that crosses the whole country. There are several of these, including four east-west lines such as Shanghai to Chengdu and four north–south lines such as Beijing to Shanghai. The second kind of HSR is a medium-length inter-city line that connects the cities of a particular mega-region, such as Beijing to Tianjing. The total length of the new operated HSR lines as of October 2012 is 7735 km, and the number will increase to 16,000 km by the end of 2020 (see Table 10).

As the literature review of the impact of HSR in cities around the world has indicated, the urban development effects of HSR are highly variable and depend on a range of factors, making it difficult, without extensive analysis, to establish how HSR is affecting urban development in China in the present and, perhaps most importantly, how HSR likely to affect future development. Adding to the complexity, the history of HSR in China is too short to draw any firm conclusions. In order to structure the discussion and give orientation to future research, what follows are statements about the potential, rather than the actual development effects of the HSR network in China, and planning challenges implied by these potential effects. To come to those statements we combine insights from: (1) the international experience discussed in the first part of the paper; (2) the unique spatial and temporal scale of urbanization, urban condition and current planning strategies in China highlighted in the introduction of the paper; and (3) where available, empirical evidence of some possibly-emerging, related trends. The same organization of the material of the international literature review will be used: direct transport effects and indirect spatial effects at the regional, urban, and station area level. However, there will be an additional focus on the planning challenges implied by the discussion. We will conclude this by outlining some of the research challenges faced (also relevant to future research). All of this is summarized in Table 14.

7.1. The potential implications and planning challenges of direct effects of HSR

7.1.1. Generation of HSR traffic

Railways are a relatively scarce resource in China. By 2010, China had about 91,000 km of railway lines in operation. The overall density of lines, including passenger and cargo transport, was 947.9 km per thousand square kilometre, or 6.6 km per thousand people, which is low by international standards (see Table 11). There are also considerable regional

Fig. 4. Medium and long-term planning of the railway network in China (2008).

differences due to the varied terrain and large population density variances of this vast country. In 2010, the Chinese railway network carried 1676 million passengers, who each travelled 523 km on average for

the year. China's rail passenger volumes grew at a compound annual growth rate of only 5.3% from 2001 to 2010 versus 10.7% growth in real GDP, 9.0% growth in road passenger numbers and 15.4% in the number of

Table 10
Newly constructed HSR lines, as of 2011.

Railway lines	Travel time				Length (km)	Date opened
	Conventional rail	HSR	Change	Bus		
<i>Type 1</i>						
Wuhan-Guangzhou	11 h	2 h 45'	75.00%	10 h'	1068.8	December 2009
Beijing-Shanghai	9 h 54'	4 h 48'	51.52%	-	1318	July 2011
<i>Type 2</i>						
Hefei-Nanjing	4 h	1 h	75%	3 h	184	August 2008
Hefei-Wuhan	5 h 25'	2 h 10'	60%	5 h 30'	364	April 2009
Fujian-Xiamen	–	1 h 30'	-	3 h	273	April 2010
Ningbo-Wenzhou	–	1 h 30'	–	4 h	282	September 2009
Fuzhou-Wenzhou	–	1 h 40'	–	4 h	330.7	September 2009
Chendu-Duijiangyan	–	30'	–	1 h	67	May 2010
Jinan-Qindao	2 h 58'	2 h 15'	24.16%		393	April 2009
Shijiazhuang-Taiyuan	2 h 5'	1 h 18'	37.60%	3 h 30'	225	April 2009
Nanchang-Jiujiang	2 h	40'	66.67%	1 h	135	September 2010
Zhengzhou-Xian	5 h 42'	1 h 48'	68.42%	6 h'	484.5	February 2010
Beijing-Tianjin	1 h 9'	30'	56.52%	1 h 15'	115	August 2008
Shanghai-Nanjing	1 h 58'	1 h 12'	38.98%	4 h	300	July 2010
Shanghai-Hangzhou	1 h 30'	38'	57.78%	2 h 15'	160	October 2010

Table 11
Density of railway networks in selected countries.

Country	Length of railway lines (km)	Density of railway network	
		km/thousand km ²	km/thousand people
China	91,000	947.9	6.6
USA	272,812	2910.7	94.1
Russia	85,542	500.2	58.2
India	63,312	2128.3	6.3
Japan	20,020	5299.1	15.8
Germany	36,044	10,110.5	43.9
UK	17,052	6988.5	28.8
France	29,269	5321.6	48.5

Source: Yu (2007)

domestic air passengers. As a result, railway's market share among the major forms of public transportation dropped to 31.5% from 36.2% over this period in long-distance and inter-city traffic versus 14.5% for air and 54% for highways (data as of May 2011: <http://7economy.com/archives/4961>). A lack of capacity is an important factor in explaining this limited growth. Another part of the equation is that the existing national railway network has been shared by cargo and passenger trains, which keeps operational efficiency low. The growth of rail cargo traffic was also very low. Building HSR was considered an important way to increase the passenger route capacity, reduce journey times and free cargo from the pressure of having to share tracks with passenger services.

From worldwide experience, we have seen that traffic flow of HSR is growing as a whole, but performance varies by country. As discussed above, in Japan and France, the operation of HSR is a success story from a traffic-number flow point of view. In Korea, Germany and Taiwan, however, the growth of HSR traffic flow was not so strong. From the current state of operation in China, we see variances in the growth in traffic between the different lines. Passenger numbers on economic-boom corridors are growing fast. The capacity of these lines is almost fully utilized. Take the Beijing–Tianjin line as an example. Prior to the year 2008, about 8 million passengers travelled on the conventional rail service each year (Bullock, Salzberg, & Jin, 2012). Since inauguration of the line in 2008, passenger numbers during the first two years of operation reached 40.96 million: 18.70 million in the first year and 22.26 million in the second year – an increase of 19% year on year (data as of August 2010: <http://www.51766.com/xinwen/11021/1102103716.html>). There are 184 high-speed trains running daily along the corridors between

Beijing and Tianjin. But in some of the less-developed economic regions, HSR's performance has been less strong. This is the case of the line from Zhengzhou–Xian, which connects the Hebei Province and Shanxi Province. There were only 4.37 million passengers in the first year of operation in the year 2010, which was far below the expected number of 37 million (data as of February 2011: <http://www.china.com.cn/news/tech/2011-02/11/content21894532.htm>). Currently, only 30 high-speed trains run along this new HSR corridor on a daily basis.

From this point of view, a key challenge for China is how to promote the utilization of HSR. HSR users are both cost-sensitive and time-sensitive in China (Wang, Xu, & He, 2013). The main reason for people choosing the HSR is that it dramatically reduces travelling time. Wang et al. (2013) did an extensive survey in Beijing South, Nanjing South, and Tianjin East of more than 5000 HSR travellers covering personal information, journey information, and the time required for each leg of the journey, and reasons for choosing HSR. 70% of travellers said they chose HSR because of “shorter travel time” as their primary reason. Low-to-middle income groups had the same percentage as the high-income group.

As mentioned previously, the railway is still a relatively scarce resource in China. Building HSR lines is considered an important way to increase the overall capacity of the railways to serve growing passenger volumes and more destinations. However, the HSR is also a very expensive transport mode for passengers considering the income of most people. For example, in 2012 the cheapest prices of return tickets from Beijing to Shanghai (1318 km) and Shanghai to Nanjing (300 km) are ¥820 and ¥176 (¥1 being equal to USD \$0.16), respectively, while the average per capita disposable income per month of urban residents in China was ¥1592.42 in 2010 (National Bureau of Statistics of China/NBOSOC, 2011). The relatively high prices mean that many people cannot afford to travel by HSR. This issue has been fiercely discussed in China, as planners and policy-makers recognise the need to have a ticket price strategy that attracts more passengers to HSR. Observations have revealed that the ticket for people who travel by HSR frequently is typically paid for by their employer (Wang et al., 2012; Hou, Liu, Zhang, & Hu, 2011). Wang et al.'s (2012) research pointed that people travelling by HSR will try to reduce the total travelling costs by saving on other parts of the trip. For instance, the percentage of travellers taking private cars/taxis to and from HSR stations was 44% for the higher-income group, 35% for

the middle-income group, and 20% for those in the lower-income group.

Another issue stems from the observation that door-to-door, rather than station-to-station travel time is what counts for HSR passengers. From this perspective, there are some clear weaknesses in the system. In China, most of the HSR stations are located on the fringes of cities, some of them as far as 10 km away from the inner city. Currently, the accessibility of the stations is poor, especially with regards to urban public transport connections between station areas and city centres. As we have seen from other countries, such as Korea and Taiwan, this difficulty in accessing the inner cities will most likely influence negatively on the generation of HSR traffic. In China, some cities built highways to connect the HSR stations and the city centre. This reduced the travel time by private cars/taxis but not for the public transportation on which many passengers rely. Take Suzhou North station as an example. Since it relocated on the north of Suzhou city, it took 20 min to get to the station by taxi from the city centre; by the bus, it took more than 1 h (Yin, Tang, & Duan, 2013). Wang et al. (2013) used an indicator of TTT (Total travel time included travelling time to and from stations and travelling time by HSR) to measure the accessibility of HSR stations in China. Their research pointed out that poor public transport connectivity is a hurdle in improving the HSR accessibility and improving the overall attractiveness of HSR.

7.1.2. Realization of a modal shift

Chinese HSR lines are designed to handle speeds between 200 and 350 km/h. Following the international experience covered in the literature, this means the HSR has a potential advantage compared to other transport for distances between 150 km and 1500 km (even though this upper limit should be questioned since, following a major accident on the Ningbo-Wenzhou line in July 2011, the operational speed has been reduced to 300 km/h). Current evidence shows in detail the inter-city HSR lines in China that have had a great impact on the numbers using traditional railway and highway transport. For example, there used to be 24 express shuttle buses every day from Nanjing to Shanghai in each direction before speed limit upgrades of the traditional railway line in the year 2007. However, since operation of the HSR commenced in 2007, passenger volumes on the bus route have been reduced by 60%. The number of buses shuttling in each direction between Shanghai and Nanjing has decreased seven-fold and the price of a bus ticket has reduced to ¥68 from ¥97 (data as of September 2010:

<http://www.gaotielu.cn/show.asp?id=747>). Hou et al. (2011) made a study of passenger behaviour along the 120 km-long Beijing–Tianjin HSR line. From the 1334 questionnaires of the passengers who used the HSR on weekdays, they found that 47.9% came from the traditional train, 26.2% from the express bus, 19.9% from private car transport and 3.1% from taxis and other transport modes (Hou et al., 2011). Another study shows that in the first year after the inauguration of the Beijing–Tianjin HSR line, the passengers of the intercity express bus between these cities had been reduced by more than 36.8% from 523,400 to 330,600 (Dai, Cheng, and Sheng, 2011).

The long-distance HSR lines have also greatly influenced traditional railway and air travel. The Wuhan-Guangzhou HSR line, with a total track length of 1069 km, opened in December 2009. The average headway of the HSR is 15 min with a daily one way frequency of more than 50. The first-class and economy HSR fares are ¥780 and ¥490 respectively (Fu, Zhang, & Lei, 2012). In 2010, the first full year of operation of the new HSR line, 20 million passengers were travelling on the HSR line. Of these, about 1 million appeared to have come from competing air services and about 10 million transferred from conventional rail services, while a few have transferred from bus and car. Based on these estimates, of the 20 million travelling on this HSR line each year, about 50% have transferred from conventional rail, about 5% have transferred from air and 45% have been either newly generated trips, or trips that replaced bus and car travel (Bullock et al., 2012). Fu et al. (2012) studied the impact of the opening of the Wuhan-Guangzhou HSR line on the respective air link. The total number of aeroplane seats on this route was reduced by 48% from 146,061 in October 2009 to 75,966 October 2010. Daily flights were reduced during this period down 32 to 17. Such a decline is remarkable given the concomitant 50% reduction in air fare. Similar patterns have been observed on the Guangzhou-Changsha HSR line, with a distance of 707 km. Upon the start of the HSR service, airlines collectively reduced their capacity by more than 60%, from 111,382 in Oct 2009 to 41,178 in Oct 2010. Daily flights were also reduced during this period, down from 25 to 10 (Fu et al., 2012). Further evidence is provided by air traffic trends at Wuhan's Tianhe international airport. After the start of operation of the Wuhan-Guangzhou and Nanjing-Wuhan HSR lines, the airport reduced its number of flights to Guangzhou and cancelled flights to Nanjing, Hefei, and Nanchang. According to the statistics of the airport by the Civil Aviation Administration of China (CAAC), air passenger numbers grew

by only 3% in 2010, while this growth number was 22.8% in 2009, 10.1% in 2008 and 37% in 2007.

The observations above are similar to those in other countries. It is clear that HSR in China has had a strong impact on the market share of other transport modes on journeys of certain distances. The literature however shows that the relationship between the HSR and other transport modes is not just a matter of competition. According to international experience, developing complementarily in the form of an integrated transport system is a very important condition for both HSR and other transport modes to thrive. Achieving this presents a major planning challenge for China, as discussed below.

7.1.3. Development of an integrated transport system

An integrated transport system blends different modes of transport, including aviation, HSR, traditional railways, urban public transport, cars, and bicycles and even walking. In China, a huge amount of transport infrastructure is under construction. In the year 2010, the length of highways in China was 74,000 km. This is expected to increase to 108,000 km by 2016 ([Central People's Government of the People's Republic of China/CPGOPRC, 2011](#)). In 2006, there were 147 airports in China; however, 97 new ones were planned to be built in the near future ([CAAC, 2008](#)). In the development of urban public transport many cities continue to experience a flurry of construction for metro, light rail and rapid bus transit.

Good inter-modal integration is not only useful for HSR, but also for the other transport modes, as integration provides a greater diversity of options and door-to-door service to meet the diverse travel demands of different passenger groups. Nevertheless, there are some big institutional and technical challenges in developing an integrated transport system in China. First, at the institutional level, the infrastructure for different transport modes belongs to different government institutions. The planning, construction and operation of railways and stations is the responsibility of the Ministry of Railways (MOR); air travel and airport planning is administrated by the Civil Aviation Administration of China (CAAC); highways are managed by the Ministry of Transportation (MOT); and urban public transport is administrated by the city governments. Although a comprehensive transport system plan is agreed at national level every five years which integrates the main transport system, different government institutions have ownership over the route choices, the location of railway stations, airports, and

seaports, among more. Most of the time, they develop their own policies without much coordination. For instance, there is no real integration between HSR stations and airport development. HSR does not connect as well with airports and city centres as it does in other countries. The problem is rooted in two separate and poorly coordinated governmental organizations. Coordination between different government institutions, therefore, is a big challenge for planning and policy-making.

Next to the institutional challenge of coordination, creating an integrated transport system presents technical challenges. Most of China's HSR is a totally new system constructed on fully-segregated infrastructure separated from the traditional system's tracks and stations. The HSR stations are typically located on the fringes of the main cities, far from the traditional railway stations and city centres. In China, road traffic congestion is becoming a serious problem, and if passengers cannot easily access the inner core of the city, the HSR's advantage is weakened. Indeed, the reduced intercity travel time by the HSR is often less than the increased travel time from the city centre to the HSR stations. Take Shanghai as an example. Before the operation of Hongqiao station, a new HSR station, the travel time from Shanghai–Nanjing was 1 h 58'. The travel time from the city centre to Shanghai station (the old station) was about 20 minutes. Now, after the opening of the Hongqiao station, the fastest travelling time from Shanghai to Nanjing by HSR is 1 h 12' – a reduction of 46 min. Even so, the travel time from the city centre to the new HSR station has increased by about 50 minutes (travel time between the old and new stations by metro is 74 min). This cancels out the time advantage of HSR on many journey combinations.

Within the actual HSR stations themselves, the transfer from one mode to another is another big problem. A smooth connection is the aim of most HSR stations, but the reality is often different. In the design of Chinese HSR stations, there is a trend to move away from a traditional waiting space to a passing space ([Zheng et al., 2009](#)). However, everyone has to go through the check-in gate from the waiting hall and then arrive at the platforms of the HSR. The route between the waiting hall and metro station, bus stations, and parking spaces is long. The transfer in Nanjing South station is considered one of the best practices among all the new stations. Even in this case, the transfer time from the metro station to the waiting hall is around eight minutes. Also just the sheer size of some of China's HSR railway stations makes transfer difficult. In

Fig. 5. Waiting hall of Nanjing South Railway Station.

Nanjing South station the floor area of the station hall alone is 83,612.3 m² (see Figs. 5 and 6). In such a huge space, seamless connections are a major planning challenge. Another representative example is the Shanghai Hongqiao transport hub that connects HSR and Shanghai Hongqiao International Airport. It joins

the airport, HSR railway station, Maglev HSR, express bus and other transport; however, the distance between the railway station and the airport is 700 m, an awkward gap for transfer by vehicle or foot. The solution that seemed most technically feasible may not have been the solution that is most practical for passengers.

Fig. 6. Platform of Nanjing South Railway Station.

7.2. The potential implications and planning challenges of indirect effects of HSR on the regional level

7.2.1. Enlarging the gap between the connected and not connected: population growth and economic activity

Based on international evidence, the HSR network in China is likely to enlarge the gap between the cities connected to HSR and those that are not connected. In population and economic activity terms, the cities connected to HSR will likely perform better than the unconnected cities. While it is too soon to draw any firm conclusion, there might be some signs of this already happening. Take the region of Yangzi River as an example. The traditional railway line had its speed limit upgraded to 200 km/h in 2004 and 250 km/h in 2007. Four new HSR lines entered services between 2010 and 2011. In 2008, eight of the 15 cities in this region were connected to the HSR network and seven were not connected. Four years earlier, in 2004, the population and Gross Regional Product (GRP) of the cities connected to HSR were 149% and 295% higher, respectively, than cities not connected to HSR, while in 2008, the gap had risen slightly to 154% and 297% higher, respectively (see Table 12). This data shows two things. Firstly, that there is a correlation between being connected to HSR and having higher population and GRP, and second, that the strength of this correlation did not substantially change, or only somewhat strengthened, in the period under consideration. It will be interesting to see how this differential develops as more

HSR lines are opened and more cities are connected. In China, the distribution of economic development, natural resources and human resources is highly imbalanced across the country as a whole. The HSR network might reinforce this imbalance. How to develop the unconnected cities is, therefore, a big challenge for planners and policy-makers.

7.2.2. Redistribution along the HSR line: tourism, business and the knowledge economy

The HSR network reduces the barriers to transport and trade. As it enables people to come and go more easily between different locations, it seems likely that the cities that have high-quality resources will become more attractive places to visit and do business. It should be expected that megacities like Shanghai, Beijing and Guangzhou will be the most enhanced. Jiang, Xu, and Qi (2010) measured the accessibility change after the start of operation of the Beijing-Shanghai HSR line and found that the cities that most benefitted from the HSR were the two megacities Beijing and Shanghai. The picture is more complex for the intermediate, smaller cities. On the one hand, the cities with their own strong, knowledge-intensive economic sectors, like Nanjing and Xi'an, or the cities that have well-developed tourism, such as Hangzhou and Kuming, might stand to benefit from the arrival of HSR. Some recent observations show that the HSR has had a positive impact on urban tourism in the cities connected to the network. Consider the example of Wuhan. Before the Wuhan–Guangzhou HSR line started operation in 2009, the trip time covering the distance of around 200 km

Table 12

Ratio of population, GRP and tertiary industry GRP between cities connected and not connected to HSR in the Yangtze River Delta.

Year	Population (millions)			GRP (trillions)			GRP in tertiary industries (trillions)		
	Cities connected to HSR	Cities not connected to HSR	Ratio	Cities connected to HSR	Cities not connected to HSR	Ratio	Cities connected to HSR	Cities not connected to HSR	Ratio
2004	45.84	30.72	1.49	2060.76	699.40	2.95	851.88	246.74	3.45
<i>The fifth rail speed limit upgraded to 200 km/h in 2004 (Nanjing-Shanghai and Shanghai-Hangzhou)</i>									
2005	46.30	30.75	1.51	2467.38	803.76	3.07	1051.49	286.95	3.66
2006	46.75	30.82	1.52	2864.01	950.91	3.01	1235.80	344.22	3.59
2007	47.18	31.08	1.52	3380.54	1133.32	2.98	1506.84	415.33	3.63
<i>The sixth rail speed limit upgraded to 250 km/h in 2007 (Nanjing-Shanghai and Shanghai-Hangzhou)</i>									
2008	47.53	30.85	1.54	3917.25	1318.98	2.97	1819.37	486.52	3.74
<i>New HSR line Nanjing-Hefei opened in 2008</i>									
2009	57.91	20.81	2.78	4980.74	803.49	6.20	2366.17	292.01	8.10
<i>New HSR line Ningbo-Wenzhou opened and railway speed upgraded to 200 km/h in Shanghai-Wenzhou</i>									
2010	58.24	20.83	2.80	5855.89	968.99	6.04	2772.22	367.24	7.55
<i>The inter-city HSR railway line opened in 2010 (Nanjing-Shanghai and Shanghai-Hangzhou)</i>									

Source: Shanghai, Jiangsu Province and Zhejiang Province Statistical Yearbook, 2004–2011.

was reduced from 11 to 3 h. This means that distance from which visitors can be attracted, has enlarged to an area of around 200 km to 1000 km, and now includes the major centre of Guangzhou. More and more people living in cities along this line have visited Wuhan as tourists since the HSR opened. 80% of the visitors to Wuhan's most famous tourist spots during the city's 2010 Spring Festival came from Guangzhou (Zhang, 2010). That was the first time since 1998 that the number of tourists coming to Wuhan from other cities was higher than the number going in the other direction (Zhang, 2010).

Aside from the opportunities for urban tourism and knowledge-intensive economic sectors in cities where local potential is present, intermediate, smaller cities with no such potential will likely face more difficulties in the development process. He and Yang (2011) argued that with the arrival of the Beijing–Shanghai HSR, the influence of cities in the Wanbei region (where most cities are medium and small cities) will over time be reduced. How to find new attraction points for these cities' economies is a big challenge. Next to the characters of the local economy, the ultimate impact of HSR will also depend on the city's location on the

railway network, the city's size and status in the urban hierarchy, its distance to major cities and the quality of other transportation links, as shown by the international experiences discussed in the first part of the paper. It is therefore very important that planners and policy-makers become aware of this interrelatedness of local and global factors and of the complementary rather than self-standing role of the HSR connection, so as not to over-estimate or underestimate development opportunities.

7.2.3. The HSR as a factor in the reconstruction of the Chinese urban-regional system

7.2.3.1. Inter-city HSR networks vs. mega-city region development. As mentioned in the introduction, the development of megacity regions is the most important spatial strategy carried out in recent years in China. There is a high urban density in China, different from European HSR countries and similar to Japan, as shown in Fig. 7. Regional plans attempt to strengthen megacity development by increasing the attractiveness of medium and small cities and improving the spatial and functional linkages between the different centres in the region. The Yangzi-Delta Regional Plan is a good

Fig. 7. Large cities on international HSR corridors (population is indicated and distances are to scale).
Source: Okada (2007)

example: it aims to strengthen the development of the core city of Shanghai, increase the attractiveness of Nanjing, Hangzhou, Suzhou, Ningbo and other smaller centres, and encourage the different cities to develop different, yet complementary economic functions and become part of a more integrated region.

The inter-city HSR network can be supportive of this strategy. Learning from the international experience, HSR could lead to a new metropolitan process and a new megaregion system. China's cities are growing rapidly. As major, core cities as Shanghai grow larger, it seems inevitable that some functions will move out of them and relocate elsewhere. The HSR will likely affect the course of relocation, as for instance was the case in Spain. Smaller, well connected cities could play a dual role: they could continue to act as a pole for a certain local area, while also adopting more of the regional functions previously limited to the core city. More individuals may choose to work in one city and live in another, stretching daily and weekly commuting patterns across the megacity region. In a preliminary study of regional combinations of living and working in the Shanghai–Nanjing HSR transit corridor Wang and Zhao (2010; see Table 13) carried out a questionnaire among 210 passengers on the HSR during one weekend. The results showed that between the two core cities of this region, Shanghai and Nanjing, there was a trend of weekend commuting. In addition, there was a trend of daily commuting between Shanghai and medium cities of the region such as Wuxi and Changzhou. For most of these journeys, travel time by HSR is just under half-an-hour (Wang & Zhao, 2010).

However, megacity regions wanting to use the HSR to reinforce their spatial structure will also face some

challenges. The HSR network strengthens transport connections between different cities in a region. However, institutional cooperation is required, because the spatial influence of each region does not always match the governance area. Take the Nanjing metropolitan area as an example. The Nanjing–Anqing inter-city HSR line will strengthen the relationship between cities in the Nanjing metropolitan area, but the metropolitan area spans several municipalities and two provinces. These cross-border territories present a challenge for managing metropolitan progress and spatial and functional integration within the megaregion. Presently, there is limited cooperation among institutions in different cities in the regions. In China, city governments compete within their region. All strive to attract the same, high-value economic activities. Competition, rather than cooperation, for similar types of economic activities located in different cities is the norm. After many governments realized that HSR could help their cities boost their economies, a new competition thus began with the aim of maximizing locally the opportunities created by HSR. Be they core cities or medium and small cities, they all aim to develop a high-level service and knowledge-intensive economy. The HSR is increasingly seen as a factor that might support this ambition, without considering the implications for the megacity region as a whole. A key challenge, therefore, is how to build coordinating institutions that would lead to a better relationship between the core cities and medium and small cities, as well as avoid the duplication of activities and waste of resources that fierce competition can cause.

7.2.3.2. Long distance HSR vs. national spatial development strategy. At national level, spatial development strategy has shifted its focus from the unbalanced development of the east coast to more balanced development of the east coast and also the inland regions (Li, 2012). The national government now encourages industry to move towards knowledge-intensive manufacturing and services on the east coast and at the same time the development of the inlands, where some of the industries previously located on the east coast can relocate. The long-distance HSR is hoped to support this strategy. The web of long-distance HSR lines across the country is named the “four verticals and four horizontals” because it not only connects the megacity regions on east coast but also the inland regions (see Fig. 4). HSR is expected to play an important role in integrating the regional economies of the east coast and strengthening the economic development of the interior. Learning from international

Table 13
Percentage of workers who live and work in the same city on the Shanghai–Nanjing HSR corridor.

City A	Working in city A (J)	Living in city A (H)	Ratio (H/J)
Shanghai	49	42	85.71%
Kunshan	7	5	71.43%
Suzhou	15	11	73.33%
Wuxi	17	12	70.59%
Changzhou	13	9	69.23%
Danyang	2	1	50.00%
Zhenjiang	4	2	50.00%
Nanjing	94	56	59.57%
Other cities	9	4	44.44%
Total	210	142	67.62%

Source: Wang and Zhao (2010).

experience, the HSR could integrate the labour, business service, and leisure markets in a corridor. While the scale of both HSR and economic development discussed in the literature review does not match that of China, the HSR in China could possibly also reinforce the connection between two megaregions. For example, the Beijing–Shanghai HSR is likely to boost the economic integration of the country's two biggest megacity regions. HSR can also aid the transfer of manufacturing from the east coast to inland cities. An example is the Shanghai–Hefei HSR which connects the booming areas on the east coast with poorer inland areas.

However, the latter point especially raises the question of how much can be expected by HSR. There is a mismatch between the role HSR has shown elsewhere in supporting the knowledge economy and the current economic trajectory in China (Chen, 2012). Manufacturing plays a key role in Chinese economic development, including even on the booming east coast. Many places in the inlands are still unindustrialized. The HSR will help the flow of people within and between megaregions, but it is unclear if it will be supportive of the transfer of manufacturing activities. It has even been asked whether the less prosperous areas in the inlands should, for the time being, build HSR at all. Fan (2011) has for instance argued that it might be instead better to improve the conventional railway network there, based on the reasoning that this might be more supportive of developing a manufacturing base.

7.3. The potential implications and planning challenges of indirect effects of HSR on the urban level

7.3.1. A catalyst for reconstructing the Chinese urban system

Improving the quality of urbanization is the most important challenge for urban development in China. During the last 30 years, the country's urban development has mostly focused on facilitating economic growth. This resulted in problems such as a low-quality built environment, traffic congestion, unpleasant and unhealthy living conditions, and depletion of scarce land resources. It is now being argued that following the period of rapid, uncontrolled urbanization, development should now become more focused on the quality of urbanization (Duan, 2012). Learning from international experience, the HSR can play an important role in the process of reconstructing the urban spatial system, and could ultimately contribute to a shift from quantitative to qualitative urbanization. It could also support the

renaissance of historical city centres or help the transformation from a mono-centric to a multi-centric urban-regional structure. It could also facilitate the transformation from a manufacturing to a service based urban economy. We cannot hope that the HSR will solve all the urban problems of China, but based on the HSR's potential implications discussed in the literature review, it can play an important role in the process of reshaping the urban system, and in turn this can have an impact on the quality of urbanization. Some opportunities and challenges are discussed below.

7.3.1.1. A catalyst for reshaping urban spatial development. When considering the potential impact of HSR at the urban scale in China, the peripheral locations of Chinese HSR stations is a key characteristic to account for. Wang (2011b) compared the distance between new HSR stations and city centres (he used the location of the city government as a reference) of all the 23 new HSR stations in 22 cities along the Beijing–Shanghai HSR corridor. Distances are large. The shortest distance is 3.3 km in Langfang. The longest distance is 24 km in Suzhou. Furthermore, there is no clear relationship between the distance and city size. The distance is not shorter in small cities or longer in big cities or vice versa (Wang, 2011b). We have also analyzed the HSR station locations in the Yangzi Delta region. As with the Beijing–Shanghai corridor, most of the new HSR stations in the Yangzi Delta region are located on the outskirts of the city (Fig. 8).

Several factors explain the choice of peripheral locations. First, city governments wanting to develop new towns used HSR as a catalyst and made profits from selling the land. Second, city governments did not want the station to be located in developed areas because of the high costs. Third, traditional railway stations had the image of a poor surrounding environment. Accordingly, city governments were afraid of a negative effect of stations in those areas and did not want to construct them in the city centre. Fourth, technical and engineering reasons were also important in some locations. The Ministry of Railways has overriding power on deciding the location of new HSR stations and it bases its decisions on considerations at the network level (e.g. overall shortest travel times) rather than the urban area level (e.g. potential for synergy with urban development – see definition and discussion in Section 3.2). The local government would have to accept decisions that might be inappropriate from a local standpoint (Wang, 2011a).

The peripheral location of HSR stations confronts Chinese cities with both opportunities and challenges.

Fig. 8. HSR station locations in the Yangzi Delta Region (red dots represent new HSR stations).

The new (peripheral) stations provide an opportunity to reduce the spatial disorder and sprawl that has affected China's cities by providing development foci. They also have the potential to change the manner of urban expansion. Already, some Transit-Oriented Development (TOD) (Bertolini, 2010) strategies have been applied around the areas that surround the HSR stations, most of which are located on the outskirts of the main cities. The new peripheral HSR station gives planners

an opportunity to upgrade the fringe areas and integrate them into the city, particularly in the present phase of rapid urbanization and urban transformation.

In China, industrial zones still tend to dominate peripheral areas – these are zones that have played an important role in urban economic growth. In Nanjing, for instance, the output of manufacturing in the suburbs accounted for 30.84% of the whole city's GDP in 2009. However lack of public facilities and a poor environment

has made these areas unattractive places to live. Most people want to live in the central areas of the city. As of the year 2007, the population density in central Nanjing is 12,790 people/km², while in the suburbs it is under 2000 people/km² (NUPB: Nanjing Urban Planning Bureau, 2010). The development of the area around the HSR station in Nanjing aims to build a new city centre. It will create an opportunity to boost the attractiveness of the peripheral area and strengthen the polycentric urban form. The new peripheral HSR station also provides a catalyst for reshaping the urban image. Traditionally, in China, the railway station was a chaotic, dirty and crowded environment. Few people wanted to go to the area around the station unless it was by train. Now, the area around the station is regarded as a gateway to the city. The scenic axis in front of the station, the modern architecture style and other aspects can help reshape the urban image (Fig. 9).

Even though the peripheral location of stations provides many possibilities for the future development of the urban structure of Chinese cities, it is also a big challenge, especially for medium and small cities. First, the long distance from and poor connectivity with the city centre will influence the development of the new central business district (CBD) or town as shown by the international experience discussed in the literature. A second issue stems from the question if a HSR station, alone, is enough to support the development of a new CBD or town; as documented in the literature we reviewed, international experiences suggest it is obviously not. The poor environment of the urban fringe, the absence of other transport links, and the lack of other facilities for residents and businesses in the area, among other factors, will pose immense challenges for using the new peripheral HSR locations as a catalyst for suburban development.

7.3.1.2. An opportunity for urban industry upgrades and transformations. International experiences show that the HSR can have a positive effect on service economies and knowledge-intensive economies. In Europe, HSR has been seen to play a facilitating role for international service cities such as Amsterdam in the Netherlands as well as a catalyst role for cities in transition from traditional manufacturing to a service economy, such as Lille in France. However, and as already remarked, manufacturing is still the focus of economic development in China, even for the biggest cities. Whether or not manufacturing will continue to play an important role in future urban economic development is an important question. In a strongly globalized economy such as in China, traditional

manufacturing is hard to sustain. Several global and local dynamics are already causing a shift in China's economic model. Externally, the global economy is performing poorly, and there is international pressure on China for environmental protection and reduction of carbon emissions. Internally, growing labour costs mean that increasing productivity through innovation becomes ever more important. These are all issues addressed in the latest five-year plan, the most important policy document in China. The implication is that transformation and upgrading of traditional manufacturing can be expected to become more and more important for urban development.

Based on international experiences, the HSR will present an opportunity for urban industry upgrades and transformation in Chinese cities. In this respect we can distinguish two trajectories. For megacities, the HSR can play a dual role of facilitator and catalyst. In megacities, secondary and tertiary industries both play an important role at present. For instance, in Shanghai, the GRP of secondary industries including manufacturing and construction takes 41.3% of total GRP while the tertiary industry takes 58.0%. High-level functions mostly concentrate in megacities. [Nin and Zhang \(2012\)](#) have shown that the headquarters and R&D centres of multinational corporations are mostly located in the megacities of Beijing, Shanghai and Guangzhou. The HSR can play a facilitating role for these high-level service functions, as shown by experiences elsewhere. Whether it can also play a catalyst role for the upgrade of manufacturing is another question. In the presence of other factors such as a highly-educated labour force or well-functioning public facilities, the HSR might be helpful for the transformation from traditional manufacturing to a more technology and knowledge-intensive manufacturing; or at least, that technology and knowledge-intensive activities already present in these cities can be further expanded. In the absence of the other factors, the HSR alone will, however, not be enough.

Medium and small cities tell a different story. Here traditional manufacturing is likely to remain the most important part of the economy. The HSR could give connected cities an opportunity to move from traditional manufacturing to technology and knowledge-intensive manufacturing. It could be, for instance, useful for attracting such enterprises to locate, or expand the markets of those already located in the cities. Again, the presence of HSR will not be a sufficient condition by itself. The process, as shown by the experiences in other countries, also needs support from other factors such as labour resources, knowledge

Fig. 9. Artist's impression of future Nanjing South station area.
Source: Regulatory plan of Nanjing South station area, 2010.

resources and targeted urban policy and planning efforts. As the latter are concerned with achieving synergy between HSR and urban transformation, as defined and discussed in Section 4.2 of this paper, they present a key opportunity and challenge. This will be discussed in the next section.

7.3.2. HSR and the need for synergy with the strategy of urban transformation

The synergy between HSR and the strategy of urban transformation is critical. As discussed in Section 4.2 and shown by the international experience, for HSR and urban development to reinforce each other a fit has to be found between the location of the HSR station and the spatial development patterns of the city; between the

functions of the area around the station and the processes of transformation of the local economy; and between the development of the area around the station and the development of other areas in the city and region.

However, if we look at the Chinese case, no such fit seems to have been achieved. There are three main issues in this respect. The first issue is that the choice of station locations does not fit the spatial development patterns of the cities. The location is based on technical, financial and spatial considerations. On the technical level, there is the requirement that the line alignment be as smooth as possible in order to achieve high speeds. On the financial level, the cost of land acquisition for building the HSR lines and the cost of building the HSR

lines are important factors which affect location choice. On the spatial level, key arguments are the quality of the connection between the HSR station and the city centre and the effects of HSR on urban spatial development. The location choice should be expected to reflect a balance among these different dimensions. However, most of the time, technical and financial considerations dominate and spatial arguments are ignored. Take Suzhou North station location choice as an example. Two choices for the location of Suzhou HSR station have been discussed. One is the existing conventional railway station district, and the other in the Xiangcheng District which is 10 km away from the former. The first choice is considered better from a spatial point of view, while the second is considered better from a technical and financial point of view. The Suzhou Master Plan (2007–2020) had suggested opting for the first choice, based on the argument that it would better support the desired spatial development of the city. However, in the end the second choice prevailed (Yin et al., 2013). Similar stories are to be heard in many other contexts.

A second issue is that the functions planned for the station areas tend to be focused on the same high-level business and commercial functions, irrespective of the size of the city and the profile of the local economy. Wang (2011b) has investigated the planned functions of all HSR station areas along the Beijing–Shanghai line. The research has pointed out that business and financial services, high-end retail and entertainment functions are planned everywhere, irrespective of the specific features of the city considered. The Danyang station area on the Beijing–Shanghai HSR line is a characteristic example. The planned functions are business services, retail and entertainment. However, the population is 0.8 million, and the GRP is just 72.4 (RMB) billion in the year 2011 – figures that are low relative to other cities in the region and other cities along the HSR corridor. The secondary industry takes 55.2% of all GRP, which is also relatively high. It seems unlikely that high-level functions can thrive on the foundations of such a relatively weak and still largely manufacturing-based local economy.

A third issue is that stations areas are not developed in a complementary fashion but rather compete with other districts in the city. Railway station areas are planned mainly to develop into a new CBD or city centre, with no regard for the implications on the prospects of other planned or existing centres in the urban area. Take Nanjing. The urban development of Nanjing has long followed a monocentric pattern. Xinjiekou was the city centre since the first city Capital Plan began to be implemented in the year 1928, and is still the main CBD in the city. Many businesses have

settled in Xinjiekou as a result. With the advent of the phase of rapid urbanization, the city began to deviate from this monocentric pattern. In 2000, it started developing Hexi New town; a new CBD was planned there. After the city realized the potential impact of HSR on business location, a third city centre was planned around the HSR station. Even though the current Nanjing Master Plan (2010–2030) has redirected the spatial strategy from “monocentric city” to “multi-centric city,” there are no clear ideas of how to achieve synergy between the three different centres. The development of the HSR station area will face tough competition from the two existing centres, and vice versa. As a result, the long-term functional profile of the station area is still unknown, which makes it extremely difficult to achieve a synergy between the HSR station and urban development.

All of the issues discussed above stem from the underlying characteristics of China’s current urban development, creating a great challenge for planners to achieve synergy between HSR and urban transformation strategies. The characteristics of China’s development have been mentioned earlier but three of them can be usefully restated here, as they are particularly relevant for this discussion. The first is the high uncertainty associated with the hectic pace of urban growth in China. Cities are experiencing a period of radical economic, social and cultural change, most visible in the rapid urbanization, and it means high uncertainty as to what the future will hold. Cities and transport infrastructure are under various states of construction and reconstruction. Many different factors will affect the direction of urban development such as the rate and character of urban population and economic growth; the policies of urban development and growth management; and even just the opinions of political leaders. Take the rate of population growth in Beijing. According to past predictions in the Beijing Master Plan (2004–2020), the population of Beijing would reach 18 million in 2020 – but this number was already reached in 2010. The expansion of the population is far above the predictions of the Master Plan. A first major challenge is thus how to cope with this uncertainty when pursuing synergy between HSR and the strategy of urban transformation.

A second key character of current Chinese urban development is the competition between the different layers of governments. China’s city governments manage their local development and see themselves as competing with other localities to ensure local prosperity (Zhu, 2004). The HSR is considered as an opportunity to boost the urban economy and attracting

high-end service and leisure functions in the HSR station area has been considered the way to realize this opportunity. The result is cities and HSR station areas competing with each other for the same functions rather than trying to complement each other, as we have shown above with the example of the HSR station areas and cities along the Beijing–Shanghai HSR line. The ensuing challenge is how to shift from competition towards complementary and more differentiated, context-sensitive station area functional programmes.

A third critical character of current Chinese urban development is that urban development has played an important role for local economic growth and the consolidation of political power, increasing the government's financial revenue from selling land, or obtaining achievements for the local political leadership to show. However, in the process the impact on the quality of urbanization has been largely ignored. The same, quantitative growth-oriented dynamic is at play in the development of HSR station areas. How to redirect this deeply rooted pattern towards more qualitative growth is a third major challenge.

7.4. The potential implications and planning challenges of indirect effects of HSR on the station-area level

7.4.1. A balance between node and place

A balance between transport-related functions or 'node' values, and area-related functions, or 'place' values should be the aim of the developments around the stations in China, as shown in the case of other countries (see discussion in Section 5.2, and further: Bertolini, 1996, 1999; Bertolini & Spit, 1998). The node value not only relies on the HSR station's position in the country's rail network, but also its position within the city transport network. As a place, its value relies on its location in the city, the function of the area around the station and the spatial quality of the station area. As discussed in Section 5.2, in order for node and place to reinforce each other, they should match. The level of access provided by the node should match the accessibility demands of the activities located in the place. Conversely, the demand for travel generated by the activities located in the place should match the transport facilities provided by the node. In other words, if we want a positive, reciprocal relationship between HSR and local development, we cannot favour the high-speed effect and discriminate against the local context, nor can we do the opposite. HSR brings cities closer. Within the same time limits, people can travel further than before and cities can access a larger market and

gain more business. However, this view only focuses on what a city can get from the HSR, ignoring whether or not it has the ability to get it. The development of a city after connecting to the HSR not only relies on the newly accessed demand, but also on the existing local supply. Local conditions such as development limits (because of existing land use or land speculation) will also have an impact on the HSR effect on the station area. How to get a balance of node value and place value in the development of station areas is therefore another key planning challenge.

Unfortunately, we can already identify some unbalanced cases in current experiences in China, even though the development of most of the station areas has just begun. There are examples of station areas with high node values in low place values, and low node values in high place values. For example, development of the Shanghai Hongqiao transport hub in the west of the city centre has a high node value, but its place value is relatively low and difficult to improve. On the node side, the interchange combines the Shanghai Hongqiao International Airport, railway station and connections with metro lines 2, 10, 7 and 5, along with inter-city express buses to other cities. Shanghai Hongqiao International Airport is one of two airports in Shanghai and focuses on domestic flights, but has some international flights. Shanghai Hongqiao Railway Station is one of four main train stations in Shanghai and serves HSR routes including Beijing–Shanghai, Shanghai–Nanjing and Shanghai–Hangzhou. It also serves the planned Shanghai–Hangzhou Maglev HSR and the traditional railway. However, because of restrictions including a 48-metre height restriction and noise levels around the airport, high-intensive development of the area around this node is impossible. Within the node itself, passengers face lengthy walking times to connect between the various modes. It is an example of high node value set against low place value, with little scope for change in the immediate future. Low node value combined with high place value is most common in China's medium and small-sized cities. Here, there is a trend to over-emphasize the effects of HSR. Many cities have tended to see a connection to HSR as a mechanism to boost the local economy and have arranged many projects around the new HSR station. The areas around the stations wish to be developed into new urban centres. Business, commercial, leisure and residential developments are planned there. The already mentioned development of the Danyang HSR station is an example of this unbalance. Danyang is a small city along the Beijing–Shanghai HSR railway line. Only 18 HSR trains stop at this

station per day and most of them pause for only one or two minutes. Even so, many skyscrapers have been planned for the area around the station. The local government expects this area to become a new business, commercial and leisure centre. The fact that the high place value is pitted against a low node value casts doubt on much of the development potential of this area (and this is not even considering the poor fit with the size of the city and profile of the local economy mentioned in the previous section)

There is an underlying institutional problem when striving to balance node and place at Chinese HSR station areas. The station, itself, is administrated by the Ministry of Railways (MOR). It is a separate and self-enclosed system. The MOR is responsible for everything in the station. On the other hand, the station area (except the station, itself) belongs to the city government. Both institutions can only focus on their own territory. The city government cannot, for instance, promote the development of commercial activities in the railway station building, making it even more difficult to modulate node or place value according to the situation.

7.4.2. Coping with rising land values and real estate rents in the area around the station

As has already happened in some cities, the value of land and the rents for real estate are likely to rise in the area around the station, especially around metro and urban public transport interconnections. For example, the price of housing in Nanjing South station area was about ¥4000 per square metre in the year 2009 before the HSR station location was approved. But as of 2012 it is about ¥13,600 per square metre (data as of December 2012: <http://nanjing.aifang.com/loupan/jiage-241556.html>). Even though the price of housing is increasing quickly all over the city, we cannot ignore the impact of the HSR station. However, there are also some case-specific factors that influence the land price and property rentals, as we know from international experiences. The first is that price increases will be based on the overall accessibility of stations. This is very important, especially for HSR stations located far from the city centre. Tainan in Taiwan is a typical example of a HSR station with poor accessibility at the urban and regional level – it has not seen a significant rise in real estate prices in the station area. A second observation is that land speculation is also likely to influence the development of the area around the station. In China, land speculation has happened in some HSR station areas because the HSR stations' impacts are speculated upon by property developers.

Property developers bought up land around the station area to develop it in the future. This has the potential to lead to poor planning outcomes. The government has to counter the purchase of the land by property developers if it wants to develop station areas holistically, and this is a difficult task. How to improve the total accessibility of station areas and suppress the land speculation of the area around the station is a key policy and planning challenge for property development. Until now, Chinese cities have been experiencing a sustained pace of growth. The expectation is that this trend will continue. However, we know from experiences elsewhere that this cannot be taken for granted, and that the possibility of an economic downturn should be acknowledged in HSR station area development plans, as current developments in Europe are strongly reminding. Also in China, it has been recently contended that, growth might be coming to a halt, at least locally and temporarily, and that a property development bubble might have been forming and could burst (http://www.pbs.org/newshour/bb/business/jan-june13/makingsense_01-24.html). How to deal with this possibility is a challenge that is presently not even taken into consideration.

7.4.3. Quality of place of the station area: urban design and beyond

Traditionally, the railway station has been considered just a node of inter-city transport in China. The quality of place of the station area is typically poor: a chaotic environment, crowding of people, and other malaises. There are only a few people that would go to the station if not taking a train. However, the HSR has changed this. Less people crowd the station thanks to the higher standards of the transfer facilities. The large square in front of the station has come to be seen as an icon of urbanity. The HSR station area is now considered as a high quality urban place, or at least a place with potential. Realizing this potential for quality of place has become a key ingredient of the spatial development strategy for the station area. This orientation has especially appeared in some new station area developments such as Nanjing Railway Station area.

In China's approach to achieving quality of place in HSR station areas, a physical design-oriented approach dominates. The underlying philosophy is to change the traditional image of the area around the stations, emphasizing seamless connections to HSR and other modes of transport and providing a window of urban imagination (Duan, 2009). Big ambitions have been shown in the planning of stations and their surrounding areas. The station area precincts are huge compared to

those of Europe. Nanjing South Railway Station area is 8 km², the Wuhan station area 11 km² and the Hongqiao station is 27 km². Meanwhile, there is some Chinese specificity in the urban design such as big squares in front and behind station buildings, a wide and long axis with a combined avenue, a square and other public spaces in front of the station. In the professional sphere, lively critical discussions have arisen about the right land use mix, the appropriate architectural styles and the quality of these public spaces. It can also be added that quality of place relies not only on the qualities of the design itself, but also on interaction of the design with the non-physical local context, including the economic, social and cultural environment at city level. Because of this, there are many specific challenges for the quality of place of HSR station areas as different cities have different situations. For example, planners envisaged small blocks, narrow streets and a creative culture industry in the expanded area of Nanjing South Station. However does the city have the environment of creative culture and are there enough potential employers in the creative culture industry? These and other critical aspects are important, and translate into yet-unsolved challenges. At the same time, it seems important to also acknowledge in design and functionality terms the huge progress being made relative to the treatment of non-HSR station areas in the past.

7.4.4. A complex station area development process: the limits of a physical planning tradition in China

From the international experience we have learned that the development of the area around the station requires an articulated, multi-layered strategy including ways to deal with the functional, financial, temporal, managerial and other dilemmas and the numerous, heterogeneous actors that characterize the development process (Bertolini & Spit, 1998). The same applies in the Chinese context, where the same dilemmas occur and many different actors also crowd station area development processes. Fig. 10 shows the main organizations that are responsible for different elements of station area development. For example, choosing the location is the responsibility of the National Development and Reform Commission, the Ministry of Railway (MOR) and of the local Urban Planning Bureau; the layout of the public square in front of the station is impacted by several organizations including the MOR, the city-wide Urban Planning Bureau and Parks Bureau and the station area-focused Construction Investment Agency. Figure 10 is a simplified representation of an even more complex constellation of actors and

institutions. For more discussion see Dai, Salet, and deVries (2013).

This vast constellation of organizations and responsibilities translates into a major coordination challenge. However, there within China there is little discussion on the institutional aspects of station area development. Plans for mega-project developments, such as HSR station areas, are embedded in a tradition of physical planning and urban design. Discussions about the merits of alternative planning theories and approaches, such as process planning, are taking place in the academic domain. However, the rapid urbanization period has witnessed a separation between planning practice and theory, with the former narrowly focusing on the physical aspects of the built environment. As concluded on the evidence of experiences elsewhere (see e.g. Bertolini & Spit, 1998) physical planning cannot resolve the complexity and uncertainty that are an integral part of the development process of a station area. Institutional factors internal to the planning process and the relationships with external stakeholders beyond those represented in Fig. 10, like industry and property developers, are also very important for the development of a station area. Only a few cities have attempted, so far, an integrated, strategic plan for the areas around the HSR station that explicitly attempt to deal with this reality (e.g. Nanjing South Station and Shanghai Hongqiao Railway Station). However, it is still too soon to say whether or not they will succeed.

7.5. Potential implications in China of HSR's effects on urban development: summary of findings

To conclude this section, we sum up the most important potential implications and planning challenges of the HSR for urban development in China (see also Table 14). With reference to Chinese urban spatial issues and strategies at different levels, we discuss potential impacts of HSR according to the international experience and identify planning challenges that are likely to emerge in the process of realizing the impacts.

In transport terms, HSR in China needs to be integrated with other transport modes. Learning from international experience, HSR will dramatically reduce travel time on certain journey combinations, and have a significant effect on different transport markets. Integration with other transport modes is not only essential to the generation of HSR traffic, but is also a factor for the market share of other transport modes. However, both technical and institutional barriers to transport integration have still to be overcome in China, as discussed in Section 7.1.3.

Fig. 10. Different agencies responsible for different elements of the station area development (for more discussion see: Dai et al., 2013). *Note 1:* This figure just lists the main organizations involved in the development of the station area. In reality, there are more organizations involved, including the Local Development and Reform Commission, the Land Management Bureau, and several others. *Note 2:* The national Ministry of Railway encompasses Local District Railway Bureaus. These, however, do not belong to the local government, and are directly accountable to the Ministry of Railway directly. There are presently 18 Local District Railway Bureaus in China. *Note 3:* The Construction Investment Agency of the station area is a company owned by the local government. It plays a key role in the development of the station area.

At the regional level, HSR might play an important role in spatial strategy by integrating megacity regional systems and achieving a more balanced spatial development at national scale. Learning from international experience, the HSR could also impact developments at regional level by enlarging the development gap between connected and unconnected cities, increasing the attractiveness of core cities, and having a more ambivalent effect on medium and small cities. The interurban HSR network is likely to increase the flows of business, knowledge, and labour and lead to more internally integrated megacity regions. The long-distance HSR lines will have an impact on the

integration between different regions and facilitate the upgrading of industry within the leading cities and transfer of industry to other regions. However, the potential mismatches between HSR and the manufacturing base of the economy in China at present needs to be acknowledged and catered for. Furthermore, institutional mechanisms to coordinate development in different cities have still to be identified, including cities not connected to HSR.

At the urban level, HSR might play an important role in ongoing urban transformation processes. As we have seen internationally, HSR can act as catalyst for the reconstruction of the urban system in both spatial and

Table 14

A summary of international experience, potential implications for China and planning and research challenges.

HSR effects (international experience)	Potential implications for China	Planning and policy challenges	Research challenges
Transport	Reduced travel times	Reduced travel times	Understand how to develop an integrated transport system: How to redistribute and integrate transport resources across national, regional and urban level. How to provide connections between different modes. How to plan seamless connections in station areas. How to match the timetables of different transport modes such as air travel, HSR, traditional railway, express buses and urban public transport.
Change of transport modal share: - Different outcomes of growth in passenger numbers in different countries; local accessibility an important factor - Different influences of HSR on other modes depending on prices, door-to-door travel times and distances.	Unclear how the traffic flow of HSR will grow in China.	-Make an attractive ticket price strategy to entice more passengers. -Improve the local accessibility of stations to increase convenience for passengers.	
	The operation of HSR will have an influence on the market shares of other transport modes.	-Handle the relationship between different transport modes.	
Not only competition but also synergy with other modes is important. Towards an integrated transport system: -Develop a complementary strategy with air. -Ensure connections between the HSR and traditional railway, express bus and other inter-urban transport. -Connect the HSR and urban public transport, as well as provide access for cars. -Develop the HSR station as a connector.	There is a need to develop an integrated transport system.	Technical level: - Integrate HSR with air travel, inter-urban transport, conventional rail, urban public transport and car travel. -Achieve seamless connections in large station spaces. Institutional level: -Achieve cooperation between different government agencies relating to different transport modes.	

Table 14 (Continued)

	HSR effects (international experience)	Potential implications for China	Planning and policy challenges	Research challenges
Regional level	<p>Enlarged gap between the connected cities and the hinterlands:</p> <ul style="list-style-type: none"> -On average, the rate of population and employment growth in the cities connected to HSR is higher than the cities not connected. -In business, tourism, accommodation and the knowledge-intensive sector, the cities connected to the HSR gain more opportunities than cities that are not connected. <p>Redistribution of activities among the cities along the HSR corridor:</p> <p>Megacities gain many opportunities from connection to the HSR. The situation in intermediate cities appears to be more complex.</p> <p>A reconstruction of the urban regional system:</p> <ul style="list-style-type: none"> - Emergence of HSR commuters and a new metropolitan process. - Long distance HSR contributes to an integrated functional region. 	<p>The average rate of population, employment growth and economic activities of the cities connected to HSR are likely to be higher than the cities not connected.</p> <p>The cities that possess high-quality resources in tourism, business and the knowledge-intensive labour force will gain many development opportunities.</p> <p>The construction of inter-city HSR networks will contribute to a new metropolitan process and a new megaregion system.</p>	<p>-Identify strategies to develop the unconnected cities, especially in terms of the distribution of economic opportunities and natural and human resources, which are already highly imbalanced in China.</p> <p>-Find a suitable role for the cities along the HSR corridor in a regional context.</p> <p>-Build efficient cooperative institutions between different cities in a megaregion.</p>	<p>Explore the new metropolitan processes and the new megaregion system, and how to manage them:</p> <p>How to manage change in the urban-regional system after the HSR network.</p> <p>How to achieve a balanced spatial redistribution along the HSR corridor.</p> <p>How to reduce the cities' territorial boundaries impact on the integration of different cities.</p> <p>(4)How to build an effective cooperation intuition to reduce harsh competition within regions.</p>
Urban level	<p>A potential catalyst rather than a sufficient condition for the restructuring of the urban system; in terms of:</p> <ul style="list-style-type: none"> - Urban economic transition - Urban spatial reshaping <p>There is a potential synergy between HSR and urban development, but this depends on local conditions and needs to be proactively pursued.</p>	<p>A potential catalyst for the restructuring of the Chinese urban system:</p> <ul style="list-style-type: none"> - An opportunity for urban industry upgrading and transfers. - A crucial role in the process of reconstructing of the spatial system. <p>The HSR needs to have a synergy with urban transformation.</p>	<p>-The HSR, alone, is not a sufficient condition for reconstructing the urban system. Therefore an holistic approach should be taken with both the HSR and other factors in the process (e.g. local demographic and economic change)</p> <p>-Respond to the uncertainty of urban development and the complexity of developing station areas in order to achieve synergy.</p>	<p>Identify opportunities and threats for the synergy between HSR and urban development:</p> <p>How to respond to the urban development opportunities of HSR.</p> <p>How to gain synergy between the HSR station and other local developments.</p> <p>How to achieve coordination between development of the station area and other locations in the city.</p> <p>How to respond to the uncertainty in the urban development process</p>

Station area level	HSR station has both a node and a place dimension, and both need to be catered for.	The development of the area around the station needs to have a balance between node value and place value.	-Identify and implement an optimal balance between node and place.	Find ways to increase the quality of station areas: How to recognise and balance the node value of a station and the place value of a station area. How to improve the quality of urban design in the area around the station in a local context
	Positive effects on property development, when overall accessibility is good. Risk of speculation.	Land value and rental prices will rise in the area around the station if overall accessibility is good, but there is risk of speculation.	-Improve the overall accessibility of station areas and suppress the land speculation of the area around the station.	-Go beyond merely focusing on building and urban design and also concentrate on strategies for integrating with developments in the local environment.
	Urban quality depends on both urban design and local environment	Urban quality is not only determined by design orientated development progress but also by the development of the local environment		
	The development of the station area is a complex process involving many different stakeholders	The development strategy of the area around the station needs a strategy to cope with the great complexity and many stakeholders of the development process.		-Identify and adopt planning approaches that can respond to the complexity of the development process

economic terms (e.g. from a monocentric to a polycentric space, from a manufacturing base to a high-technology and service-based economy). However, as shown by the international experience, the development of HSR must fit in with other, context-specific developments (e.g. developments within the urban fabric and the local economy). Furthermore, and more specific to the Chinese case, ways must be found to cope with the great uncertainties of the on-going urban transformation in China; the competition between Chinese local governments; and a quantitative growth-oriented mode of urban development, which produces short-term economic and political gains, but neglects implications for the long-term functionality of the urban system and for the quality of life in cities.

At the HSR station area level, stations may become high-quality urban centres and public spaces. The international experience shows us that finding a balance between the transport-related node dimensions and the area-related place dimensions is a key challenge of station area development. In this respect, HSR seems just an added value, not an essential pre-condition for the quality of the station area as urban centre and public space. We have also seen how in China HSR station areas have become the objects of ambitious urban design efforts. However, a high-quality urban centre and public space not only depends on the quality of its design, but also on the interaction with the local context, including its economic, social and cultural aspects. An approach that goes beyond a narrow urban design focus is also needed in order to master the complexities of the multi-dimensional, multi-stakeholder planning process characteristic of station area development.

8. A final note on research challenges

Table 14 provides a summary of all the different parts of the paper. While potential effects and implications cover many dimensions, a common thread seems also to emerge. HSR is at best a catalyst for desired urban developments, and it can also reinforce less desirable ones. Positive impacts will be realized only if interactions with other dimensions and with context specifics are duly acknowledged. Accordingly, HSR developments and policies must be fine-tuned to developments and policies in other domains, and most importantly in the economic and spatial domain of each different city. Our voyage through the Chinese context has reconfirmed the findings from the international experiences and added some findings specific to China. These importantly include an even more pronounced institutional fragmentation and lack of coordination

among key stakeholders. This is reinforced by insufficient acknowledgement by those involved that this is a problem, and lack of insight into the broader spatial and economic implications for cities of only apparently just technical choices, such as HSR routing, station location choice, level of service and integration with other transport modes. In this paper we have tried to provide some of these missing insights combining evidence from abroad with the characteristics of the Chinese urbanization process and planning context. Much more needs to be researched. To conclude, we list some of the key research issues.

In transport terms, the major research issue is how to respond to the institutional and technical challenges in the process of developing an integrated, door-to-door transport system. Consensus has been reached in China about the need to develop an integrated transport system. But how can this integration be achieved? There seems to be little understanding of the complexities of the task. The research needs to focus on how to construct a system which is integrated in both its technical, hard components, and in its institutional, soft components. This overarching question should be further articulated by more specific questions, such as how to best distribute transport resources in a national, regional and urban context; how to ensure seamless connections between transport modes and what should be the role of HSR stations in this; how to design a ticketing system that facilitates inter-modal and multi-modal trips; and how to coordinate the timetables of different transport modes including air, HSR, bus, traditional railways and urban public transport.

At the regional level, there are major opportunities for more research to help the strategy of developing a megacity region system. This includes researching ways of reducing the impact of cities' territorial barriers on their integration into the region, and of building an effective process of cooperation between the different cities involved in the process (both those connected to the HSR and those which are not), in order to limit destructive competition between cities. Understanding current metropolis formation processes and the emergence of a new megacity region spatial system seems a prerequisite for finding answers to these questions. The HSR network changes the mobility patterns and accessibility features of a locality. It will be a factor in changing past directions of urbanization and eventually contributing to a reshaping of the urban-regional system. Arguably, this is a novel process in all respects, as in most if not all other countries HSR was deployed when the height of the urbanization process was already passed (this has been most clearly the case

in Europe). In China, urbanization and HSR deployment are proceeding next to each other, and thus can shape each other much more than elsewhere. This creates the research challenge of gaining insights into how to develop the urban-regional system in interaction with the progressive deployment of the HSR network, how to ensure a balanced redistribution of activities along the HSR corridor in the process and how to enable different cities to gain development opportunities.

At the urban level, HSR is expected to play an important role in the urban economic and spatial transformation strategy. Within this strategy, a major research challenge is how to develop effective approaches and institutions to deal with the great and inevitable uncertainties of the development process, the competition among different local governments, and a much-needed shift from quantitative to qualitative urbanization. These are all issues that go beyond the HSR itself, but are at the heart of current Chinese urbanization. Within these broader processes, the HSR creates an opportunity for reconstruction of the urban system, both in spatial and economic terms. We have tried to pinpoint some lessons, but more research is needed on how to achieve synergy between the improved accessibility granted by the HSR, the development of the area around the station as an urban centre, the function of other centres in the city, and the trajectories of transformation of the local economy. Again, the challenge would not just be that of identifying spatial and economic development models, but also institutional arrangements that can cut across scales and sectors.

At the station area level, how to achieve a balance between the node and place dimensions of the area in the Chinese context is a key issue for further research. The node-place model (Bertolini, 1996, 1999) can be a useful way to help structure the discussion about development opportunities and threats and recognise the interdependencies between the different functions and development dynamics of a station area. However, the HSR and the Chinese context add their own specific issues, derived from the uniquely central position of the HSR station area in both transport networks and the urban space. This reflects, again, the unique situation of HSR deployment and urbanization happening at the same time. These more specific issues include researching what might be the public function of this most central place and how to realize it; how urban design could interact with local economic, social and cultural dimensions in realizing quality of place; and what institutional arrangements might help manage the great complexity of the station area development process.

The above research challenges are based on the observations we have made of the international experience and the potential implications and planning challenges for China. The construction of huge HSR networks is being widely discussed in China. Many cherish its potential to change the way we travel and create opportunities for development. Skillfully integrating HSR with urban transformation has the potential to also contribute to a shift from a quantity-focused, short-term oriented and largely unbalanced urban development, to a more quality-focused, long-term oriented and more balanced approach. This should be a fundamental goal in the current Chinese context. It is critical for the long-term success of and urban development in general and HSR in particular. In the end, this wider development impact is likely to prove more important than the construction of the transport system itself, on which up until now most energy has been focused.

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