High-speed rail networks and economic integration in China and Europe

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1. Introduction

The role of transport in the process of economic development and integration remains an area of controversy in both the economics literature and policy-making. The theoretical literature following the work on the new economic geography (Fujita et al, 1999) implies that there is no a priori certainty in whether improved accessibility will lead to convergence or divergence in economic performance. Despite this policy makers have emphasised the importance of investment in transport infrastructure as an instrument of both economic growth and cohesion. Pre-eminent in this thinking has been the role of high-speed rail which has been seen as enabling a significant shift in transport supply equivalent to the introduction of a completely new mode of transport. This belief has been to the fore in both European transport policy and in the rapid development of high-speed rail in China.

As originally conceived, high-speed rail (HSR) was seen as a means of improving accessibility between core cities in the distance range 400-600km (Vickerman, 2012). Studies in Europe focused on the way in which changing accessibility could impact on regional economic development (e.g Gutierrez et al, 1996, 2010), although some studies were more sceptical about the overall spatial impact of such changes (Vickerman et al., 1999). In Europe evidence from Spain, France and the UK has shown that it may also have a role in enhancing intra-regional integration in the distance range up to 200km (Garmendia et al, 2012). A similar situation can be identified in China where HSR is seen as one of the elements in the long-term national economic integration and a catalyst for economic growth. Some segments also have the objective of promoting development and integration within a particular region. A case in point is the HSR in the Pearl River Delta area, which aims to enhance the integration of Hong Kong with Guangdong (Wang et al., 2009; Hou and Li, 2011).

Policy makers are also faced with the claim that the cost of high-speed rail (HSR) makes it an expensive way of achieving the supposed benefits. Nevertheless many countries have been developing significant high-speed rail networks. This paper explores the development of HSR as an instrument for promoting economic integration both through enhancing competitiveness and achieving greater economic cohesion in the European Union and China. Both have developed ambitious plans for HSR networks.

2. Methodology

Most studies of HSR have been of individual links or of networks within a single country. Furthermore most studies consider only the transport implications of HSR developments. This paper aims to embed the development of HSR in the wider process of economic integration which has been a major policy objective in Europe and China. By comparing HSR developments in Europe and China, two aspects will be considered:

(i) The rationale for the development of HSR: the problem HSR seeks to solve; the appraisal process; issues in the approval process – a comparison between Europe and China (essentially a comparison between the Trans-European Network for HSR in the EU and the National Plan for HSR in China).
(ii) The economic implications of the links: methods of estimating the economic impact on national and regional economies using both macro- and micro-approaches.

The new economic geography approach has demonstrated that the changing economic structure resulting from transport improvements would depend on the incidence of scale economies and the size of market areas of firms in different economic sectors and the relative elasticities of these to changing transport costs.

In his classic paper, Krugman (1991a) demonstrates by a simple two-sector- two-region model that transport costs may interact with various factors to give rise to different patterns of agglomeration. When the expenditure share of the consumer goods that incur transport costs is small and the elasticity of substitution among them is large, a sufficiently low level of transport costs will lead to the concentration of production in a city. The underlying assumption is that workers are attracted to locations with higher real wages. The larger number of workers creates a larger market for firms, which are able to exploit scale economies. They will not lose much business in other smaller cities if transport costs are low. Thus, if HSR leads to a lower level of transport costs, it is possible that further agglomeration will occur in core cities at the expense of smaller cities.

However, in an enriched model with intermediate and final goods, Venables (1996) shows that when economic integration comes with a reduction in transport costs (more generally, trade costs), both concentration and dispersion of industries are possible results, depending on the strength of the vertical linkages and the level of trade costs. Specifically, if vertical linkages are strong and trade costs are not low enough, agglomeration will occur. Conversely, if linkages are weaker and transport costs become very small, integration may lead to dispersion. By implication, as different economic sectors might have different relevant parameters, economic integration could lead to a change in the specialization patterns among regions. In the context of HSR development, whether a new line leads to further concentration of activities in large cities or it will help spread economic activities to smaller cities on the line depends on its economic structure which defines the linkage effects.

Although HSR typically may be seen to have little direct impact on the integration of manufacturing (except from the relatively small amount of costs absorbed by business travel), as it is normally a purely passenger railway, it can have a significant indirect impact through the release of capacity on the existing network for both commuting traffic and freight

The direct benefits from any transport investment can be measured by the estimated user benefits in terms of the willingness to pay for time savings. What is of particular interest however is the scope for wider economic benefits which derive from the contribution to agglomeration benefits. Recent research in the UK has identified that the potential for agglomeration economies are in fact much greater in service sectors, especially financial services (Graham, 2007; Venables, 2007; Vickerman 2008a). This might suggest that the scope for wider economic impacts would also be significant in the Chinese case. However, such benefits are case-specific such that some basic research will be needed into the potential for such benefits in the local case on the basis of local economic structures. Such agglomeration effects are also much more likely in the case where HSR is used to increase the labour market potential of a metropolitan area as evidence suggests that the distance decay of such benefits is quite pronounced.

The allowance for these wider effects implies that conventional transport demand forecasting models which take existing patterns of demand and project these on the basis of the change in generalised costs will be inappropriate when there is both a significant shift in such costs and the introduction in effect of a new mode of transport (Loo, 2009). The existence of a new HSR connection may lead to significant diversion of trips from other modes, other destinations and the generation of completely new trips. There is evidence that once half-day return trips become possible allowing up to four hours at the destination there is a significant shift in trip generation (Vickerman et al, 1999). In addition the simultaneous introduction of other measures of integration such as reduced border controls, removal of trade barriers, harmonisation of regulations, which are concomitant with economic integration, change international travel patterns significantly.

Because of the potential inequalities in the distribution of benefits between the affected regions, it is important to identify the decision-making processes involved to assess the degree to which different authorities seek to use the HSR as a means of increasing their competitiveness vis a vis neighbouring regions or as part of a cooperative venture to increase the agglomeration effect in a group of regions (Vickerman, 2008b).

It is thus important to emphasize that the impact of HSR on the location of economic activities depends on the specific economic and geographic conditions and how policy-makers react to the possible opportunities and challenges brought about by the availability of HSR lines. To demonstrate the diverse impact of the HSR, our empirical study will start from an analysis of how HSR lines in Northern Europe and China compress the travel time between cities and thus transform their accessibility. This is followed by an investigation of the resulting passenger flows and an examination of the employment growth and specialization patterns. We do not attempt to investigate the peculiar factors that affect the growth pattern of individual cities. Rather, throughout the process, we try to show the diversity of the growth patterns of the cities even though they are all on HSR lines.

3. **Case studies**

Two case studies are used to illustrate the issues:

(i) The northern European network of HSR that links major cities across several countries.
(ii) The national HSR network in China that links major cities in coastal and inland regions.

The full opening of the UK Channel Tunnel Rail Link, now known as HS1, in 2007 provided both a complete high-speed route between London and the Channel Tunnel with direct international services to Paris and Brussels and, from 2009, a regional high-speed service between London, Stratford, Ebbsfleet and Ashford with through services to a range of towns in Kent largely used for commuting traffic. Prior to the opening of this line both international services and local commuter trains competed for space on the historic rail network. In France the Nord-Pas de Calais region has introduced regional services using the high-speed line (TER-GV) to provide better integration of the coastal towns with the regional centre of Lille. What has not yet been achieved is an effective inter-regional service between the intermediate regions and the impact on the regions between the capital cities has been minimal. These lines are part of the North-European HSR network linking Paris, Brussels, Cologne, Amsterdam and London (Figure 1).

The idea of building a national network of HSR in China was first laid out in the Mid and Long-term Railway Development Plan released in 2004. The plan, after revisions in 2008, aims to increase the total railway network to 120,000 route-km by 2020.[1] Included in the plan was the construction of an HSR network of 16,000 km, which is often called the "four verticals" (north-south lines) and "four horizontals" (east-west lines). The former includes the Beijing-Shanghai line, Beijing-Wuhan-Guangzhou-Shenzhen line, Beijing-Shenyang-Harbin (Daline) line, and Hanzhou-Ningbo-Fuzhou-Shenzhen line, while the latter includes Taiyuan-Shijiazhuang-Qingdao line, Lanzhou-Zhengzhou-Xuzhou line, Chengdu-Chongqing-Wuhan-Nanjing line, and Changsha-Nanchang-Hangzhou line. These lines cover major cities in the affluent coastal region as well as those in the inland regions with a lower level of economic development (see Figure 2). In the wake of the outbreak of the global financial crisis in 2008, the speeding up of the construction of the HSR network was part of the central government's stimulus package. There was a slowdown of the construction subsequent to the train crash in Wenzhou in 2011, but a quickening-up was seen in late 2012 after consolidation measures were implemented in the Ministry of Railway.

It is argued that the HSR lines would enhance the competitiveness of the coastal region by linking the cities in it. For instance, when the travel time between Shanghai and Nanjing (also between Shanghai and Hangzhou) is reduced to approximately one hour, resources within the region can be better utilized and thus the competitiveness of the Yangtze River Delta region will be greatly enhanced. Likewise, by linking China's political centre in Beijing and the economic centre in Shanghai, the two cities as well as the whole corridor between them will benefit. It is also suggested that by improving the link between coastal and inland cities, the economic expansion in the former will be "radiated" to the latter. This is important from the perspective of the regional disparities in China, which have widened for a prolonged period after the start of economic reforms in the late 1970s. One important case is the Guangzhou-Wuhan line, which has been in operation since late 2009. With a total length of 968 km, the line covers three provinces (Guangdong, Hunan and Hubei) and passes a number of large cities in central China. Guangzhou aspires to become the most important service centre in southern China with services covering neighbouring provinces. With rising production costs in the Pearl River Delta within Guangdong, manufacturing industries may choose to migrate to Hunan and Hubei provinces. The installation of the HSR line may facilitate this transformation process. (Dai, Cheng and Sheng, 2011).

The historic rail link between Kowloon and Guangzhou, due to the slow speed in Hong Kong , does not provide the capacity needed to effect the integration potential between the Hong Kong SAR and

[1] The revised plan can be downloaded from the website of National Development and Reform Commission: http://jtyss.ndrc.gov.cn/fzgh/t20090605_284526.htm.

the rest of the Pearl River Delta region. In the 1990s, railway infrastructural improvements have been most closely associated with urbanization, export-orientation, rural development and service sector production, but not income growth, industrialization or the development of industrial-supporting tertiary sector (Loo, 2000). Moreover, the existence of immigration and customs check-points between Hong Kong and the rest of the Pearl River Delta under “one country, two systems” suggests that the generalized transport cost of crossing the border for passengers was about three to six times higher than traversing the same distance within Hong Kong or the Mainland Pearl River Delta (Loo, Wong and Ho, 2005). Beyond the Pearl River Delta, there are also long-distance overnight services provided between Hong Kong and Shanghai and Beijing which take 20/24 hours respectively. Proposed HSR services will reduce the Beijing-Hong Kong time to 10 hours. (Figure 2)

Figure 1 North European HSR Network Source: Conseil Régional, Nord Pas de Calais

Figure 2 Chinese National HSR Plan Source: MTR, Hong Kong

In both cases there are major centres of population likely to benefit from high-speed city to city communication and intermediate areas which may benefit from greater integration into the higher level centres, but may also find themselves increasingly excluded by the new high level links. The research in Spain, reported in Garmendia et al (2012), has shown how dedicated shorter distance HSR services can create completely new travel opportunities with major impacts on regional labour markets and on residence-workplace location and choice. The scope for this, and its likely impacts, both positive and native will be examined in these cases. Both cases also show the possible consequences of using improved transport as a means of removing the barriers which international borders imply.

4. Results

The key to any impact is clearly the change in accessibility and this is best represented initially by the changes in access time between the major population centres. (Figures 3 and 4).

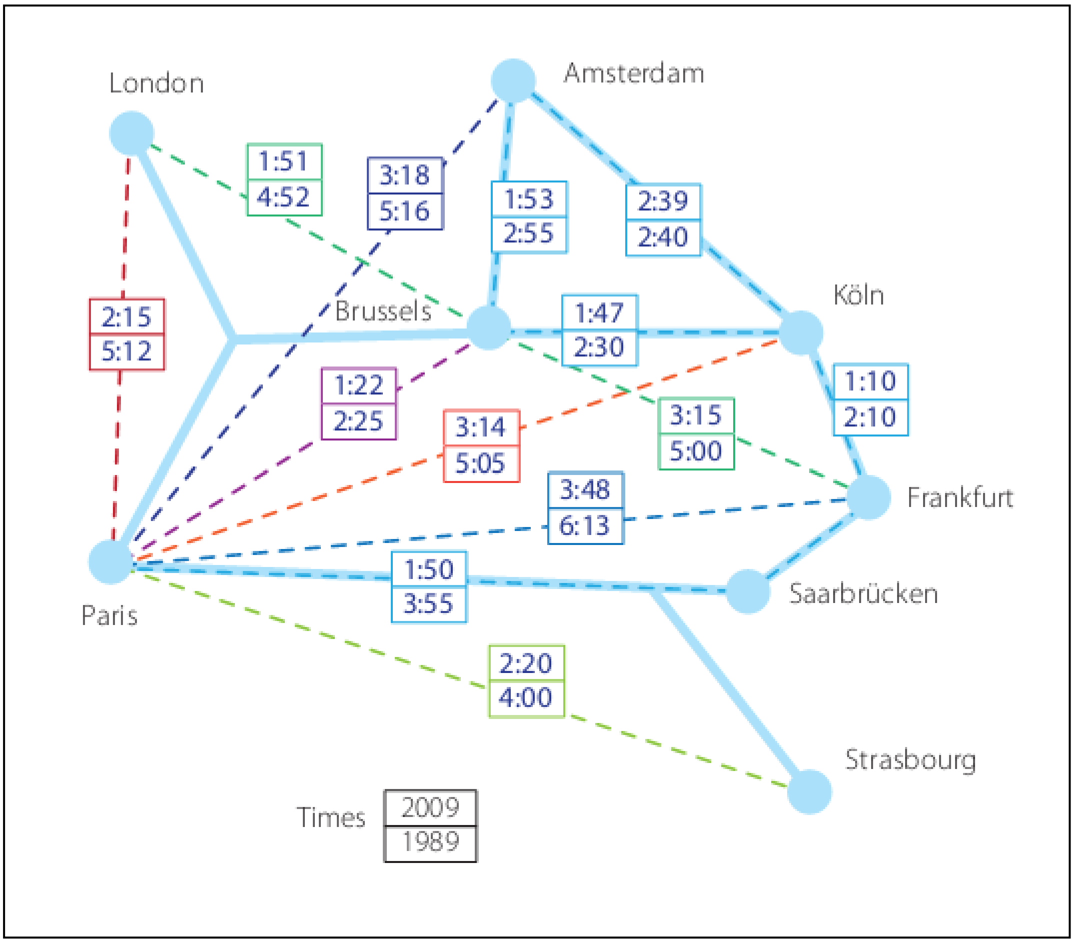
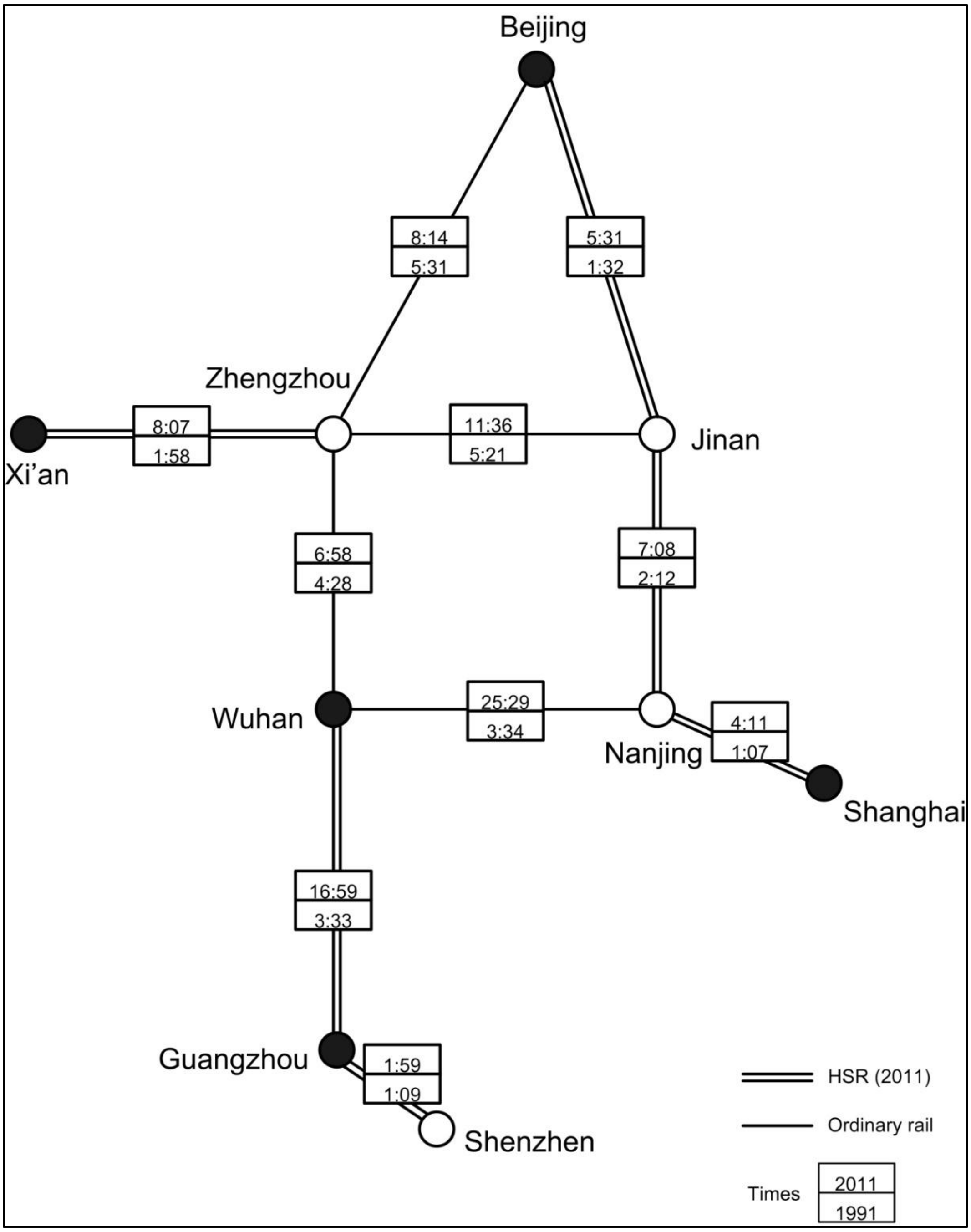


Figure 3 Changes in journey times, Northern European HSR Network, 1989-2009
Source: European Commission, DG Move



Note: there is no direct train from Wuhan to Nanjing in 1991

Figure 4 changes in journey times China, 1991-2011
Source: Ministry of Railway, China Railway Timetable 1991 and 2011. China Railway Press, Beijing.

The changes in accessibility show clearly how significant HSR has been in reducing the effective distances between the major cities in both the European and Chinese cases. Given the greater distances in China, the ability to bring major centres of population within daily return journeys has an enormous impact on the potential both for mode switch from air to rail and for trip generation and hence economic interaction between these major cities. In Europe the creation of new international rail services such as those operated by Thalys (Paris-Brussels-Amsterdam/Köln) and

Eurostar (London-Paris/Brussels) has helped to reduce the previous border effects of separate national rail systems. There has however been relatively little use of new HSR infrastructure by competing services; Thalys and Eurostar share common infrastructure between Paris and Lille and Lille and Brussels but do not provide competitive services, Thalys and Deutsche Bahn's ICE service do both share infrastructure and compete between Brussels and Köln and eventually there will be competition between Thalys and the new Fyra service between Brussels and Amsterdam. Eurostar is planning to extend services beyond Brussels to Amsterdam and possibly Köln, and possibly more direct trains to other destinations in France; DB has plans to extend its Frankfurt-Brussels service to London.

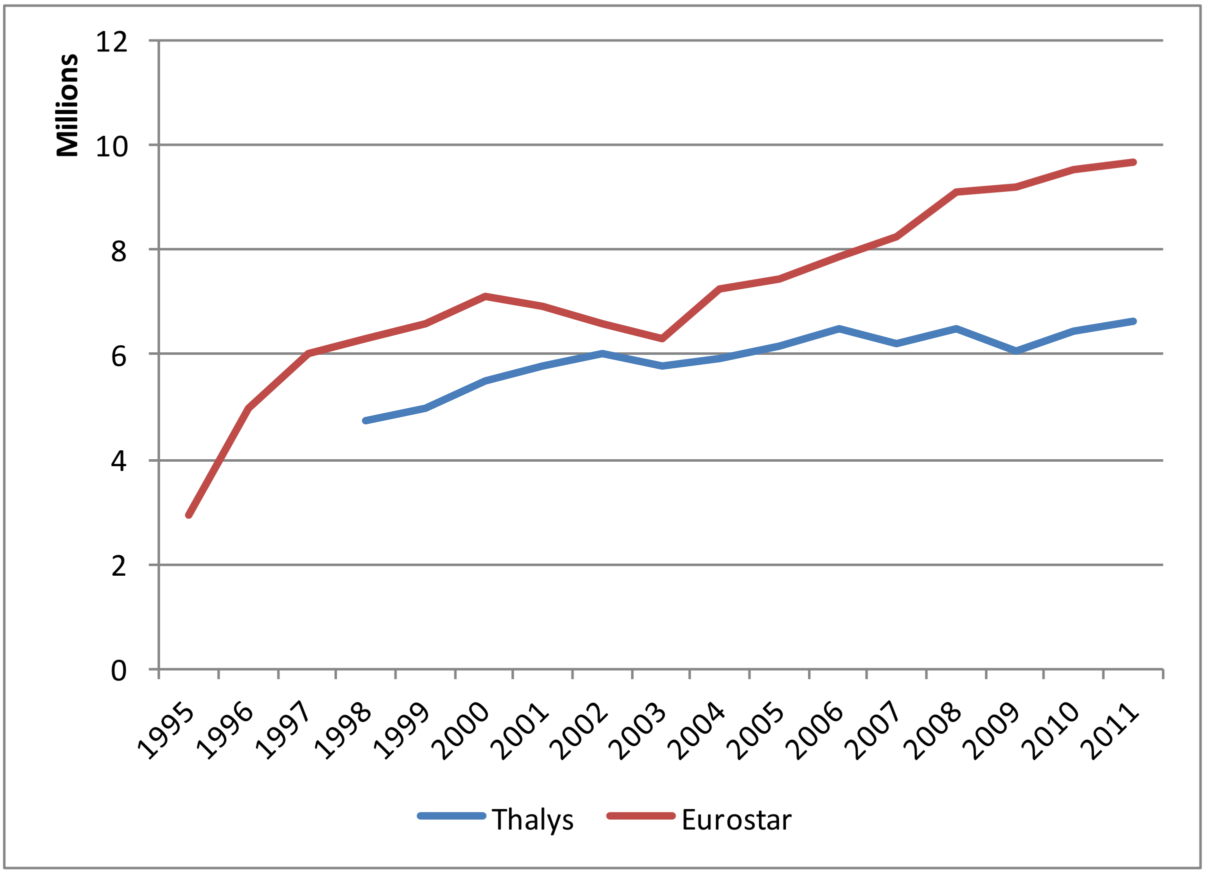


Figure 5 Evolution of Thalys and Eurostar Traffic
Source: Annual Reports

Figure 5 shows the evolution of the key inter-city traffic between Paris-Brussels, Amsterdam and Köln (Thalys) and London-Paris, Brussels (Eurostar). The operators do not report individual inter-city traffic flows. In the case of Eurostar it is estimated that of the total passenger numbers of just under 10 million around 2 million travel between London and Brussels and a further 400 thousand between London and Lille. Services between the other intermediate stations are much less frequent and flows relatively unimportant for the operators (Vickerman, 2013). For both sets of services these remains significantly below the potential capacity of the services.

But there is an argument that this enhanced level of service between the major cities is at the expense of smaller intermediate cities. In some cases this is because the new more direct HSR line by-passes cities on the historic route. In other cases despite being on the route, the level of service provided at intermediate stations is much less as operators seek to minimise end to end journey times between the major cities which provide most of the traffic. In some European cases these intermediate cities were often important border stations where a change of locomotive and crew often took place. There are examples where capacity on the HSR infrastructure has been sufficient to enable the introduction of regional high-speed services linking these intermediate cities to the nearest metropolitan centre (see Garmendia et al, 2012; Vickerman, 2013). However the net effect of these pressures is to increase the centralisation of activity towards the major metropolitan areas by enlarging the effective density of their labour market areas.

The introduction of high-speed services between Ashford and London which reduced typical journey times from over 70 minutes to 37 minutes, led to an increase in traffic of 17 per cent over two years. Similarly the introduction of local high-speed services on the corresponding high-speed line in France, the TER-GV service, also showed strong growth after a slow start

The new HSR lines in China have brought about even larger volumes of traffic. The Wuhan-Guangzhou line, for instance, carried 20 million passengers in the first year of operation.[2] The passenger number increased to 34 milion in the second year.[3] By the end of the third year, the accumulated number of passengers exceeded 90 million.[4] As for the Beijing-Shanghai line, total passengers in the first 6 months amounted to 25.39 million.[5] When the first anniversary was celebrated, number of passengers totalled 52.6 million.[6]

An important question is whether HSR is part of the process of enhancing the agglomeration effects of large cities increasing the overall tendency to centralisation in an economy. This is not necessarily a process of centralisation towards the largest city in the system, in fact there is no strong evidence to suggest that cities such as Paris or Madrid have gained at the expense of other major metropolitan centres such as Lyon or Barcelona, but of centralisation towards the metropolitan areas at the expense of their own hinterlands. This is the process originally identified clearly as the likely result of accessibility changes in Vickerman et al (1999).

To have a more systematic picture of how employment and specialization have changed in cities on HSR lines and the hinterland of these cities, it is necessary to collect data for various areas. To serve this purpose, we treat each of the cities on the HSR lines (depicted in Figure 3) as the core of a larger region and identify the hinterland for each of them. We have collected employment data of the core cities and the respective hinterlands using the definition of the NUTS 2 system for the period of 1999-2008. Figure 6 shows the geographic location of the core cities and hinterland areas.

[2] See the report in http://www.chinanews.com/cj/2010/12-25/2746493.shtml.

[3] See the report in http://news.huochepiao.com/2011-12/20111227110628.htm.

[4] See the report in http://finance.chinanews.com/cj/2012/12-25/4436309.shtml.

[5] See the report in http://finance.people.com.cn/GB/70846/16873400.html.

[6] See the report in http://www.stdaily.com/stdaily/content/2013-03/07/content_579684_4.htm.

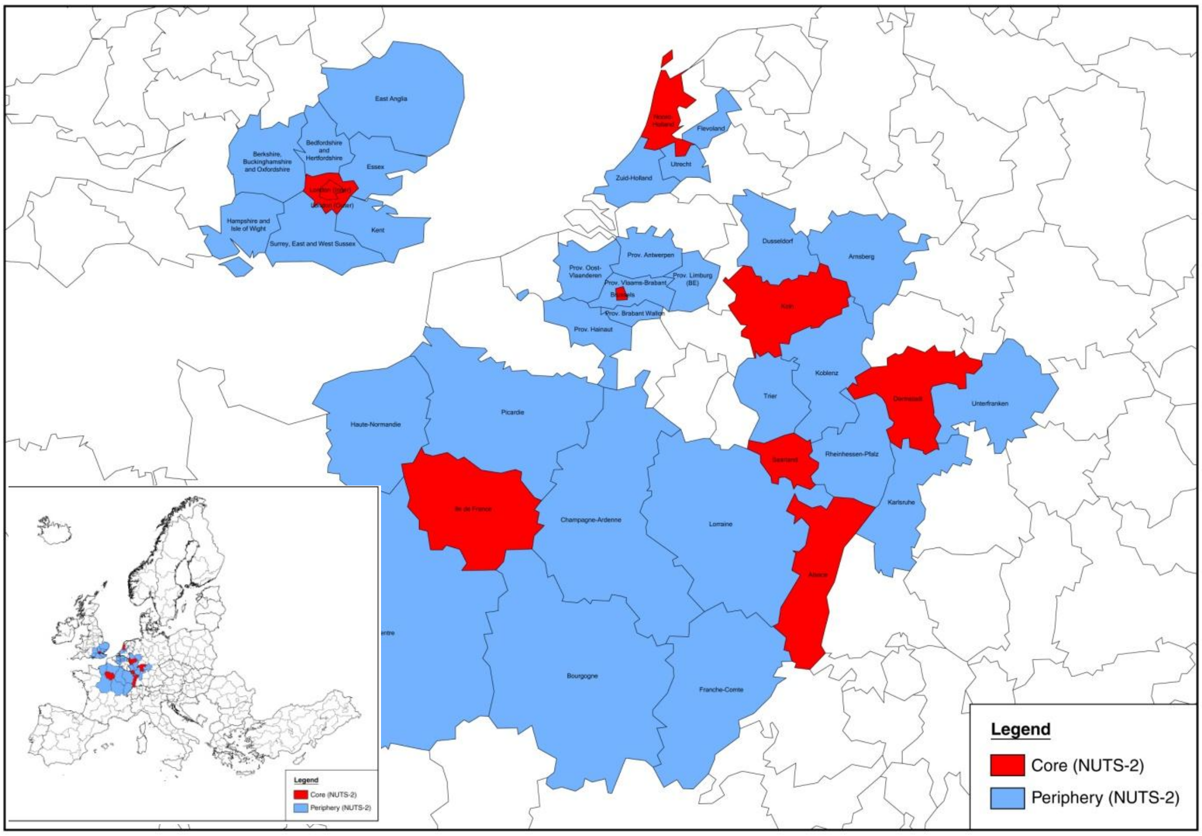


Figure 6 Core Cities with HSR Service and their hinterlands

Table 1 reports the growth rates of employment of the six economic sectors in each of the cities and their hinterlands. For each region, we list the figures for a core city on the HSR line followed by the hinterland areas we have identified. The absolute change in the employment numbers are tabulated in Table 2. The core cities exhibited an employment growth of 10.1% during these years, slightly higher than the 8.9% in the hinterland areas. The variation in growth rates among the core cities is big, ranging from the highest 17.0% of Brussels to the lowest 3.3% of Saarbrücken. Particularly interesting is the case of Amsterdam, which was not fully connected to the HSR network until 2009 (although served by Thalys trains from 1994). Even without the HSR service, it registered a growth of 14.1%, the second highest among the cores. Whether the connection to the HSR network will help it to maintain a high growth of employment has yet to be studies in the future. It should be noted that Saarbrücken and Strasbourg have had HSR service only after 2007 (see Table 3). The impact of the HSR on their development remains to be seen. Overall, our evidence shows that the core cities on the HSR lines had diverse performances in employment growth.

It is also interesting to see whether the fate of the hinterland is closely tied to the core city. Theoretically, a high-growth core may spread it economic activities to "periphery" regions. However, the growth in the core may also draw resources from neighbouring regions, resulting in a backwash effect hurting the development in the latter (Williamson, 1965). Distinct patterns can be identified from the results. Growth rates are higher in the core than in hinterland areas in several regions: Amsterdam (growth of core:growth of hinterland areas is 14.1%:12.8%), Brussels (17.0%:11.1%), Köln (10.0%:6.4%),London (11.6%:7.3%), and Strasbourg (13.2%:7.5%). Those with a reverse relationship between the core and hinterland areas are: Frankfurt (7.7%:9.5%), Paris (8.7%:11.8%), Saarbrücken (3.3%:6.7%).

As mentioned in Section 2, the agglomeration patterns due to a decrease in transport cost may vary across different economic sectors. Table 1 and 2 allow us to further investigate what sector has contributed to the pattern of aggregate employment growth. It can easily be seen that the largest increase in employment (2.23 million) came from the sector "public administration, household and others". That is largely related to the growth of the public sector, which should not be associated to the impact of HSR. The sector "finance and real estate" recorded the highest growth rate (22.6%) but the second largest increase in employment number (1.43 million). Most remarkable is London, where an increase of 170,900 jobs in the core was recorded, though the growth rate (20%) was not so great impressive due to its large base number in 1999.

The next question is whether the sectoral changes in employment have led to a significant transformation in the specialization patterns. In particular, it is interesting to find out whether there are any changes in the specialization relationship (a) among the cores and (b) between the cores and the hinterland. To do this, we apply the specialization index used by Krugman (1991b, p.76)to the employment data of European cities. The index is defined as follows:

$$I = \sum_i |s_i - s_i^*|$$

where s_i is the share of employment of industry i in the total employment of a city (or a hinterland area) and s_i^* is the respective share of another city or a benchmark region. Essentially it is one way to characterise how the employment structure of a city is different from another city (or the relevant benchmark). It can be easily verified that the minimum value is zero (when two cities have exactly the same employment structure) while the maximum value is 2 (when two cities have non-overlapping employment in the economic sectors).

Figure 7 shows the change in the specialization indexes for the core cities, where their aggregate employment is used as the benchmark. The indexes thus shows how each of the city deviates from the average employment structure of the eight core cities. Several cities were becoming less specialized, particularly after 2002, as evident from the downward trend of the curves. Strasbourg, Köln, Frankfurt, Amsterdam and Brussels are clear examples, although they have very different levels of specialization. Strasbourg showed the most drastic change, with a rapid convergence of economic structure to other core cities. The curves of Paris and London look relatively stable. If a linear trend line is fitted to each of them, the line is slightly downward sloping in both cases. The only special case is Saarbrucken, which shows a slight rising trend. Based on these results, the economic structures of the core cities have become more similar to each other, though the effect is mild in most of the cases.

Regarding the specialization between the core and the hinterland, we have computed for each region the specialization index of each hinterland area using the employment structure of the respective core city as the benchmark. Thus the index show how the employment structure of each hinterland area is different from the core city in the region. Figure 8 presents the average of the specialization indexes of hinterland areas in each region, using the core city as the label. If we fit a trend line to each of them, the trend lines are all downward sloping, except in the case of Frankfurt. Certainly, some of the trend lines are steep while others are quite flat. The downward trend indicates that the difference in employment structure between the hinterland areas and the core is converging. For cities with high employment growth, a decrease in the specialization of the hinterland is likely to be caused by the concomitant expansion of the high growth sectors in the core. This can be seen as the "spread effect" of the core to benefit the hinterland. For cities with slow employment growth, it is likely to be caused by the catching up of the hinterland in developing economic activities similar to the core.

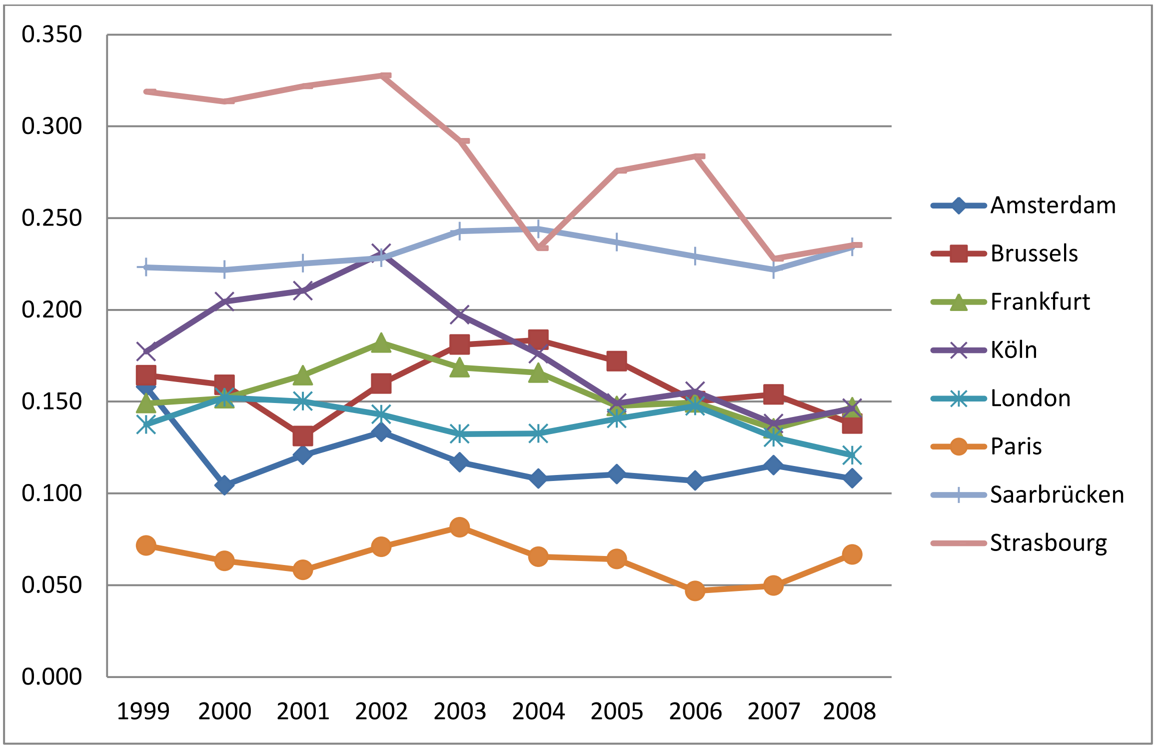


Figure 7 Specialization index of core European cities (with employment share of the aggregation of the 8 cities as the benchmark)

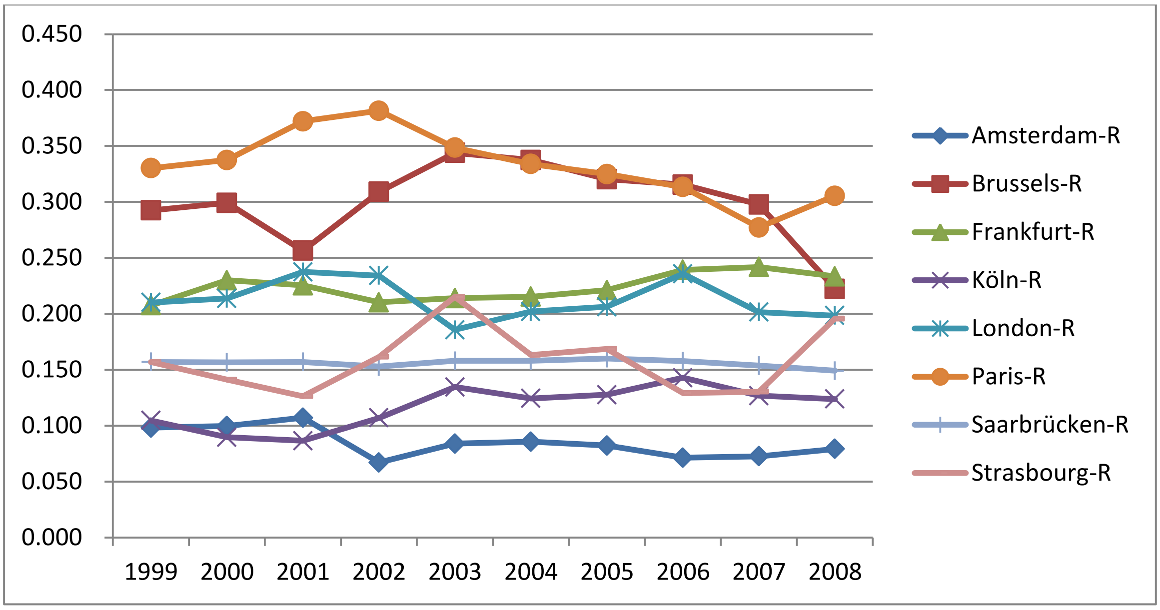


Figure 8 Average specialization index of the hinterlands in Northern Europe (with the employment shares of the core city as the benchmark)

The above results thus show that HSR may lead to a diversity of consequences on the relative performance of the core cities and between the core and the hinterland. There is a mild evidence indicating a growing economic similarity in the economic structure among the core cities and between cores and their respective hinterlands. The challenge for China is whether HSR will also continue to reinforce the role of the major cities in the east. So far the development has focused on completing the major inter-city links. It is not certain whether the HSR connection will help the cities in east to draw resources from the west or to spread the economic growth of the east to the west. Likewise, it is not clear how hinterlands of these cities will be affected.

Since the HSR lines depicted in Figure 4 were constructed after 2008, it is premature to provide any concrete analysis on their impacts. However, it should be noted that the railway connection between Guangzhou and Shenzhen is a conventional line that was already upgraded to facilitate a maximum speed of 200 km per hour by early 2000s. By European standard, it can be classified as a HSR line. To get some insights on the impact of HSR in China, we investigate the employment growth and specialization pattern in the Pearl River Delta (PRD) during 2003-2010. The line passes through the most dynamic region in South China. Guangzhou was historically an important trading port and has been the major transportation hub in South China in the past decades. Shenzhen is one of the special economic zones that China opened up for foreign investment and experimented reforms in the early 1980s. The two cities can be considered as the core of the PRD, though Shenzhen has more interaction on the east coast of PRD region. Both relied very much on investment from Hong Kong in the earlier stage of China's open-up and have continued to have close economic relationship with Hong Kong. There line is connected to Kowloon of Hong Kong. However, the part in Hong Kong has been running at far lower speed. To evaluate the impact of the line in the Mainland part, we have collected a data set covering 19 industries of the 9 cities (all at prefecture or above in administrate rank) officially defined as the Pearl River Delta region. Similar to what we have done for the European case, we analyse the employment growth pattern and changes in regional specialization in the region.

Total employment in the PRD region grew from 5.23 million in 2003 to 8.23 million in 2010, representing an increase of 57.4%. Table 4 and Table 5 show the employment growth figures in percentages and in absolute numbers respectively. The cities with the largest increase in employment were Shenzhen and Guangzhou. Shenzhen, in particular, came out as the major winner in the development process, contributing to nearly half of the employment growth in the whole region. The process represents a relatively concentrated pattern that favoured one of the cores. However, this was not realized at the expense of other cities. In fact, all the 9 cities experienced a respectable growth of employment. The regional is still undergoing a rapid industrialization process, with a 167.8% growth in the employment in the manufacturing sector. During this period of time, the PRD region continued to attract migrant labour from inland areas to work in the factories.

Figure 9 shows the specialization index of the cities in PRD, with the employment share of Guangzhou as the benchmark. Not surprisingly, the index of Shenzhen has been the lowest, indicating that its economic structure is rather similar to that of Guangzhou. Most of the cities registered a clear upward trend in the specialization index, including Huizhou, Dongguan, Jiangmen, Zhaoqing, and Foshan. Thus, Guangzhou is developing an economic structure increasingly different from that of its hinterland.

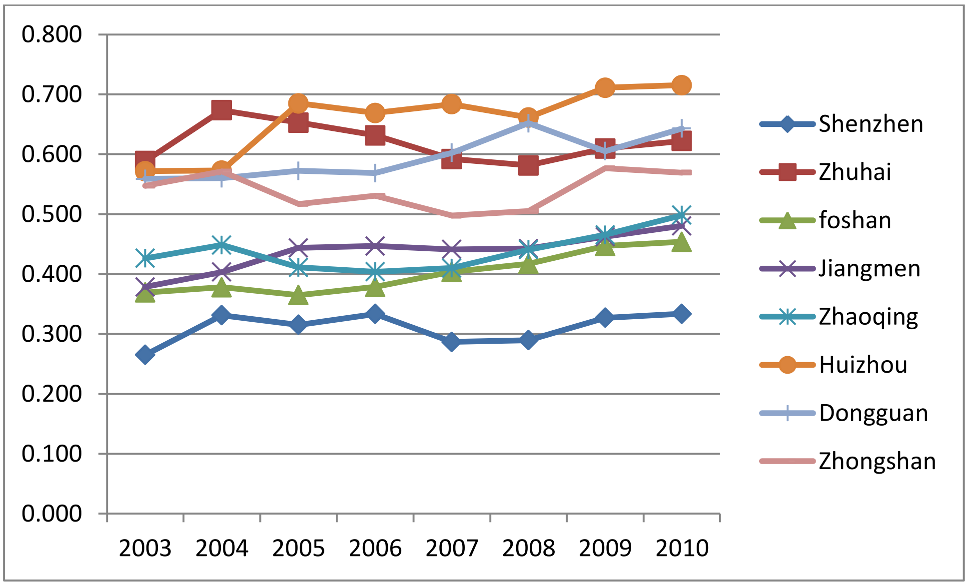


Figure 9 Specialization index of the cities in the Pearl River Delta region in China (with the employment shares of Guangzhou as the benchmark)

5. Implications for Policy

The paper shows first that the impact of HSR development depends on location and results cannot easily be transferred. It suggests that transport improvements alone will not necessarily lead to either local economic development or economic integration, especially when this involves links across borders between different countries or regions. Apart from major inter-city routes, most shorter distance services have been developed within regions and have the effect of reinforcing existing travel patterns towards the major regional centre. Examining timetables also shows the way that service is concentrated on the major centres so that, despite apparent changes in nominal accessibility for intermediate and smaller cities, in practice the actual level of service is inferior.

If high-speed rail is to be an instrument of policy for reducing regional inequalities, both inter-regional and intra-regional, then it is clear that a number of factors would need to be considered. First, from the European perspective, the creation of profit-oriented subsidiaries to run high-speed international rail services may be incompatible with providing a level of service to all potential stations which can have a positive impact on their economic development. Low potential ridership will mean operators are reluctant to compromise the headline times for end to end passengers between major cities and thus provide low levels of infrequent service which are unattractive to potential passengers and thus to potential investors in an area. Secondly, the development of connecting local feeder services and relevant land-use developments at or close to stations may be an explanation of significant differences in economic impact. Larger intermediate cities, such as Lille or Rotterdam in the examples used above, have been able to do this in a way in which smaller cities such as Ashford, Calais or Breda, have not.

If we transpose the implications to China, we can see that the emphasis to date has been on securing new capacity for travel between the major cities as a means of increasing accessibility between urban centres which are at significant distances from one another. But it is not clear that this will be compatible in the future with any policies aimed at securing a better distribution of economic activity across the country.

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Table 1 Employment growth in North Europe – core cities and hinterlands
(% change during 1999-2008)

	Total employ-ment in 1999 (1,000)	Total employ-ment growth (%)	Industry 1	Industry 2	Industry 3	Industry 4	Industry 5	Industry 6
			Agriculture; fishery	Industry (except construc-tion)	Construc-tion	Trade; hotel; transport	Finance; real estate	Public admin; household; others
Amsterdam	1173.2	14.1	-10.7	0.1	17.0	6.2	30.7	17.5
NAmsterdam (Flevoland)	144.2	29.6	23.9	-19.7	77.4	63.7	21.9	28.4
NAmsterdam (Utrecht)	534.2	14.5	34.4	-5.1	2.6	4.4	16.2	28.1
NAmsterdam (Zuid-Holland)	1533.6	10.6	-0.9	-4.1	2.3	10.0	11.9	17.3
Total of the hinterland areas		12.8	5.4	-5.7	5.8	11.7	13.7	20.6
Brussels	340.1	17.0	260.0	3.6	92.1	0.2	18.5	23.0
NBrussels (Prov. Antwerpen)	659.2	13.0	42.7	-1.4	18.7	6.9	24.9	22.7
NBrussels (Prov. Limburg (BE))	319.8	13.5	13.7	-3.4	15.4	12.0	33.3	22.5
NBrussels (Prov. Oost-Vlaanderen)	580	11.0	-31.8	-2.3	12.5	4.5	25.6	24.6
NBrussels (Prov. Vlaams-Brabant)	444.5	7.0	1.8	-3.0	-6.4	-3.1	19.5	15.7
NBrussels (Prov. Brabant Wallon)	140.3	12.7	-5.7	-3.7	18.9	14.7	38.5	7.7
NBrussels (Prov. Hainaut)	426.4	10.4	-11.6	-1.8	-9.1	-2.1	64.6	19.7
Total of the hinterland areas		11.1	-4.8	-2.3	7.8	3.9	29.5	20.3
Frankfurt	1699.5	7.7	13.9	-11.2	-11.9	6.9	34.6	11.5
NFrankfurt (Karlsruhe)	1185.7	13.9	-6.7	2.2	8.0	10.6	62.4	11.9
NFrankfurt (Unterfranken)	602.3	10.3	-7.7	0.4	-16.8	10.9	55.7	16.4
NFrankfurt (Koblenz)	578.5	5.6	6.3	-3.7	-10.9	6.9	27.6	7.9
NFrankfurt (Rheinhessen-Pfalz)	767.3	7.0	30.5	-10.7	-14.0	6.8	30.6	16.2
NFrankfurt (Gießen)	447.9	10.7	0.0	-2.3	-14.8	10.6	43.9	20.0
NFrankfurt (Kassel)	536.5	5.4	-1.9	-4.5	-34.4	2.1	26.9	23.1
Total of the hinterland areas		9.5	1.5	-2.3	-12.2	8.2	44.6	15.0
Köln	1824.4	10.0	-26.4	-6.4	-10.6	8.0	46.0	15.1
NKöln (Düsseldorf)	2188.4	6.8	11.1	-9.5	-3.8	2.3	39.6	13.8
NKöln (Arnsberg)	1547.6	5.9	-24.9	-4.2	-11.1	1.8	40.2	14.9
NKöln (Koblenz)	578.5	5.6	6.3	-3.7	-10.9	6.9	27.6	7.9
NKöln (Trier)	192.8	9.0	14.3	4.0	-12.0	14.9	19.1	9.9
Total of the hinterland areas		6.4	-3.2	-6.3	-7.7	3.3	37.6	13.0
London	3347.2	11.6	16.7	-14.4	36.2	0.5	20.0	18.5
NLondon (East Anglia)	1035.1	11.0	3.1	-25.1	28.5	12.8	29.4	21.3
NLondon (Bedfordshire and Hertfordshire)	776.4	8.3	56.9	-23.5	28.2	-0.6	24.5	20.5
NLondon (Essex)	768.9	6.0	27.6	-26.3	9.5	9.7	8.7	17.8
NLondon (Berkshire, Buckinghamshire and Oxfordshire)	1101.1	5.5	9.2	-29.1	26.9	16.4	1.5	17.8
NLondon (Surrey, East and West Sussex)	1234.5	6.7	10.2	-13.9	39.1	0.0	-1.4	19.8
NLondon (Hampshire and Isle of Wight)	870.9	7.6	-19.8	-26.7	28.5	14.7	6.9	18.1
NLondon (Kent)	741.9	5.6	-14.1	-26.4	29.4	-1.6	10.1	20.5
Total of the hinterland areas		7.3	5.9	-24.7	27.2	7.2	9.0	19.4
Paris	4848.2	8.7	-22.8	-15.8	12.2	4.3	11.9	20.4
NParis (Champagne-Ardenne)	473.3	14.9	12.5	-0.8	29.1	13.9	23.1	21.5
NParis (Picardie)	663.3	20.0	-48.1	-0.8	25.1	27.4	40.6	32.9
NParis (Haute-Normandie)	709	3.9	-0.6	-13.5	16.1	8.9	29.9	3.4
NParis (Centre)	922.8	14.1	-17.3	-19.5	61.0	33.5	23.5	22.6
NParis (Bourgogne)	624.3	6.6	-13.5	-12.1	28.0	16.5	18.8	11.1
Total of the hinterland areas		11.8	-12.6	-10.8	32.7	21.1	27.4	18.2
Saarbrücken	452.4	3.3	14.3	-7.1	-12.0	1.6	16.6	11.0
NSaarbrücken (Koblenz)	578.5	5.6	6.3	-3.7	-10.9	6.9	27.6	7.9
NSaarbrücken (Trier)	192.8	9.0	14.3	4.0	-12.0	14.9	19.1	9.9
NSaarbrücken (Rheinhessen-Pfalz)	767.3	7.0	30.5	-10.7	-14.0	6.8	30.6	16.2
Total of the hinterland areas		6.7	21.0	-6.6	-12.4	7.9	28.3	12.1
Strasbourg	741.9	13.2	-8.6	-21.8	26.5	26.7	53.8	21.9
NStrasbourg (Lorraine)	863.7	9.0	-27.1	2.0	10.0	4.9	20.7	16.5
NStrasbourg (Franche-Comté)	444.6	4.7	-23.7	-15.8	56.9	9.1	33.9	11.3
Total of the hinterland areas	1308.3	7.5	-25.6	-5.2	23.3	6.2	24.4	14.8
Total of all cores and hinterland areas	**1752.9**	**9.3**	**-5.0**	**-10.0**	**10.8**	**7.2**	**22.6**	**17.4**
Total of all cores	3061.2	10.1	-9.2	-12.1	13.0	5.1	22.2	18.0
Total of all hinterland areas	4814.1	8.9	-4.2	-9.1	9.8	8.3	23.0	17.1

Table 2 Employment growth in North Europe – core cities and hinterlands
(change in employment number during 1999-2008, in thousands)

	Total employ-ment growth (%)	Industry 1	Industry 2	Industry 3	Industry 4	Industry 5	Industry 6
		Agriculture; fishery	Industry (except construc-tion)	Construc-tion	Trade; hotel; transport	Finance; real estate	Public admin; household; others
Amsterdam	166.0	-3.0	0.1	10.1	21.0	66.8	71.0
NAmsterdam (Flevoland)	42.7	1.1	-4.4	4.8	20.9	6.5	13.8
NAmsterdam (Utrecht)	77.4	2.2	-2.9	0.8	6.2	18.0	53.1
NAmsterdam (Zuid-Holland)	162.9	-0.4	-6.9	2.2	39.3	33.9	94.8
Total of the hinterland areas	283.0	2.9	-14.2	7.8	66.4	58.4	161.7
Brussels	57.9	1.3	1.3	12.8	0.2	12.5	29.8
NBrussels (Prov. Antwerpen)	85.6	3.5	-2.1	8.5	12.4	20.1	43.2
NBrussels (Prov. Limburg (BE))	43.2	0.7	-2.9	4.0	8.6	8.9	23.9
NBrussels (Prov. Oost-Vlaanderen)	63.8	-5.4	-3.2	5.1	6.4	16.7	44.2
NBrussels (Prov. Vlaams-Brabant)	31.1	0.1	-1.9	-1.5	-3.9	14.6	23.7
NBrussels (Prov. Brabant Wallon)	17.8	-0.2	-0.8	1.4	4.5	8.7	4.2
NBrussels (Prov. Hainaut)	44.5	-1.0	-1.4	-3.4	-2.2	19.5	33.0
Total of the hinterland areas	286.0	-2.3	-12.3	14.1	25.8	88.5	172.2
Frankfurt	131.4	2.5	-44.0	-12.5	29.7	103.3	52.4
NFrankfurt (Karlsruhe)	164.7	-1.2	8.2	5.4	25.7	86.4	40.2
NFrankfurt (Unterfranken)	62.0	-1.3	0.7	-8.8	14.1	30.3	27.0
NFrankfurt (Koblenz)	32.2	0.4	-5.1	-4.3	9.7	16.2	15.3
NFrankfurt (Rheinhessen-Pfalz)	53.9	3.6	-21.9	-6.3	12.0	27.5	39.0
NFrankfurt (Gießen)	47.8	0.0	-3.0	-4.9	10.6	18.3	26.8
NFrankfurt (Kassel)	29.2	-0.3	-6.5	-15.6	2.6	12.1	36.9
Total of the hinterland areas	389.8	1.2	-27.6	-34.5	74.7	190.8	185.2
Köln	183.0	-7.2	-27.6	-12.8	34.2	108.5	87.9
NKöln (Düsseldorf)	148.7	3.6	-54.1	-5.3	13.2	107.0	84.3
NKöln (Arnsberg)	91.3	-6.6	-19.9	-11.7	6.6	58.8	64.1
NKöln (Koblenz)	32.2	0.4	-5.1	-4.3	9.7	16.2	15.3
NKöln (Trier)	17.4	0.4	1.7	-1.8	7.1	3.3	6.7
Total of the hinterland areas	289.6	-2.2	-77.4	-23.1	36.6	185.3	170.4
London	389.4	1.5	-50.4	65.4	4.2	170.9	197.8
NLondon (East Anglia)	113.7	0.9	-50.9	22.2	35.4	38.1	68.0
NLondon (Bedfordshire and Hertfordshire)	64.8	3.3	-32.4	16.1	-1.3	34.7	44.4
NLondon (Essex)	45.9	2.4	-34.1	6.7	17.9	13.3	39.7
NLondon (Berkshire, Buckinghamshire and Oxfordshire)	60.9	1.4	-59.9	17.3	43.4	3.5	55.2
NLondon (Surrey, East and West Sussex)	82.8	1.6	-20.5	29.1	0.0	-3.6	76.2
NLondon (Hampshire and Isle of Wight)	66.1	-2.6	-41.5	17.7	31.2	10.0	51.3
NLondon (Kent)	41.6	-1.3	-31.2	19.7	-3.3	12.0	45.7
Total of the hinterland areas	475.8	5.7	-270.5	128.8	123.3	108.0	380.5
Paris	422.6	-5.5	-111.3	30.7	51.4	128.8	328.5
NParis (Champagne-Ardenne)	70.3	5.1	-0.8	8.8	14.1	9.2	33.9
NParis (Picardie)	132.4	-12.6	-1.3	11.1	42.8	22.4	70.0
NParis (Haute-Normandie)	27.9	-0.1	-23.6	9.1	14.1	20.3	8.1
NParis (Centre)	130.1	-9.5	-45.6	33.5	61.4	21.8	68.5
NParis (Bourgogne)	41.2	-5.6	-18.2	10.4	22.6	7.9	24.1
Total of the hinterland areas	401.9	-22.7	-89.5	72.9	155.0	81.6	204.6
Saarbrücken	14.8	0.3	-8.9	-3.0	1.7	10.7	14.0
NSaarbrücken (Koblenz)	32.2	0.4	-5.1	-4.3	9.7	16.2	15.3
NSaarbrücken (Trier)	17.4	0.4	1.7	-1.8	7.1	3.3	6.7
NSaarbrücken (Rheinhessen-Pfalz)	53.9	3.6	-21.9	-6.3	12.0	27.5	39.0
Total of the hinterland areas	103.5	4.4	-25.3	-12.4	28.8	47.0	61.0
Strasbourg	97.8	-1.2	-47.2	15.5	44.1	39.8	46.8
NStrasbourg (Lorraine)	77.5	-7.0	4.2	6.6	9.2	15.7	48.8
NStrasbourg (Franche-Comté)	20.8	-4.9	-22.8	14.9	7.5	10.0	16.1
Total of the hinterland areas	98.3	-11.9	-18.6	21.5	16.7	25.7	64.9
Total of all cores and hinterlands	3790.8	-36.2	-823.4	281.3	713.8	1426.6	2228.7
Total of all cores	1462.9	-11.3	-288.0	106.2	186.5	641.3	828.2
Total of all hinterland areas	2327.9	-24.9	-535.4	175.1	527.3	785.3	1400.5

Table 3 Year of Opening of HSR Stations in North European Cities

City	HSR Station	Year of Introducing HSR Services
Amsterdam	Amsterdam Centraal	2009[1]
	Schiphol Airport	2009[1]
Brussels	Brussels-Midi	1997[2]
Frankfurt	Frankfurt Central	2002
	Frankfurt Airport long-distance station	1999
	Frankfurt South	2000
Köln	Cologne	2002
	Köln Messe/Deutz	2002
	Cologne/Bonn Airport	2004
London	St Pancras	2007
	Stratford International	2009[3]
	Ebbsfleet International	2007
	Ashford International	2007[4]
Paris	Paris Lyon	1981
	Paris Nord	1993
	Paris Est	2007
	Paris Montparnasse	1990
	Paris Charles de Gaulle Airport	1994
	Marne la Vallée-Chessy	1994
	Massy-TGV	1985
Saarbrücken	Saarbrücken Central Station	2007
Strasbourg	Gare de Strasbourg	2007

Notes:

1 Refers to the date of opening of the HSL-Zuid HSR line. High-speed Thalys services served these stations from Paris from 1994

2 Refers to the opening of the Belgian high-speed line. Thalys and Eurostar trains served this station via conventional lines in Belgium from 1994

3 Despite its name Stratford International is served only by domestic high-speed trains and not by Eurostar

4 Refers to the opening of the UK HSL. Ashford International was served by Eurostar trains on conventional lines from 1996.

Table 4 Year of Opening of HSR Stations in Chinese Cities

City	HSR Station	Year of Introductioing HSR Services
Beijing	Beijing South Station	2008
	Beijing South Station	2011
Zhengzhou	Zhengzhou Station	2010
Xi'an	Xi'an North Station	2010
Jinan	Jinan West Station	2008
	Jinan West Station	2011
Nanjing	Nanjing South Station	2008
	Nanjing South Station	2011
	Nanjing Station	2010
Shanghai	Shanghai Hongqiao Station	2010
Wuhan	Wuhan Station	2009
	Wuhan Station	2009
Guangzhou	Guangzhou South Station	2009
	Guangzhou North Station	2012
Shenzhen	Shenzhen North Station	2011

Table 5 Employment Growth in Pearl River Delta Region - % change during 2003-2010

		Guangzhou	Shenzhen	Zhuhai	foshan	Jiangmen	Zhaoqing	Huizhou	Dongguan	Zhongshan	Regional total
	Total of all sectors	31.03	131.77	76.10	19.35	29.25	13.92	57.91	33.26	80.93	57.39
Industry01	Primary Industry（Agriculture, Forestry, Animal Husbandry and Fishery）	-46.90	-66.67	-23.71	-42.86	-50.00	-48.15	-86.75	16.67	-100.00	-52.73
Industry02	Mining	-81.82	200.00	-25.00	-92.31	-100.00	26.67	-40.00	0.00	0.00	-26.87
Industry03	Manufacturing	32.79	151.96	85.77	24.87	59.17	33.29	82.01	15.63	103.89	73.59
Industry04	Production and Distribution of Electricity,Gas and Water	-14.69	40.60	-19.64	6.60	-15.79	-10.61	-8.75	58.33	40.00	2.11
Industry05	Construction	-1.42	80.81	153.95	-24.63	-3.01	-36.73	-19.78	75.00	7.69	14.14
Industry06	Traffic, Transport, Storage and Postal services	27.59	126.21	16.00	4.35	-14.15	-11.24	19.05	-22.89	87.27	45.08
Industry07	Information Transmission, Computer Services and Software	74.59	196.57	151.43	23.53	19.44	-13.51	-16.67	-48.98	-6.67	77.27
Industry08	Wholesale and Retail Trade	-3.78	87.21	88.50	-37.50	-19.08	-25.37	1.85	21.82	-5.56	21.67
Industry09	Hotels and Catering Services	15.15	102.87	29.59	9.18	15.38	-3.57	49.06	-12.50	43.48	35.20
Industry10	Financial services	27.77	186.54	112.64	-5.82	20.00	-3.66	114.94	29.89	34.00	59.47
Industry11	Real Estate	111.34	132.84	135.59	42.31	39.29	56.25	30.88	0.00	1300.00	114.82
Industry12	Leasing and Business Services	88.78	247.90	52.46	-1.56	-36.17	0.00	-2.67	60.00	354.55	118.66
Industry13	Scientific Research, Technology Services and Geologic Prospecting	76.15	334.40	100.00	66.67	-17.24	3.85	23.53	75.00	69.23	111.80
Industry14	Management of Water Conservancy, Environment and Public facilities	24.91	23.13	125.00	32.65	22.92	30.00	35.85	-46.15	-45.83	27.54
Industry15	Services to Households and Other Services	82.63	1285.71	-5.26	120.00	375.00	-25.00	366.67	100.00	300.00	161.47
Industry16	Education	28.94	87.29	78.57	36.00	8.50	15.40	14.89	23.11	36.67	32.65
Industry17	Health, Social Security and Social Welfare	51.15	74.11	47.30	81.50	33.53	25.81	39.85	80.26	64.44	56.46
Industry18	Culture, Sports and Entertainment	35.21	46.55	36.36	-21.43	11.11	25.00	71.43	100.00	23.53	35.73
Industry19	Public Administration and Social Organization	38.93	71.41	44.04	30.77	29.69	13.69	48.86	106.73	99.12	48.08

Table 6 Employment Growth in Pearl River Delta Region - change in emploument number during 2003-2010

(10,000 persons)

		Guangzhou	Shenzhen	Zhuhai	foshan	Jiangmen	Zhaoqing	Huizhou	Dongguan	Zhongshan	Regional total
	Total of all sectors	58.34	143.85	27.29	9.09	10.15	3.37	29.48	5.79	12.99	300.35
Industry01	Primary Industry（Agriculture, Forestry, Animal Husbandry and Fishery）	-0.53	-0.54	-0.23	-0.03	-0.11	-0.13	-0.72	0.01	-0.04	-2.32
Industry02	Mining	-0.18	0.12	-0.01	-0.12	-0.01	0.04	-0.02	0	0	-0.18
Industry03	Manufacturing	21.89	74.58	19.28	5.07	8.42	2.72	25.93	1.06	8.81	167.76
Industry04	Production and Distribution of Electricity,Gas and Water	-0.42	0.54	-0.11	0.07	-0.15	-0.07	-0.07	0.28	0.12	0.19
Industry05	Construction	-0.21	5.81	1.17	-0.83	-0.11	-0.54	-0.54	0.09	0.02	4.86
Industry06	Traffic, Transport, Storage and Postal services	4.88	9.1	0.2	0.07	-0.15	-0.1	0.2	-0.19	0.48	14.49
Industry07	Information Transmission, Computer Services and Software	2.26	3.44	0.53	0.2	0.07	-0.05	-0.07	-0.24	-0.02	6.12
Industry08	Wholesale and Retail Trade	-0.48	6.41	1	-0.75	-0.25	-0.17	0.02	0.12	-0.02	5.88
Industry09	Hotels and Catering Services	1.33	3.59	0.29	0.09	0.1	-0.02	0.26	-0.01	0.1	5.73
Industry10	Financial services	1.73	7.07	0.98	-0.17	0.3	-0.03	1	0.52	0.34	11.74
Industry11	Real Estate	4.81	7.24	0.8	0.22	0.11	0.09	0.21	0	0.39	13.87
Industry12	Leasing and Business Services	4.67	8.85	0.32	-0.01	-0.17	0	-0.02	0.09	0.39	14.12
Industry13	Scientific Research, Technology Services and Geologic Prospecting	3.32	4.18	0.21	0.22	-0.05	0.01	0.08	0.09	0.09	8.15
Industry14	Management of Water Conservancy, Environment and Public facilities	0.67	0.34	0.45	0.16	0.11	0.12	0.19	-0.06	-0.11	1.87
Industry15	Services to Households and Other Services	1.38	1.8	-0.01	0.06	0.15	-0.01	0.11	0.01	0.03	3.52
Industry16	Education	4.11	3.57	0.99	1.89	0.35	0.63	0.53	0.49	0.66	13.22
Industry17	Health, Social Security and Social Welfare	3.79	2.29	0.35	1.85	0.57	0.4	0.53	1.22	0.58	11.58
Industry18	Culture, Sports and Entertainment	0.94	0.54	0.12	-0.06	0.02	0.05	0.15	0.09	0.04	1.89
Industry19	Public Administration and Social Organization	4.38	4.92	0.96	1.16	0.95	0.43	1.71	2.22	1.13	17.86