High-speed rail networks, economic integration and regional specialisation in China and Europe[1]

Abstract

The role of transport in the process of economic development and integration remains an area of controversy. Policy makers, faced with the claim that the cost of high-speed rail (HSR) makes it an expensive way of achieving the supposed benefits, seek to identify wider economic impacts through productivity gains as a justification. This paper explores the development of HSR as an instrument for promoting economic integration both through enhancing competitiveness and achieving greater economic cohesion in China and the European Union. The paper examines changes in accessibility and provides evidence on changes in specialisation for both main cities and their hinterlands. The evidence confirms that impacts differ widely and that the process of convergence and divergence differs at different stages of economic development.

Keywords: High-speed rail; economic integration; regional specialisation; China; European Union

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 from the early work of Bonnafous (1987) on the regional effects of the French TGV network. More detailed studies of the accessibility impacts followed (e.g. Gutierrez et al, 1996, 2010), although some studies

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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 internal 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 of the network also have the objective of promoting development and integration within a particular region. An example of this 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 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. The key to understanding the effect is the impact on productivity which comes about from agglomeration. Evidence is presented on changes in industrial specialisation following the introduction of HSR as an initial exploration of these effects. Of course, HSR is only one of many factors influencing productivity change. Other changes in accessibility may have taken place as road improvements may also have taken place. Changes in international competitiveness may affect the location of industries. Nevertheless, it is valuable as a first approximation to explore what changes have taken place in the period following the introduction of HSR as these events rarely take place exactly in parallel. This evidence also provides pointers to areas for further research.

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: 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 in terms of changing specialisation.

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 in a simple two-sector- two-region model how 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. In a similar model, Krugman and Venables (1995) postulate that a long-run decline in transportation cost could lead to first a divergence and then a convergence of income and economic structure across regions. Baldwin *et al* (2003) provide a synthesis of relevant theories developed on this issue and Combes (2011) reviews the econometric tests of the bell-shape relationship between transportation (or trade) cost and spatial disparity.

By implication, as different economic sectors may have different relevant parameters, economic integration can 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, as it is normally a purely passenger railway, 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), 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 easier to identify in the case where HSR is used to increase the labour market potential of a metropolitan area. Here the evidence suggests that the distance decay of such benefits is quite pronounced. But what happens when HSR is used to link two or more major metropolitan regions. The approach so far has focussed just on the impact of each city and its hinterland (or a dominant core region and a peripheral one), not on two cities of similar size. Here the theory is generally lacking although some recent research suggests that by focussing on task specialisation rather than sector specialisation the process of agglomeration in an inter-urban context may be easier to explain (Michaels et al. 2013; Venables, 2013)

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 a 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 north-west 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, but with a specific focus on those links in the Pearl River delta region including links to Hong Kong.

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 and, from 2009, along with the opening of the Dutch HSL-Zuid link, the completion of a network linking the major cities of North-west Europe, Paris, Brussels, Köln, Amsterdam, Frankfurt and London. Paris and Frankfurt are additionally linked via the French LGV-Est route. Parts of this network are also used for regional high-speed services, for example between London and a number of towns in Kent largely used for commuting traffic, and 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. Figure 1 illustrates the geographical importance of this network, which is different from most HSR networks in being international, albeit constructed as separate national sections, but within the overall plan of the European Union's Trans-European Transport Network for high-speed rail. Moreover it is operated on by a range of different operators, which compete for traffic on some of the links.

Figure 1 near here

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.[2] 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 (Dailin) line, and Hangzhou-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 speeding-up was seen in late 2012 after consolidation measures were implemented in the Ministry of Railway.

It is argued that these HSR lines should 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 other cities along the 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. It is beyond the scope of this paper to consider the effect of the total Chinese network, but as in the case of the EU it is important to see the regional developments on which we shall focus as part of a much wider network. 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 links 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

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

Guangdong, manufacturing industries may choose to migrate to Hunan and Hubei provinces. The completion 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 the rest of the Pearl River Delta region. In the 1990s, railway infrastructure 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 2 near here

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 negative is not examined in detail here (see Vickerman, forthcoming, for a fuller discussion). Both cases also show the possible consequences of using improved transport as a means of removing the administrative/political barriers.

4. Results

4.1 Changes in accessibility

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

Figures 3 and 4 near here

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), Eurostar (London-Paris/Brussels) and Deutsche Bahn (Brussels- Köln- Frankfurt) has helped to reduce the previous border effects of separate national rail systems.

Figure 5 near here

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 traffic flows relatively unimportant for the operators (Vickerman, forthcoming). For both sets of services these remains significantly below the potential capacity of the infrastructure.

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 since December 2009.[3] The passenger numbers increased to 34 million in the second year.[4] By the end of the third year, the accumulated number of passengers exceeded 90 million.[5] As for the Beijing-Shanghai line opened in June 2011, total passengers in the first 6 months amounted to 25.39 million.[6] When the first anniversary was celebrated, the number of passengers totalled 52.6 million.[7]

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 is rather of centralisation towards the

[3] See the report in http://www.chinanews.com/cj/2010/12-25/2746493.shtml.
[4] See the report in http://news.huochepiao.com/2011-12/20111227110628.htm.
[5] See the report in http://finance.chinanews.com/cj/2012/12-25/4436309.shtml.
[6] See the report in http://finance.people.com.cn/GB/70846/16873400.html.
[7] See the report in http://www.stdaily.com/stdaily/content/2013-03/07/content_579684_4.htm.

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).

4.2 Changes in specialisation: Europe

To provide a more systematic picture of how employment and specialization have changed in the European cities on HSR lines and the hinterland of these cities, 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 by sector of the core cities and the respective hinterlands at the NUTS 2 level for the period 1999-2008. Figure 6 shows the geographic location of the core cities and their hinterland areas.

Figure 6 near here

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 changes 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 employment growth rates among the core cities is large, ranging from a high of 17.0% for Brussels to a low of 3.3% for 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. Saarbrücken and Strasbourg have only had HSR service since 2007 (see Table 3). The likely impact of HSR on their development remains to be seen. Overall, our evidence shows that the core cities on the HSR lines had diverse performances in terms of employment growth.

Tables 1 and 2 near here
Table 3 near here

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 its 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 costs may vary across different economic sectors. The data in Tables 1 and 2 allow us to investigate further which 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 may not be directly related to the impact of HSR, although it could be argued that this is one of the sectors where HSR could make a major difference to the pattern of administration between national/regional centres and local towns and cities. The other sector more likely to be dependent on HSR for business travel, "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 the case of London, where an increase of 170,900 jobs in the core was recorded, though the growth rate (20%) was not so great due to the large base number in 1999. Note that this is the sector generating the greatest elasticity to changing accessibility in the study of Graham (2007).

The next question is whether the sectoral changes in employment have led to a significant transformation in the specialisation patterns. In particular, it is interesting to find out whether there are any changes in the specialisation 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 for the 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, using their aggregate employment as the benchmark. The indexes thus show how each of the cities 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 Saarbrücken, which shows a slight rising trend. Based on these results, the economic structures of the core cities appear to have become more similar to each other, though the effect is mild in most of the cases.

Regarding the specialisation between the core and the hinterland, we have computed for each region the specialisation index of each hinterland area using the employment structure of the respective core city as the benchmark. Thus the index shows how the employment structure of each hinterland area is different from the core city in that 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. Some of these trend lines are fairly steep while others are quite flat. The downward trend indicates that the employment structures in the hinterland areas and the core are 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 the benefit of 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 near here

Figure 8 near here

The above results do not demonstrate that HSR has a specific impact on city specialisation; we have simply demonstrated an association between changes in specialisation and the coming of HSR. To go any further would require a much more detailed modelling of specific changes in transport costs associated with the time savings occasioned by HSR, which is beyond the scope of this paper. To model such time savings in the hinterlands would also require a much more detailed analysis of regional accessibility to HSR. However, these results do show that for city regions which have experienced the introduction of HSR there may be a diversity of consequences on the relative performance of the core cities and between the core and the hinterland. There is, however,

tentative evidence indicating a growing economic similarity in the economic structure among the core cities and between cores and their respective hinterlands in the European network studied.

4.3 Changes in specialisation: China

The challenge for China is whether HSR will 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 the east to attract 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 (Table 4), it is premature to provide any concrete analysis on their likely impacts. However, 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 the early 2000s. It can be classified as a high-speed line, although not a very high-speed line with speeds of 250km/h or above usually used to signify an HSR line (Nash, 2013). 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 the period 2003-2010. The data for 19 industries of the 9 cities are obtained from the *Urban Statistical Yearbook of China*, various issues. The line passes through the most dynamic region in South China. Guangzhou was historically an important trading port and has been the major transport hub in South China in the past decades. Shenzhen is one of the special economic zones that China opened up for foreign investment and experimental reforms in the early 1980s. The two cities can be considered as the core of the PRD, though Shenzhen has more interaction with the east coast of the PRD region. Both relied very much on investment from Hong Kong in the earlier stage of China's opening-up and have continued to have a close economic relationship with Hong Kong. The line is connected to Kowloon in the Hong Kong SAR. However, the part in Hong Kong runs at a far lower speed, being essentially part of the Hong Kong MTR urban transit system. To evaluate the impact of the line in the Mainland part of the region, we have collected a data set covering 19 industries of the 9 cities (all at prefecture or above in administrative rank) officially defined as the Pearl River Delta region. Similarly to the analysis of the European case, we analyse the employment growth pattern and changes in regional specialization in the region, but at a rather finer degree of sectoral specialisation.

Table 4 near here

Total employment in the PRD region grew from 5.23 million in 2003 to 8.23 million in 2010, an increase of 57.4%. Table 5 and Table 6 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 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 region is still undergoing a process of rapid industrialisation, with a 73.6% growth in employment in the manufacturing sector. During this period, the PRD region continued to attract migrant labour from inland areas to work in the factories.

Tables 5 and 6 near here

Figure 9 shows the specialization index of the cities in the PRD, relative to 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 appears to be developing an economic structure increasingly different from that of its hinterland. This may not be inconsistent with the expectation of sectoral change in a rapidly industrialising region where divergence is often associated with rapid growth. Only in a subsequent phase would we expect to see a replication of the process identified in Europe of increasing convergence between similar mature cities.

Figure 9 near here

5. Conclusions and Implications for Policy

This paper has attempted to shed some light on the way that regions with well-developed HSR services demonstrate changing patterns of specialisation. This is an important step in understanding the productivity and agglomeration changes which lie behind the claims for wider economic impacts (those beyond simple transport user benefits) associated with such development. The paper shows first, that the impact of HSR development depends on location and results cannot easily be transferred. It suggests also 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 within regions may have the effect of reinforcing existing travel patterns towards the major regional centre.

The detailed analysis of specialisation changes indicates that in the more developed regions of North-west Europe the period following the introduction of HSR there has been a general tendency towards convergence. This is observed both between the major metropolitan regions and, within those regions, between the core cities and their hinterlands. This runs counter to a frequent assertion that improvements in transport will be centralising both within and between regions. However, the preliminary results for China suggest that there may be more of a diverging impact where HSR is introduced in regions which are going through a process of rapid development.

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, HSR as a general policy has not had the transformative effect often claimed. The creation of profit-oriented subsidiaries to run high-speed international rail services may be one reason which has kept fares relatively high failed to provide a level of service to all potential stations thus having a negative 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/regional feeder services and promoting relevant supportive land-use developments at or close to stations may be an explanation of differences in economic impact.

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 policies aimed at securing a better distribution of economic activity across the country, unless this comes naturally as part of the process of economic maturity. It will be important to monitor the changes as the economies of the major cities have time to adjust to the major new HSR links being created.

The next stages in this analysis are to relate the economic changes more closely with the changes in accessibility and to attempt a more micro-level analysis of the economic changes. The former requires much finer data on the actual travel patterns of those using HSR with detailed origin and

destination data. The latter requires data on occupations and skills as well as on sector of employment. Only then will we be able to provide a more definitive account of the impact of HSR based on evidence rather than supposition.

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