The accessibility impact of a new High-speed Rail line in the UK – a preliminary analysis of winners and losers

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The accessibility impact of a new High-speed Rail line in the UK – a preliminary analysis of winners and losers
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Abstract:
This paper analyses changes in accessibility that might result from a new High-Speed Rail (HSR) line in the UK. A proposal for such a line put forward by Network Rail is used as the basis for the analysis. Using travel time to London as the main benchmark to measure accessibility of a station on the current (conventional) and future (high-speed) rail networks the paper examines the likely winners and losers from the construction of the new line. The results show that the accessibility benefits from the proposed line are relatively limited in terms of geographic spread and that many cities close to it would not see any travel time reductions on journeys to London, thus will not see any accessibility benefits it this respect. For such places, this will translate to a relative reduction in the accessibility to London, when compared to other locations, and thus to potentially adverse socio-economic implications. The paper also draws on evidence from Spain to indicate the likely impact of HSR development on the conventional rail network, and this suggests a substantial reduction in services, suggesting that the accessibility benefits that were identified in the analysis are probably overestimated. The paper concludes by arguing that any examination of a HSR line must consider a wider geographic area than just the stations on the line, and that the case for a HSR line in the UK from a regional accessibility perspective, at least based on current proposals, is questionable.

1. Background and introduction
The UK was relatively late to enter the High-Speed Rail (HSR) era in 2007, when the line leading from the Channel Tunnel to London was completed, called at the time the Channel Tunnel Rail Link (CTRL, and nowadays High-Speed1 or HS1). At present, a political consensus is building that supports the construction of a HSR network in the UK, with trains running at maximum speeds of more than 350 kph. The next step in the development of such a network is the construction of the next line - High-Speed 2 (HS2) from London to the north of the country, most likely terminating in Scotland.

Seen as the way forward in terms of UK transport policy, the discussion on HSR has been gaining momentum for some time now (Table 1). The fast development of the European HSR network in the background certainly contributed to this momentum. However, not that long ago, in 2004, an extensive study on HSR (or lack of it) in different countries around the world, including the UK, questioned why is it that the UK still does not have such a network. The report (CfIT, 2004) pointed to several important differences between the UK and countries like Japan, France, Germany and Spain which already gained extensive HSR operation experience. Mainly, that at the time the UK did not suffer from lack of capacity on the conventional network. Although a report in 2005 did provide support for HSR in the UK (WS Atkins, 2005), a major study for the prime minister on the UK transport system also ruled out the need for investments in a HSR line or network (Eddington, 2006). But from 2007, very much followed the creation of Greengauge21 (http://www.greengauge21.net/), a non-for-profit organisation which promotes the development of HSR in the UK, and led by different (mainly rail) stakeholders, the wind has changed. From that point HSR was considered as a solution to meet expected increase in demand for rail transport and uptake of the existing capacity (Table 1). With demand for rail transport in the UK at record levels (ATOC,
2008) and forecast for further increase in the future, the conditions seem right to advance the idea of a UK HSR network.

Table 1: Review of the main HSR documents in the UK

<table>
<thead>
<tr>
<th>Year</th>
<th>Report</th>
<th>Author</th>
<th>Keynotes</th>
</tr>
</thead>
<tbody>
<tr>
<td>February</td>
<td>High Speed Rail: International</td>
<td>Commission for Integrated</td>
<td>- International market differences due to geographical and demographic factors</td>
</tr>
<tr>
<td>2004</td>
<td>Comparisons</td>
<td>Transport (CfIT)</td>
<td>- Britain’s market traditionally had a strong well developed conventional rail network</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- No apparent lack of capacity</td>
</tr>
<tr>
<td>2005</td>
<td>High Speed Line Study</td>
<td>WS Atkins</td>
<td>- Overcrowding online forecast</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- High investment cost in HSR but economic case under specific terms</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Proposed opening date 2016</td>
</tr>
<tr>
<td>December</td>
<td>The Eddington Transport Study</td>
<td>Sir Rod Eddington</td>
<td>- Local (short distance) connections are more likely to improve the national economy rather than long-distance ones</td>
</tr>
<tr>
<td>2006</td>
<td></td>
<td></td>
<td>- There are strong doubts about real benefits of HSR</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- HSR is not going to contribute to carbon reduction</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Long-distance connections can be addressed by other more effective and less costly solutions than HSR</td>
</tr>
<tr>
<td>June 2007</td>
<td>HS2 Proposition, the WCRL corridor</td>
<td>Greengauge21</td>
<td>- HSR is the best way to address the capacity shortfall</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- HSR is not as costly as previously evaluated</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- HSR network would provide continuity to HS1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Demand on the WCML will reach capacity and a high speed connection along its corridor will boost national economy</td>
</tr>
<tr>
<td>January</td>
<td>High Speed Two</td>
<td>Dep. for Transport</td>
<td>- A new (government) starting point to consider HSR</td>
</tr>
<tr>
<td>2009</td>
<td>Prop. for Transport</td>
<td></td>
<td>- Create a company (HS2) to work on specific network planning</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Overcrowding the main problem for the HSR to address</td>
</tr>
<tr>
<td>September</td>
<td>The case for new lines</td>
<td>Network Rail</td>
<td>- London the focus of the new network/line</td>
</tr>
<tr>
<td>2009</td>
<td></td>
<td></td>
<td>- WCML the alignment of the first HST to be built</td>
</tr>
<tr>
<td>September</td>
<td>A step forward</td>
<td>Greengauge21</td>
<td>- Including the East Coast Rail Line (ECML) and the Great Western Main Line (GWML) in the network.</td>
</tr>
<tr>
<td>2009</td>
<td></td>
<td></td>
<td>- Consider the upgrade of lines (rather than new lines) a slower but more cost effective solution for part of the HSR network</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- The length of the network considered double that of Network Rail</td>
</tr>
</tbody>
</table>

Most of the studies in Table 1 focus on a Cost-Benefit Analysis (CBA) of a UK HSR line or network, very much following the methodology reported in De Rus (2008). The focus of the reports is usually on the investment required on the one hand and the economic benefits, mainly in terms of travel time savings, on the other. The analysis is mainly restricted to the line in question without due consideration of areas beyond (but close to) the line or areas bypassed by it. This paper aims to provide a broader (geographic) consideration of a new HSR line in the UK.

In 2009, Network Rail (2009) published a report in which a suggestion for the HS2 line is made. Lack of capacity on the UK rail network is expected mainly, or first, on the West Coast Main Line (WCML) the rail corridor leading from London to Manchester through Birmingham, even though this line was only recently upgraded to increase speed and capacity. The HS2 proposal put forward by Network Rail and shown in Figure 1 was chosen after considering numerous alternatives, and roughly follows the
alignment of the WCML. Also this proposal is based on a CBA approach. Although alternative plans are already emerging, mainly from High Speed Two, the company set up by the Government to consider the case for new high speed services between London and Scotland, the Network Rail proposal is used as the basis for the analysis in this paper.

The analysis in this paper is set to examine the wider accessibility impact of a new HSR line in the UK. It is based on the assumption that changes in accessibility are a precondition for any other gains or losses from the construction of HSR line. Using accessibility indicators (namely changes in travel time) the aim of the paper is to provide a wider examination of the effect a new HSR line might have, looking also beyond the line and cities directly served by it.

Figure 1: Network rail proposal for HS2

Experiences from continental Europe, and especially from countries like France, Germany and Spain can provide important evidence on the impact of HSR operation. In this paper, some evidence from Spain is used. In the next section the data and methodology used are explained followed by the results of the analysis in Section 3. Before discussing the main conclusions from the UK analysis is Section 5, some relevant evidence from Spain is discussed in Section 4.

2. Methodology and data
In this paper, the basis for assessing changes in accessibility from a new HSR line in the UK is travel time by rail. Network Rail (2009) estimates for travel times on the proposed line are used together with travel times on the conventional (current) network based on current operators’ time-tables. First, an analysis of changes in accessibility was performed only for the cities that will benefit from a HSR station (London, Birmingham, Manchester, Warrington, Liverpool, Preston, Glasgow and Edinburgh). Second, in order to assess the wider regional impact of a new HSR line, additional 114 stations which are currently served by the conventional network were considered. The
114 stations on the conventional network chosen for the analysis are all in relative (geographic) proximity to the proposed HS2 and thus are expected to gain some accessibility benefits from its construction. These stations (and the cities they serve) are within three defined regions (Figure 2): the area east of HS2 and South of Manchester (covering roughly the counties of Derbyshire, Nottinghamshire, Staffordshire and parts of Leicestershire – area A); the area west of HS2, north of Birmingham and south from Liverpool and Warrington (roughly the counties of Shropshire, Worcestershire and Cheshire – Area B); and an area in which the chosen stations are within 90 minutes (of current) travel time to London by rail, which is defined as the London commuting area (area C).

Figure 2: The proposed high-speed line stations and the sample of stations on the conventional rail network

Cities, or stations, in areas A and B are assumed to benefit from greater accessibility if following the construction of HS2 travel times to London will be cut by using the new high-speed services through one of the new stations. Otherwise, it is assumed for the purpose of the analysis, travel time (to London) using the conventional rail network will not change. Cities which will not benefit from travel time reductions on journeys to London are expected to be adversely effected since their relative accessibility to London
(relative to other cities) will deteriorate. This is likely to be the impact for cities in Area C, which are not expected to use the new line to reach London. Examining changes in the relative accessibility is one way used to identify winners and losers from HS2.

The nature of rail services means that it was enough to select only a few cities on each line serving one of the cities which will have a HSR station to understand the accessibility impact. If a station on a specific line leading to a HSR city (station) would not benefit from travel time reductions, as defined here, after the construction of the HSR line then stations beyond it would not as well. This is the main method used to select the 114 stations on the conventional network.

To measure regional accessibility we use travel time by rail, accounting also for a travel time penalty when a transfer between trains is required. Two calculations of travel time are considered. First, travel time on the conventional rail network based on the current official timetables and second, travel time when using the new HSR line. For most of the analysis, the reference point taken to measure accessibility is travel time to London. London is taken as the reference point due to its economic and political importance in the UK landscape. In many respects, the circumstances of many UK cities are determined by their (relative) accessibility to London (Leuning et. al., 2007). For many (smaller) regional cities and towns, travel time and accessibility to the nearest major conurbation (e.g. Birmingham, Manchester, or Liverpool) is expected to be, from a socio-economic perspective, more important, but travel times to the nearest major city will not change as a result of the HSR, it is assumed. Yet, the relative accessibility of those smaller locations to London might change and this can have important, probably negative, implications.

Current travel time calculations are based on the current timetables considering a) the fastest available connection during office hours - to represent ‘best’ commuting opportunities, and b) adding an interchange penalty of 17.61 minutes, as estimated by Wardman (2001) for a rail to rail interchange in the UK. An important assumption included in the calculations is that the change from the conventional rail service/network to the high-speed service/network is done at the same stations and is relatively seamless. In other words, the HSR station is located where the current main station is, e.g. Piccadilly station in Manchester, Lime Street station in Liverpool, etc. This will not necessarily be the case, an issue which is discussed in the concluding section.

To represent spatial changes in accessibility a GIS framework is used. By calculating the journey time to each HSR station, and assuming passengers will choose the closest (in travel time) station, the catchment area of each HSR station could be defined.

3. Results

3.1 Accessibility changes on the HSR network

Figure 3 shows journey times between the cities which will benefit from a station on the HSR line before and after it is opened. For example, journey time between London and Manchester is expected to go down from 127 minutes at present to only 66 minutes, while for the Edinburgh-London route travel time will go down from 239 minutes at present to 129 minutes once HS2 is complete. Figure 3 also shows that for the journeys Liverpool-Birmingham, Manchester-Liverpool and Edinburgh-Manchester no travel
time reductions are expected from the completion of HS2 since current plans do not envisage a direct HSR connection between all the cities with a HSR station. Lastly, Figure 3 illustrates the pattern of services envisaged on HS2. The service from London to, for example, Glasgow will only stop at Preston and there will be no direct HSR connection between Birmingham and Liverpool, and therefore no change in travel time by rail. In terms of absolute travel time reduction on services to London, Glasgow benefits the most with 116 minutes travel time reduction followed by Edinburgh with 110 minutes. The reduction on the service to London from Birmingham will be 38 minutes.

Figure 3: Journey times between cities with a proposed HSR station at present and after the opening of HS2.

The average travel time between each city and the other cities with a HSR station before and after the line is open is a way to illustrate the changes in connectivity on the HSR network (Figure 3). As expected, travel time savings are mainly gained at the end of the line (London and Scotland), while cities in the ‘middle’ of the line, like Liverpool and Preston altogether will see relatively minor improvements in accessibility (under 10 minutes) to other cities with a HSR station. London, if considering the connections envisaged and the travel time reduction, will gain the most from the proposed line, as all cities with a HSR station will now be closer. This is likely to reinforce the dominant position of London, while the impact of the other cities might be positive or negative depending on other factors.

Figure 3 also shows that the ability of the HSR to ‘shrink’ space does not depend only on having a station on the HSR network, but also on the patterns of services on that network and their frequency. Having a station on the line is a prerequisite but not necessarily sufficient condition for a city to gain substantial travel time reductions, and as a result, improved accessibility by rail.

3.2 Accessibility changes beyond the HSR line

All the cities with a station on the new HSR line will benefit from a reduction in rail travel times to London, and to some other cities with a HSR station. The benefits for
cities close to, but not on, the proposed HS2 are not guaranteed and are investigated below.

Figure 4: Changes in travel time to London after the opening of HS2.

As noted, to measure changes in accessibility travel time to London was used as a benchmark. The alignment of the proposed HS2 follows very much that of the current WCML and therefore cities which currently have a relatively good access to the WCML are expected to benefit (more) from the new line. Assuming, as we do here, that the current pattern of services on the conventional network will remain the same, cities which are currently served by the WCML will naturally have good rail connections to those cities with a future HSR station and thus will benefit the most from this line once it is open. However, Figure 4 shows this is not the case (e.g. for Crewe) probably because to use the HSR service to London passengers from Crewe, for example, need to transfer at Birmingham which entail travel time penalty. Furthermore, as discussed below, it is more likely that the level of service on the current WCML will be reduced substantially in the future.

Figure 4 shows which of the cities included in the analysis will benefit from travel time savings on journeys to London (by using the high-speed services) and which will not
(i.e. will continue to rely on current services). All the cities in Figure 4 south of Birmingham will continue to rely on current (relatively good) services to London and would not see travel time benefits. This also applies to a substantial number of cities north-east of Birmingham. North of Birmingham, Figure 4 shows which cities have a good (often direct) service to a city which will have a HSR station in the future, as these cities will benefit from travel time reductions on journeys to London. For example, cities on lines such as the Matlock-Derby-Birmingham and Shrewsbury-Wolverhampton-Birmingham currently use Birmingham to access London and therefore will benefit from HS2, but only if the assumption on seamless transfer between high-speed and conventional service will hold. Cities in the Manchester and Liverpool areas will benefit from the new line but to a varying degree, some gaining less than 30 minutes. This apparent regional accessibility benefits from HS2 can be considered as a positive side effects of building HS2, not an intended effect, and as noted depend on the quality of connection between the conventional and high speed rail networks.

Figure 5: Changes in the accessibility ranking to London

Figure 4, in essence, points out the winners and losers from the proposed HS2 under the assumptions made for this analysis. In Figure 5, the winners and losers are explicitly...
indentified by indicating the change in the ranking of cities according to their accessibility (by rail) to London after the completion of HS2. In green colours are those cities which see their ranking improved and in red those which will see their ranking going down. The blue dots represent cities which will not see their ranking much affected. If no changes will be made to the pattern of services on the (current) conventional network the number of cities that will benefit from HS2 is relatively small and so is the geographic area they cover. The area north-east of Birmingham appears as a clear loser from the construction of HS2 and there seems to be no clear area which is a winner. Thus, based on current rail services only a selective number of cities will benefit from HS2.

The changes in the ranking can be substantial for many cities. At the extreme cases, Buxton and Chinley, close to Manchester, are ranked 114th and 98th respectively in terms of current travel time to London amongst the 114 cities in the sample. With HS2 in place, these cities will see their ranking go up by 79 and 76 places respectively, turning them into one of the closest cities to London. At the same time, Loughborough and Radcliffe which currently are ranked 22nd and 31st amongst the cities in the sample will see their rankings drop by 69 and 72 places respectively. It is clear how HS2 can turn the Geography of the UK upside down - cities which are about 100km closer to London will experience longer travel times to it.

3.3 Linking the network and regional accessibility – the station catchment area

By examining which cities will experience travel time reductions when using HS2 to get to London, the catchment area of the proposed HSR stations can be defined. Naturally, passengers will also use the new high-speed line to get to other places than London, but using London is a good indicator. In the analysis below three catchment areas are considered that of the Liverpool and Warrington stations, that of Manchester station, and Birmingham station.

The Liverpool-Warrington catchment area, based on the above analysis and the assumption made, is shown in Figure 4 (dotted line, also in Figure 5). It is made up of only several stations west to the WCML and is relatively small. Chester, a station located 45 minutes travel time away from Liverpool, but geographically close to it, would not benefit from using Liverpool and HS2 to get to London, this is even when assuming the service from Chester to Liverpool and from Liverpool to London on HS2 are fully integrated (starts and ends at the same station). Stations farther away from Liverpool (south) than Chester will have shorter travel time to London using the conventional network via (Crewe and) Birmingham.

The Manchester catchment area (also shown by a dotted line in Figures 4 and 5) is different. First, it covers a larger area and the travel time savings, on journeys to London, are substantially higher. Even Leeds would benefit from better connection to London via the HS2, compared to current travel times on the East Cost Main Line (ECML). Chesterfield marks the south-east border of the Manchester station catchment area, while Kidsgrove marks the south border. Kidsgrove is 50km south of Manchester and thus it appears that also the Manchester station catchment area is not large. The main reasons are probably, the relative close proximity (in HSR terms) of Manchester to London, the relatively good rail services to London, from places like Kidsgrove (via Stoke-on-Trent) and/or the relatively slow services from places like Kidsgrove to Manchester.
The future HS2 station in Birmingham has the potential to benefit from the largest catchment area, given that Birmingham is a central node on the current rail network and a station which many of the services going from the North to London pass through. However, despite that, Figure 6 shows a relatively small catchment area when measured by the number of stations who will benefit from a new HS2 station in Birmingham. Within a relatively close proximity to Birmingham, many cities currently have good connections to London which is not via Birmingham, which means in the future these places would not benefit from the completion of HS2 and would see their relative accessibility to London adversely affected. This has important implications for the potential economic development of Birmingham once a new station is opened. Cities along the rail line from Matlock-Bath to Birmingham who currently use Birmingham for the fastest connection to London are in a way unique in that they will benefit from the new line, but travel reductions will be relatively small (by 5% on journeys to London). Again, it is important to note that these travel time benefits depends on full integration of the conventional and high-speed rail networks.

Figure 6: Birmingham station catchment area.

Source: based on National Rail (2009) and current time-tables.

4. Regional accessibility effects of HSR – some evidence from Spain

The above analysis is based on several key assumptions which have an important effect on the conclusions that can be drawn. To discuss the validity of these assumptions evidence from HSR operation in Spain, focusing on the region of Andalusia, is considered next. After a brief introduction to HSR experience in Spain, regional accessibility is discussed.
4.1. HSR in Andalusia
The traditional Spanish rail network was built to a different standard than that used across most of Europe (the UIC gauge), it is wider. On that network, demand on the lines towards Andalusia (south Spain) from the centre of the country (Madrid) reached capacity and a new, high-speed passenger line emerged as the solution in the late 1980s. The approach taken was to build a ‘straight’ line between Madrid and Seville (Andalusia’s capital city), following the French approach and experience with the TGV - fast connections between the main cities with no or relatively few intermediate stops and following the shortest route between those cities. The new line was built to the standard (UIC) gauge to allow full integration with the emerging (and especially French) HSR network. This meant that unlike the TGV model of HSR, which allow HSR services to fully operate on the conventional network, the Spanish HSR was limited, in Spain, to the HSR network (Givoni, 2006).

Figure 7: Part of the current Spanish conventional and high-speed rail network between Madrid and Seville

The inauguration of HSR services in Spain took place in 1992 when the line Madrid to Seville opened, serving also three relatively small intermediate cities: Ciudad Real, Puertollano and Cordoba (Figure 7). At the time the population of Ciudad Real and Puertollano, which are only 40 km apart (or 15 minutes travel time by HSR) was less than 100,000 inhabitants and that of Cordoba about 300,000. Soon after the opening of the new line it became apparent that most of the carriages on the HSR service were full in Madrid but empty past Ciudad Real on the way to Seville, while passengers wanting to travel from Madrid to Seville could not find seats on the new services. This situation later led to the introduction of regional HSR services serving the intermediate cities only. These new regional services were slightly slower with intermediate stops in the three small cities and cheaper than the full high-speed service between the large cities.
Parallel to these two types of HSR services, services on the conventional rail network continued (including freight transport services).

The impact of opening the Madrid-Seville HSR line on the modal share of passengers travelling between the cities was considerable (Table 2). Within four years of operation the HSR captured over 40% of demand, with substantial shift of passengers from air transport but also from car and rail transport. The opening of the new line also resulted in a large traffic generation effect. Within five years the number of passengers travelling between the cities increased by 25% (over 0.7 million additional passengers). While the conventional network played an important role in providing transport services between Madrid and Seville in 1991, four years after the inauguration of the HSR service, it only played a marginal role (catering for only 2.8% of the demand between the cities). The effect this had on cities still relying on the conventional rail network to travel to, for example, Madrid, is of particular relevance to the UK analysis described above and is considered next (for further analysis on the impacts of HSR operation in Spain see Ureña et al, 2009; Coto-Millan et al, 2007; Martin and Nombela, 2007).

Table 2: Modal split in the Madrid-Seville (Thousands of passengers).

<table>
<thead>
<tr>
<th>Transport mode</th>
<th>Before HST (1991)</th>
<th>%</th>
<th>After HST (1996)</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>HSR</td>
<td>-</td>
<td>-</td>
<td>1438.2</td>
<td>41.3</td>
</tr>
<tr>
<td>Car</td>
<td>1436.4</td>
<td>52</td>
<td>1407.4</td>
<td>40.5</td>
</tr>
<tr>
<td>Conventional train</td>
<td>392.3</td>
<td>14.2</td>
<td>96.4</td>
<td>2.8</td>
</tr>
<tr>
<td>Air transport</td>
<td>694.4</td>
<td>25.1</td>
<td>352.2</td>
<td>10.1</td>
</tr>
<tr>
<td>Bus</td>
<td>239.2</td>
<td>8.7</td>
<td>182.9</td>
<td>5.3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>2762.3</strong></td>
<td><strong>100</strong></td>
<td><strong>3477.1</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

Source: De Rus and Inglada, 1997.

4.2 The impact of HSR on the city of Alcázar de San Juan

The traditional rail network from Madrid towards Andalusia did not follow the ‘shortest-path’ between two major cities, but was aligned to include many (smaller) cities along the way. In the Castilla-La Mancha region (south Madrid-north Andalusia) network considerations meant that the capital city of Ciudad Real province (named the same) was not a major regional node on the network. Traditionally, the city of Alcázar de San Juan (Figure 7) was the rail hub for all flows (passenger and freight) from Madrid towards the East (Valencia, Alicante and Murcia), the South (Andalusia) and the West (Extremadura and Portugal). The city became reliant on the transport sector to provide employment (freight delivery, rolling stock garages, workshops, and catering for passengers transferring at the station) and transport became the main driver for the growth of the city.

The position of Alcázar changed when the Madrid-Seville HSR line opened (Figure 7). As a result of the new line, the number of rail services at Alcázar decreased while the number of services at neighbouring Ciudad Real increased (Figure 8). The decrease (increase) in the number of daily rail services at Alcázar (Ciudad Real) continued well after the opening of the HSR line in 1992, and after what might be considered as the first effect. The number of daily services at Alcázar in 2007 was more than 40% less than it was in 1989, a period in which the general population of Spain and level of mobility increased. In 1996, out of the 43 daily rail services stopping at Ciudad Real only 7 were services on the conventional network (services which also stopped at Alcázar). The potential adverse socio-economic impacts of reduced rail accessibility at Alcázar, due to the opening of the HSR line, are clear.
The very brief account of some evidence from Spain suggests the following with respect to the UK analysis described above. First, the introduction of HSR services results in significant modal shift, including a shift from the conventional rail network to the high-speed network. Second, and due to the nature of HSR with relatively small number of access points (stations), while a few cities would see increase in the level of rail service many more are likely to see a decline in the level of rail service. It is therefore expected that rail use will in many places decline, probably in favour of other modes, even if overall at the national level rail use will increase. Evidence from Spain also shows that as a result of HSR development much of the available resources for rail transport are directed at the HSR (for maintenance and expansion), resources which otherwise would have been used for developing and maintaining the conventional network. The above can have detrimental effects for rail operators providing services on the conventional network and further reduce the commercial viability of these services, resulting in increasing demand for state subsidies.

Figure 8: Daily Rail Operations in Alcázar de San Juan and Ciudad Real before and after HSR operation

<table>
<thead>
<tr>
<th></th>
<th>1989</th>
<th>1996</th>
<th>2007(*)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alcázar de San Juan</td>
<td>83</td>
<td>69</td>
<td>48</td>
</tr>
<tr>
<td>Ciudad Real</td>
<td>14</td>
<td>43</td>
<td>60</td>
</tr>
</tbody>
</table>


5. Discussion and conclusions

There is a strong political backing for the development of a HSR network in the UK from all the major political parties, and plans have already been drawn for the next line on this network – the High-Speed 2 (HS2) line from London to the north. Network Rail, the non-for-dividend company responsible for rail infrastructure in the UK presented in 2009 a first proposal for such a line (Figure 1) which was the basis for the analysis described above. Since then, several other proposals have been put forward and discussed (e.g. Greengauge21, 2009 - with the main significant change being the addition of an east line which will run, more or less, along the East Coast Main Line), but the discussion remains focused on the line itself without due consideration to the regional and wider effect of building such a major and expensive piece of infrastructure. The analysis described above and the conclusions drawn from it are equally relevant for any HSR proposal currently considered.
Given the proposal for a new line as shown in Figure 1, this paper provides an analysis of its likely accessibility impact. This is considered as an initial analysis that aims to draw general conclusions with respect to the possible impact of a new HSR line and in order to highlight the issues which need to be better investigated and accounted for as the planning of the line continues. The main justification for constructing a new HSR line in the UK is economical and environmental. We do not touch on the environmental aspect in this paper, but believe the environmental argument is questionable, mainly due to the following reasons. First, the likely traffic generation effect of a new HSR line (as evidence from Spain shows), second the fact that electricity in the UK is still very much produced from non-renewable energy (see Givoni et al., 2009), and third, the distances between the main cities on the line means mode substitution from air to rail is not likely to be large, especially given that domestic air transport in the UK is fairly limited. With respect to the potential for economic (development) benefits these are primarily dependent on accessibility benefits. Large infrastructure investments, such as a new HSR line, are expected to generate wider economic benefits than just travel time savings, such as employment benefits, agglomeration benefits and (as a result) economic development impacts, but might take place or not only if core transport benefit, i.e. improved accessibility, materialize and, probably more important, other conductive conditions for economic development are present (Banister and Berechman, 2000). For this reason, a preliminary analysis of the accessibility impact of a new line can indicate the potential for wider economic benefits, assuming the other conditions for economic growth are present.

A new HSR line, as proposed by Network Rail, will result in significant reductions in travel time, but only to a relative small number of cities with a station on the new line. The pattern of services envisaged, however, suggest that travel time savings will not occur on all journeys between the cities with a HSR station. Thus, even when considering the limited number of cities that will have direct access to HSR services, the accessibility benefits are limited and are mainly restricted to journeys to London. This is expected to further strengthen the position of London as the ‘centre’ of the UK (economically, socially and politically).

On the regional level, the accessibility benefits that the HSR could bring to cities close to the new line appears to be limited and restricted to a relatively small number of cities, which currently ‘happen’ to have direct rail link to a HSR station and at the same time do not have such a link to London. This conclusion from the above analysis is based on two assumptions. First, that there will be no change in the current conventional rail network and no change in the level of service provided, and second that there will be full coordination of services between high-speed and conventional rail services, mainly that both services will start and end at the same station. It is likely that both of these assumptions will not hold for HS2 which suggests that the (somewhat limited) accessibility benefits that were indentified in this paper are probably an overestimation.

Evidence from Spain showed how the opening of the Madrid-Seville HSR line had an adverse and continuous effect on the level of services on the conventional network. Given that demand will be shifted to the new high-speed line from the conventional network and, in addition, that the limited resources available for maintaining the rail network will also need to go towards the new line, it seems inevitable that the level of service on the UK conventional rail network will be negatively affected. This does not only mean that rail links to (cities with) HSR stations will not be as at present, but
probably worse, but that many cities which currently benefit from good rail services and access to London will have a reduced level of service in the future. These are mainly cities on the WCML which currently are ‘rail hubs’, but also all other cities across the current UK rail network. Crewe and Stoke-on-Trent are probably good examples, which might have some parallel with the story of Alcázar in Spain. This situation might mean that the catchment area of the HSR stations will increase (as for more cities travel time to London will be shorter using HS2) but travel times to London will be longer. Thus, overall from a rail network perspective, it is likely that a new HSR line will result in accessibility reduction and inferior position for the rail in the competition with other modes and mainly road transport. Due to the relatively small number of access points (stations) to a HSR service, such a service is bound to reduce the accessibility of many locations (in between the stations - the tunnel effect of the HSR) unless services on the conventional network are upgraded and aligned with the HSR network.

The choice of station location is crucial with respect to the potential accessibility benefits of a new HSR, and therefore other economic effects, and is considered as the main factor in determining the ‘success’ of HSR related development (Menéndez et al, 2002). This aspect is not yet explicitly addressed in the UK debate. The station location is important from a local (city) perspective and a regional one. From a regional perspective, the focus of this paper, it will determine the catchment area of any station on the HSR line. For economic reasons, both in terms of potential development around the station (land availability) and the cost of building the station and line to it, there is pressure and some advantages in building the new stations HSR outside the city, in a different location to the current main rail stations. This will mean, in most cases, that a time consuming and inconvenient transfer will be required from the conventional network to the HSR network. Given that significant investments in the conventional network are not expected, the current structure of the conventional network should be considered as given. To reduce the polarization effect of HSR, the increase in travel time distances between places on the line and those not on it, any new HSR line and especially the stations on it, must be planned with careful considerations of the current alignment of the conventional network and not just demand projections between major cities. The current discussion and documents, e.g. Network Rail 2009, suggests new locations for the stations are currently the preferred option.

Overall, a new HSR line in the UK will have substantial effect on the UK Geography. In many respects it will ‘shrink’ the UK, as the HSR did for continental Europe (see Spiekermann and Wegener, 1994). But for many (more) places it will expand the UK. HS2, or a larger HSR network, might turn the geography of the UK upside down, with cities closer to London by distance being further from it in many other aspects. This is likely to have adverse effects on demand for transport and overall might results in more travel and even more travel by car considering the reduction in the level and quality of rail transport on the conventional rail network. Furthermore, depending on the location of the station and how it is integrated with the rest of the (public) transport network car travel to reach the new HSR stations might be the most attractive mode.

Given the relatively small distances between the major urban conurbations in England (the aerial distance between London and Birmingham is about 150 km and between London and Manchester 250 km), and the relatively well developed (in terms of geographic coverage) rail network in the UK, a new full scale HSR line, with maximum
speeds of over 350 kph, might not be the best (cost effective) way to increase rail capacity and meet increases in demand for rail travel.

As noted, accessibility analysis as performed in this paper is the first step in trying to investigate the potential impact of a new HSR line. Such an analysis provides an indication of the likely winners and losers from a proposed new line and an indication of the possibility for wider accessibility and economic benefits and the geographic area in which they might occur (or not). As a next step, it is important to add to the accessibility analysis a socio economic analysis of the locations which will benefit or lose from travel time changes, to more precisely assess the likely impacts. An analysis at a local level is also necessary to try and locate the most suitable location for the station.

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