Indirect and wider economic impacts of High-Speed Rail

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Abstract
The paper considers the development of high speed rail in Europe in terms of its wider impacts on economic development. It shows how the focus has changed from the more limited objectives of enhancing rail capacity to a recognition of the potential for use as an instrument for enhancing competitiveness and cohesion within the context of the development of the trans-European networks. This however raises a number of complex issues relating to the way transport interacts with the economy, particularly in a world of imperfect competition. The paper reviews attempts to evaluate these benefits from simple accessibility and potential models to recent developments of computable general equilibrium models.

Introduction

Indirect impacts, especially on regional economic performance, are often used as a justification for additional benefits from high-speed rail (HSR) projects – sometimes to make the difference between a project which is not justifiable on a strict user benefits basis and viability. Regional authorities have been especially vocal in using this argument in favour of projects, for example regional claims for the priorities in the development of the Schéma Directeur LGV in France and those made for both the Madrid-Sevilla and Madrid-Barcelona-French border lines in Spain. Similar arguments have been made in Italy and have surfaced in the recent discussion for a new north-south line in the UK.

The usual assumption is that the improvements in accessibility which the creation of an HSR link makes will enlarge market areas and increase the implicit competitiveness and productivity of firms in a newly connected region. In addition the time savings made by all travellers are equivalent to an increase in productivity. These assumptions tend to lead to three outcomes: an overestimation of potential demand which inflates predicted user benefits; an overestimation of non-user or induced benefits; an assumption that all potential non-user benefits accrue to one region, ignoring any redistribution which the changing pattern of accessibility brings about.

More recent theories of the role of infrastructure and transport improvements in regional development have stressed the way that transport costs (and hence accessibility) interact with other determinants of economic development, particularly scale economies and the size of market areas, in an imperfectly competitive world. Improvements in transport may thus benefit firms in more developed core regions more than those in less developed peripheral regions. Thus transport improvements to (and within) core city regions not only provide a

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direct benefit in terms of the enhanced productivity of existing workers and an increase in employment, but through agglomeration effects they raise the productivity differential of the core city relative to the rest of the economy. This reflects the positive relationship between city size and productivity. Transport improvements may thus be as likely to lead to an increase in regional disparities as they do to increasing cohesion. This is not a universal or inevitable outcome, it will depend on the specific situation of the region, the initial levels of accessibility and the change in them and the existence of other policy measures which may accompany the transport improvement.

Most analysis tends to have been undertaken of individual links of HSR developments, or at most of what are in most cases simple national networks. As the networks have developed they have begun, in both north-west Europe and southern Europe, to form international networks. This poses new issues for analysis and appraisal. In this paper we begin to address these issues by looking at the evidence on the impacts on development the emerging European HSR network has had.

We look in particular at evidence on the links between changes in accessibility and changes in regional economic activity for a selection of regions which have benefited from the introduction of HSR services. In doing this we identify some of the limitations of existing modelling approaches. A particular focus is on the relationship between HSR networks and regional and local transport networks and the role of accompanying policies towards economic development. We also identify the way that some intermediate regions may suffer from the introduction of HSR services which form a corridor through the region with little or no benefit and often considerable costs.

The broad conclusion from the paper is that HSR can be an element in improving the economic performance of regions, but there is no guarantee that all the impacts on any one region are positive. This leads to some suggestions for improvements to the techniques of appraisal for HSR projects.

The Emerging European HSR Network

High-speed rail in Europe has had a 25 year period of development from the inauguration of the first French TGV service between Paris and Lyon in September 1981[2]. From slow beginnings national networks have emerged in France, Germany, Italy and Spain. An international network bringing in Belgium, UK and Netherlands to form the so-called PBKAL (Paris-Brussels-Köln-Amsterdam-London) will be complete in 2007 and further international links are planned or under construction to links the French network to Germany (via TGV Est), Italy (via Lyon-Turin) and Spain (via Perpignan-Barcelona).

This network (and the rationale for it) has emerged a little haphazardly. The original lines in France, Germany and Italy were seen largely as a means of overcoming bottlenecks on the original classic rail network. Such bottlenecks limited capacity, caused conflicts between types of traffic and imposed unpredictability. Increased speed was in many respects an accidental by-product of improved reliability. Constraints on improving existing, often highly curved and circuitous routes through mountains or along river valleys led to the often cheaper

[2] This refers to what is now conventionally thought of as HSR, operating on dedicated newly constructed track with operating speeds of 250 km/h or above. The first Japanese Shinkansen was introduced in 1964 with speeds of around 200 km/h, speeds also achieved in both France and the UK by conventional trains on conventional track.

option of new construction[3]. New construction could take more direct routes – the rail distance between Paris and Lyon was reduced by about 120 km or 20 per cent - and take advantage of more efficient new traction and rolling stock to employ steeper gradients and sharper curves – there are no tunnels on the more than 400 km of LGV between Paris and Lyon.

Taking more direct routes could mean that traditional centres along the route were no longer served. This applied to cities such as Dijon on the TGV-Sud Est and later similar problems arose in connection with such towns as Orléans (on TGV-Atlantique), Amiens (on TGV-Nord) and Metz and Nancy (on TGV-Est). Attempts to use the new lines to generate new access points to the high level networks through a range of stations such as Montchanin-Le Creusot in Bourgogne, TGV Picardie (between Amiens and St Quentin) and TGV Lorraine have not thus far been a success either in generating traffic or in providing a focus for economic development. On the other hand TGV-Est is linking Reims more closely into the high-level network and the redevelopment of Lyon La Part Dieu and Lille Euralille shows how accompanying regeneration policies can be effective. TGV Lorraine is also interesting in that although as far as 27 km from Metz and 37 km from Nancy, it is relatively close to the regional airport for these two cities. Furthermore, the use of a technology which enables HSTs to travel at normal speeds on conventional rail enables connection-free services to penetrate to large parts of the rail network.

In Germany and Italy, where the lack of a dominant metropolitan focus has led to a more diffuse development of HSR to overcome bottlenecks without creating a national network, this focus on the major centres has been less strong until recently. This the first German NBS (Neubaustrecke) provided parallel routes over the links between Göttingen and Würzburg and Mannheim and Stuttgart avoiding particularly slow and circuitous routes. Similarly the first Italian links sought to improve journey times on the core Milano-Bologna-Firenze-Roma route where again the traditional route suffered from speed penalties due to the topography. Second and third generation developments have led to a greater concentration on key inter-city routes rather than by-passing natural barriers, for example the Frankfurt-Köln line and improvements to lines serving Berlin in Germany and the eventual moves to completing a T-shaped network in Italy serving all the major cities. The emphasis has now shifted to more detailed improvements to the network in terms of smaller ABS (Ausbaustrecke)

The success of HSR in generating traffic and in switching traffic from both air and road led to an increasing desire for regions not to be excluded from the emerging network. Although there had a been an overall national network for France, through a developing Schéma Directeur, and ones began to emerge in Germany, Italy, and more lately in Spain, this was largely to provide a ranking of projects to determine the likely order of construction according to rates of return. The early projects carried sufficiently large estimated rates of return on a financial basis to make them worthwhile, later projects would increasingly rely on the need to identify a wider social benefit to justify the use of public funds. Moreover as a network began to emerge, it became more difficult to identify a precise added value for each new link as the network effects became more complex.

Experience with the first HSR in France, TGV-Sud Est, showed that for distances of around 400-450 km and a two hour typical journal time, HSR was not just competitive with air, it

[3] It was estimated that the cost of the new Paris-Lyon LGV would be about 40% of the cost of upgrading the classic route, even where this was feasible

would completely dominate the market. Even at the 600-800 km range, HSR could be highly competitive given access times, frequencies and reliability. HSR thus started to be seen not just as a competitor to air for inter-regional journeys, but as a complement for longer international and inter-continental journeys. Thus interconnection of the HSR network with airports became seen as a core design feature. The French network serves Paris Charles de Gaulle and Lyon St Exupéry (Satolas) directly and a number of smaller regional airports by close proximity. The Frankfurt-Köln line serves both Frankfurt (Main) and Köln-Bonn airports.

At a European level, the emergence of the concept of trans-European networks (TENs) during the 1990s led to the designation of an HSR network independent of that for classic rail. To some extent this was simply an amalgamation of the four main national networks already referred to, but it went further in two main areas: the designation of Northern and Southern European HSR networks. The Northern network is the star shaped link of the PBKAL; the Southern network provides links between the Spanish, French and Italian networks. These have (or still are) being built on a link by link basis with little or no regard for the overall network effects and the by-passing and redistributive impacts are significant.

The major problems of the TENs are the duplication between networks and the desire of regions to ensure they are on each network in the (mistaken) belief that there is a financial advantage. In fact the amount of central EU funding for each TEN link is relatively small and although dedication can give rise to eligibility for Structural and Cohesion Funds, national and regional governments (and the private sector) have to find the bulk of the finance and this can prove a long-term burden on the public sector's commitments.

Because the various HSR projects were in a reasonably advanced state of planning, and because the promotion of a new mode of transport which could provide a serious competitive challenge to the environmentally less attractive road and air modes (with both of which HSR competes) was an attractive proposition, HSR featured strongly in the initial list of priority projects determined at Essen in 1994. The extension of the priority list to around 30 projects following the Van Miert report of 2003 reveals that there are now six HSR TEN priority projects of which only three will have been completed by 2007 (Table 1). Of these the Lyon-Torino-Venezia project has been broadened to include multiple uses and arguably the West Coast Main Line in the UK is not a true HSR project as it involves upgrading rather than new build and is for maximum speeds well below 300 km/h.

It will be clear from Table 1 that the priority TENs build on national links to provide international networks. In some cases this is because the international linkage underwrites the viability of the national project and vice versa. For example TGV Nord only makes full economic sense in the context of Paris-Brussels and Paris-London links, although each of these would be difficult to justify in its own right without the domestic Paris-Lille service and the ability to link Brussels-London services on the same infrastructure.[4] Some similar issues arise in the routing of TGV-Est and in the various elements of HSR South West. The problem has been that the intentional impact of HSR has so far been much less dramatic in traffic generation terms than domestic HSR services. Eurostar services between Paris/Brussels and London have only reached about one-third of the original forecast passenger numbers after

[4] Paris-London via Lille is a longer route than the direct route from Paris via Amiens to the Channel Tunnel. The latter is listed as a future project in the French Schéma Directeur, but it is likely to be some time before it becomes viable. The failure to serve Amiens has remained a persistent point of contention.

more than ten years of operation although the rail share of the air plus rail market has reached more than 70 per cent.

Table 1: HSR Projects in Priority TENs

Projects or sections of projects	***Date for start of operation***
A. Essen List Projects	
PP2 High Speed Railway Paris-Brussels-Cologne-Amsterdam London	2007
PP3 Southern TGV	
- Madrid-Barcelona	2005
- Barcelona-Figueres-Perpignan	2008
- Madrid Vitoria-Hendaya	2010
PP4 TGV Est	
- Paris-Baudrecourt	2007
- Metz-Luxembourg	2007
- Saarbrücken-Mannheim	2007
PP6 Lyon-Torino-Trieste-Torino-Venezia	2010
PP14 West Coast Main Line (UK)	2007
B. New 2003 Projects	
High Speed Railway, South-West	
– Lisboa/Porto – Madrid	2011
– Perpignan – Montpellier	2015
– Montpellier - Nîmes	2010
– Irún – Dax (cross border)	2010
– Dax - Bordeaux	2020
– Bordeaux – Tours	2015

Source: European Commission (2003)

That HSR has thus become a central plank in the development of the European transport infrastructure network is not in doubt. What remains in doubt is the rationale for this. Three broad objectives can be identified:

- A pure transport objective in which HSR is promoted as a less environmentally damaging alternative to road and air;[5]
- A competitiveness objective in which HSR has both direct impacts on productivity and indirect impacts through agglomeration and scale;
- A cohesion objective in which transport infrastructure investment impacts on accessibility and contributes to the process of convergence.

From a European Union perspective the real difficulty is how to determine the European added value from these networks, both from the key cross-border elements and from the key linkages between cities within member states (Vickerman, 2006b). It to these issues we turn in the following part of this paper.

[5] Although it is maintained by some that the search for speed has been gained at the expense of environmental sustainability (e.g. Whitelegg, 1993)

Defining the wider effects of HSR

Although the primary motivation for the early HSR lines was, as we have seen above, one of enhancing capacity, it was also clear that the step change in speeds involved from the maximum of around 200 km/h which had been achieved on some classic lines (and even more so from the ruling maximum on most of the network of 160 km/h) to 250 km/h and later to 300 km/h plus was bound to have a major impact on both rail's competitiveness and on traffic generation. Greater speed implied lower generalised costs of travel and lower costs implied a reduced impedance of distance which would raise accessibility and the economic potential of the major centres served.

Early work on the impacts of HSR focused on this impact on accessibility. Using conventional gravity-based models a series of studies demonstrated how higher speeds would lead to very pronounced changes in the time-space maps of Europe (e.g. Spiekermann and Wegener, 1995; Gutiérrez et al, 1996; Gutiérrez, 2001). Changes in accessibility defined simply in terms of time are only a part of the impact. First, there is the problem that although absolute accessibility may improve there are improvements in accessibility to all nodes in the network such that relative accessibility may not change significantly. As Vickerman et al (1999) demonstrate, using the same basic data as Spiekermann and Wegener (1995), but including access times to the new HSR networks and allowing for the changes to all nodes, the new networks may reinforce the dominance of the major metropolitan centres. Secondly, changes in relative accessibility do not imply unambiguous changes in competitiveness and economic performance, a point to which we return in the following section.

Following this theme, initial research into the impacts of the French TGV lines focussed on the relative impacts on Paris and the provincial cities. This suggests that although such services led to a substantial growth of traffic the impact on the local economies of the cities served was much less certain. Generally such services cannot be shown to have had a major impact on the net redistribution of economic activity between Paris and the provincial cities, or on the overall rate of growth of these cities.

The evidence includes studies of the TGV Sud Est, Paris-Lyon, opened in 1981 (Plassard and Cointet-Pinell, 1986), the TGV Atlantique, including a study of Nantes, opened in 1989 (Klein and Claisse, 1997; Dornbusch, 1997), and early studies of TGV Nord, including studies of Lille and Valenciennes, opened in 1993 (SES, 1998; Burmeister and Colletis-Wahl, 1996). All of these studies demonstrate a considerable growth in traffic between Paris and each of the provincial cities since the opening of TGV. The impact on business traffic is more mixed. In the case of TGV Sud Est there was a substantial growth, in the case of TGV Atlantique as a whole there was a marginal reduction in business traffic, but the period immediately after opening coincided with a serious recession.

The Paris-Lyon study showed a major impact on the pattern of mobility, but with changes in both directions. Essentially many businesses in both locations modified their pattern of working leading to increases in travel in both directions. There was no overall net impact on the economies of either of the major cities, but a general tendency towards the concentration of economic activity towards these major cities from the regional hinterland, especially in Bourgogne and Rhônes-Alpes regions. This centralising effect of high speed rail is now a well established impact.

In the case of TGV Atlantique, the development of business traffic showed interesting contrasts. Tours, at 240km (1h 10m) from Paris showed a significant reduction in business traffic of 24 % in total and 40% by rail between 1989 and 1993. Nantes, 380km (2h 05m) from Paris showed a total increase in business traffic between the two cities of 66% with a tripling of rail traffic. In 1989 some 73% of the traffic originated in Nantes, but there was a much larger increase in Paris originating traffic (+99%) compared with that originating in Nantes (+55%) with the coming of TGV. For Toulouse, 700km from Paris (5h 06m), the increase in total business traffic with TGV was 21%, but this increase was totally dependent on plane (+45%) whilst despite the gain in time by rail of just over one hour traffic fell by 58%. In this case however, more of the increase in traffic was locally based (+35%) and Paris originating traffic actually fell by 5%. However, much of the driving force behind these changes was seen to be the business cycle rather than changes in the supply price of transport. The key factor here is seen to be the differential impacts on the city around 2 hours from Paris, those closer and further away did not benefit to the same extent. This consistent with other evidence that high speed rail has its major impact in the 2-3 hour journey time band.

In Nantes there was considerable anticipation of the coming of the TGV in the light of some of the experiences of Lyon, but this was mainly felt in property development and relatively little impact on, for example inward movement of enterprises was identified. As in the case of Paris-Lyon there was evidence of a degree of internal reorganisation within firms to take advantage of changing transport costs for business travel. Note the stronger impact on Paris originating journeys consistent with the relative lack of development realised in Nantes. Given the general economic situation at the time of introduction there was stronger impact on tourist traffic than on business traffic and this was reflected in a large increase in tourist facilities (an increase of 43% in hotel rooms in central Nantes for example between 1988 and 1993, although some retrenchment was noted after 1993 and occupation did not match expectations)

For TGV Nord the distances are shorter than would be likely to make a major impact – Lille is just 1 hour from Paris. Nevertheless total traffic grew substantially over the first three years of operation, 5% in the first year, 6% in the second year and 11% in the third year. Except in year two the growth was stronger for traffic originating in Nord Pas de Calais region. What is of interest is that rail showed much stronger growth in the latter market than for traffic originating in the Paris region.

The Lille study suggested that about one-third of all business travel was changed as a result of the introduction of TGV (both outward from regional based enterprises and inward by clients of such enterprises). However, 90% of enterprises identified no impact of TGV on their overall activity. As in the earlier studies there was evidence of some internal reorganisation, described in this study as a form of "spatial dualisation". Some considerable differences were noted between Lille and Valenciennes, just as in the Paris-Lyon study there was some evidence of centralisation of activity towards Lille, the major regional centre at the expense of the weaker one, Valenciennes.

The French studies demonstrate the critical importance of time thresholds in the impact which TGV services will have on the relationships between major centres. Thus the headline time of two hours between Paris and Lyon was very significant. This is particularly true of the diversion of trips from air to rail, but it has also affected the potential for generation of new journeys reflecting new activity possibilities. A further issue is that although much of the success of the TGV in generating new traffic has been by providing through services from locations off the new infrastructure the economic spin-off for these centres has not been as great as the for the locations on the main lines.

Economic impacts of HSR

Recent theoretical work in new economic geography provides us with a basis for a deeper understanding of the relationship between accessibility change and economic impacts. This focuses on the interrelationship between transport costs, market size, backward and forward linkages and scale economies (Fujita et al, 1999). The essence of the approach is to recognise that in imperfectly competitive markets for transport-using activities, there will not be an unambiguous predictable response to changes in transport costs. This is equally true for the movement of goods and people, particularly in the latter case where the movement is for business or commuting purposes. Thus changes in user benefits will not be a complete measure of the change in total economic benefit as they will not include these wider economic benefits (Jara-Diaz, 1986). Wider economic benefits do not, however, just constitute a simple add-on or multiplier effect to the user benefits (SACTRA,1999). Moreover, the distribution of those benefits between the affected regions is an empirical question.

Wider economic benefits can be viewed in two ways. On the one hand they involve an increase in total welfare which is greater than the measured increase in consumers' surplus to users through time savings, reductions in accident rates etc. On the other hand these benefits can be seen as the increase in GDP which occurs as a result of the changes in economic activity which derive from the transport change. These represent different ways of measuring benefits and typically give different numerical results. For example, time savings accruing in the course of commuting or leisure travel are welfare gains to the user, but do not have a direct effect on GDP unlike time savings in the course of work. However, where such time savings lead to an overall gain in productivity because people can access more productive jobs more easily, this will be recorded as a change in GDP. For the economy as a whole the overall impact will be broadly similar, but the ratio of total benefits to user benefits will differ. There could also be important differences in the impact on individual regions such that the welfare gain accrues in one place but the GDP benefits accrue in another. If improved transport infrastructure leads to greater concentration of employment this could have different relative impacts on central and more peripheral regions.

Wider benefits are those which typically cannot be recouped from users through charging and they arise in a number of ways, through impacts on the labour market, through direct impacts on productivity and competition in product markets and through changes in patterns of agglomeration. In each of these cases the main reasons for wider benefits occurring is due to the absence of perfect competition. As Jara-Diaz (1986) has shown, where there is perfect competition in transport using markets then user befits will be an accurate and sufficient measure of total benefits from transport improvements.

We stress the importance of the labour market, because it has frequently been ignored in studies of wider benefits. Labour market effects in imperfectly competitive labour markets arise in three possible ways: changing participation rates, increased working hours and moves to more productive jobs (Department for Transport, 2005). Improved transport can enable access to jobs which would not otherwise have been possible. If this enables workers from employment-deficient regions to access jobs in labour-deficient regions there will be gains to the workers, to employers and to the public sector which gains tax revenue and faces lower social security payments. Similarly if easier commuting encourages existing workers to work longer hours there will be potential gains to all three groups, although it might seem more likely that in practice workers would takes the gains in increased leisure rather than increased work. Possibly of greatest importance, however, is the impact on productivity which arises thorough workers being able to move more easily from less productive to more productive jobs. HSR has the important effect of creating a potential step-change in the size of labour markets, not just for daily commuting, but also for reinforcing the possibility of long-distance weekly commuting where the constraints of housing or personal circumstances prevent job-related migration.

Jara-Diaz (1986) recognised that if the degree of monopoly was different in the two regions connected by a new infrastructure there could be differential effects. In an imperfectly competitive world there will be agglomeration forces which enable firms which have larger markets and enjoy scale economies to take more advantage of any reduction in transport costs. Hence reductions in transport costs can lead to more agglomeration and to unequal impacts on regions connected by the same infrastructure (Venables and Gasiorek, 1999). However, the nature of this approach is that the impact of any particular reduction of transport costs cannot be determined a priori. It will depend on the initial level of transport costs, the degree of agglomeration already present, the size of each market, the extent of scale economies and of the backward and forward linkages within that market (Fujita et al, 1999; Fujita and Thisse, 2002).

The key factor is the extent of the mark-up over marginal cost in the transport-using activities, whether these are industries or labour markets. In perfectly competitive sectors there is no mark-up and hence any changes in transport costs will have to be passed on directly to the final activity, so the extent of the impact on the wider economy is dependent on the elasticity of demand for that final activity. Since the amount of transport demanded depends directly on the demand for the final activity the direct user benefits capture all the economic benefits. As mark-ups increase there is in effect a wedge driven between the market for the transport-using activity and the transport associated with it. Any reduction in transport costs from the HSR does not need to be passed directly on to the customers of the final activity, but firms can use the opportunity to increase or reduce the mark-up. Reducing the mark-up by passing on more than the reduction in transport costs could be a way of increasing a firm's market area and gaining market advantage over firms in a more competitive market. On the other hand firms may use the fall in transport costs to increase the mark-up, for example to invest so as to reduce other costs and gain from potential scale economies. It is also possible that the net impact can be negative. If the mark-up is negative, for example where there are industries with significant subsidies, such as in economically lagging regions, then the direct user benefits may over-estimate the total economic benefit. Hence the ultimate impact from any infrastructure project is likely to be unpredictable, both in terms of magnitude and sign.

How then can the total economic impact be assessed? There are three main elements to this. First is the impact on competition in the affected regions, secondly there is the impact on the ability to gain benefits from the change in market power through agglomeration, and thirdly is the impact on the linkages and in particular on backward linkages such as the labour market. Once these have been assessed we have to identify how to include them in a full cost-benefit framework.

The impact on competition is ambiguous. In perfectly competitive markets, as we have seen, the impact of increased competition is essentially neutral and should be adequately captured by the direct user benefits. In imperfectly competitive markets, the direct effect of any increased competition resulting directly from lower transport costs is also likely to be essentially neutral in its impact. It is traditionally argued that monopoly power is derived from the effective barriers to competition provided by higher transport costs so that reductions in such barriers are pro-competitive, reducing monopoly mark-ups and hence there is a wider benefit resulting from the reduction of prices. On the other hand such competitive pressures if they do exist may also drive firms out of the market and the effect of lower transport costs is to reduce the number of firms able to compete in the market in the long run. It is likely that such effects cancel each other out in most cases and thus there is little in the way of wider economic benefits which can be added.

There may be some exceptions to this where new links are created which have such a significant impact on transport costs (which are already very high) that significant market restructuring takes place introducing competition to previously protected local monopolies. This is the ‘unlocking’ argument advanced by SACTRA (1999) and reaffirmed in its latest guidance by the Department for Transport (2005). These are likely to be rare in most developed market economies.

Much more significant than the market competition effects are the agglomeration benefits which may result from the change in transport costs. The argument here is that the rise in output which follows from the lower transport costs has cumulative effects through the way in which firms interact in a market. This involves both localisation economies, in which firms within the same industry benefit from proximity to each other through such factors as specialised labour pools or shared R&D, and urbanisation economies, in which firms obtain a form of public goods benefit from the existence of an urban infrastructure including knowledge, research and culture as well as the physical infrastructure. The larger the market the greater the likely net additional impact which arises because there is an additional impact on productivity. There has been a long debate over the extent to which urban size and productivity are related, and the direction of causality, but there is an increasing consensus that there is a strong positive relationship which can have a significant additional impact on the benefits from transport improvements (Fujita and Thisse, 2002; Venables, 2004; Graham, 2005). This argues that although the lower transport costs may cause firms to increase the size of their market, that increased size provides an incentive for the firm to enjoy scale economies and to benefit from proximity to other more efficient firms. Typical productivity elasticities are in the range 0.01 to 0.1. Ciccone (2002), using data for EU regions, finds an elasticity with respect to employment density of 0.05. Graham (2005) finds for UK industries a weighted average elasticity of 0.04 for manufacturing, but significant variations between industries with some as high as 0.2, and an average of 0.12 for service industries. Graham also identifies some important variations between regions reflecting different degrees of localisation of industry groups.

A further element of this output benefit under imperfect competition is that because productivity is increasing, the direct user benefits will also be greater than would be the case under an assumption of perfect competition. The largest direct user benefits form most projects are time savings, valued relative to the wage level assuming that wages reflect productivity. The increase in productivity implies that a higher value of time savings should be applied. But the increased productivity enables firms to increase output (or produce the same output with fewer workers) which implies an uplift needs to be applied to the time savings.

The basic advantage which some regions obtain in an imperfectly competitive world derives from a larger market size which enables firms to increase both output (scale) and productivity. However, it is useful to break that larger market size effect up into a pure market size effect and the backward and forward linkages which are associated with agglomeration. One of the key backward linkages relates to the labour market. As transport costs are reduced labour markets become larger as commuting times are reduced and firms have access to a larger labour supply. This enables firms to benefit both from wage levels which might be lower than they might be as result of more competition in the larger market, but access to more skilled labour which will be more productive for the reasons discussed above.

Normally it would be expected that there would be a wage premium at the market centre reflecting its greater accessibility, scale and productivity effects, but also to reflect the wage necessary to attract labour to commute in from across the wider region. As transport is improved more workers find it attractive to work in the market centre, both in terms of there being a larger catchment area for which commuting is feasible and more people at each location find it worthwhile to seek work in the centre rather than elsewhere (or not at all), or if they are working in the centre to be prepared to work longer hours. Hence there is an output effect which arises because of the increased size of the labour market. Where there is also a productivity effect due to agglomeration effects at the market centre the output effect from the expansion of employment is added to by the increased output of all existing workers.

Note that it is not the size of the infrastructure project which determines the scale of the wider economic benefits. Large projects are likely to have a wider impact in terms of greater direct user benefits, but the wider benefits are not simply proportional to the direct user benefits. Some relatively minor projects, the ‘unlocking’ projects, can have disproportionately large wider benefits, whereas some very large projects may have relatively little impact on the key scale, productivity and linkage effects. This is why there is no a priori reason for applying a simple wider benefits multiplier. It also demonstrates that seeking a simple output elasticity as in the macro analyses can be misleading.

Evidence on the wider economic impacts of HSR

Most of the detailed studies of HSR impacts have not formalised the analysis to identify the components outlined in the previous section. The technical key to estimating such benefits has come from the application of computable general equilibrium (CGE) models and a number of models of this type these have been applied both to attempts to estimate the impact of the development of TEN networks and to specific case studies.[6]

CGE models use evidence on the actual mark-ups observed in a range of economic sectors and thus allow for the differential impacts which a given change in transport costs can have on different regions depending on their sectoral and competitive structures. The basic structure of CGE models (see Bröcker, 2004; Gunn, 2004, for valuable introductions). involves a demand system which expresses final consumers’ preferences over a range of differentiated goods, a social accounting matrix which expresses the input-output structure of the economy and a profit function for firms. Firms are assumed to be in imperfect competition producing differentiated goods. The outputs of the CGE model are the demands for goods and labour and the implicit flows between regions which these demands generate, and a direct measure of changes in consumer welfare in terms of the equivalent variation in

[6] For a more detailed analysis of the issues raised in the appraisal of major projects see Vickerman (2006a).

income (the income equivalent of the change in welfare resulting from a change in any input such as the cost of transport).

One large-scale application of this approach is the CGEurope model developed by Johannes Bröcker has been used in a number of research projects looking at the impact of the Trans-European Networks (see for example, Bröcker et al, 2004a, b). This uses a detailed representation of the European transport network mapped onto a detailed regional structure of Europe at the NUTS3 level. The model generates three important results. First, it demonstrates that despite significant changes in transport costs and accessibility occasioned by the development of the TENs (accessibility in some regions changing by as much as 40 per cent), the impact on welfare is relatively modest (equivalent typically to less than 2 per cent of regional GDP). Secondly, it shows that the network as a whole has both positive and negative impacts and, although the largest positive impacts relative to regional GDP are in the more peripheral, poorer regions, it is difficult to claim that, despite significant investment expenditures the TENs are a major force towards convergence and cohesion. Thirdly, specific investments can be seen to have differential impacts both on the specific regions they serve and in the added value they bring to the European economy as a whole. Thus even using a fairly aggregated modelling structure much of parameter dependence and variety of impact predicted by the theoretical model can be identified. This contrasts strongly with the purely accessibility-based estimates of HSR effects which implied much larger benefits. Although the model does allow for the measurement of the impact of each link in the context of the development of a complete network, it not, however, allow for the possible dynamic impacts which the development of this network could have (Laird et al, 2005).

A more specific application has been developed to evaluate the possible impact of a high-speed rail link between the Randstad and the Northern Netherlands, including the possibility of using an ultra high-speed maglev system (Oosterhaven and Elhorst, 2003; Elhorst et al. 2004). The Dutch model focuses not just on the output and welfare implications, but also very specifically on the labour market since the improvement to transport will not just affect the location of employment but also the residential location decision. This introduces further difficulties because it requires not just a balance of production and consumption in the goods markets, with a potential response through migration to long-term imbalances, but a period by period balancing of labour markets demands and supplies, zone by zone. Furthermore, once the key benefiting users of the system are passengers rather than goods some of the simplifying assumptions used in the typical CGE structure become less plausible. For example, the use of ‘iceberg’ transport costs, in which the cost of transport of a good is subsumed into the value of the goods moved such that they are worth less at the destination than at the origin by the amount of the cost of transport, is inappropriate for passengers. Similarly the assumption of constant costs of transport per unit of distance is even less appropriate for passenger transport.

Nevertheless the application of a CGE model to this project has produced an interesting set of results. The wider benefits are shown to vary significantly as a result of the precise nature of the project and the region studied (especially core-periphery differences), and constitute a higher proportion of direct benefits than earlier studies suggested, of the order of 30-40 per cent. These wider benefits are higher than theoretical simulation models have suggested; SACTRA (1999) suggested that a figure of 10 to 20 per cent was a likely range, following Venables and Gasiorek (1999) conclusion that 30 per cent was a likely to be exceeded in only a few cases. (It is worth noting however that in the earlier version Oosterhaven and Elhorst had produced a figure of 83 per cent). What is clear from Elhorst et al (2004) is that the degree of detail in the modelling of labour market responses may be crucial here. These employment effects arise by linking areas of surplus labour to those of labour shortages, rather than through the productivity effects arising as a result of agglomeration benefits which have been argued elsewhere (Venables, 2004).

Some local impacts – evidence from the North European HSR Network

The North European High-Speed Rail Network is the most developed network of high-speed rail connections in Europe, linking Paris, Brussels, Köln, Amsterdam and London, with direct onward linkages to Frankfurt and via the Paris Ceinture to the rest of the French TGV network (Figure 1). The first elements of this network were completed in 1993 and the final stages should be in operation by the end of 2007. The network involves five EU member states. As well as providing high-speed rail links between these major metropolitan regions in Europe, the network has opened up new opportunities for other possible nodes, particularly Lille, but at the same time has removed or reduced access to international rail services from other towns and cities. Significantly for our purposes a number of these are on or close to the international borders, the effects of which could therefore be reinforced by the new links.

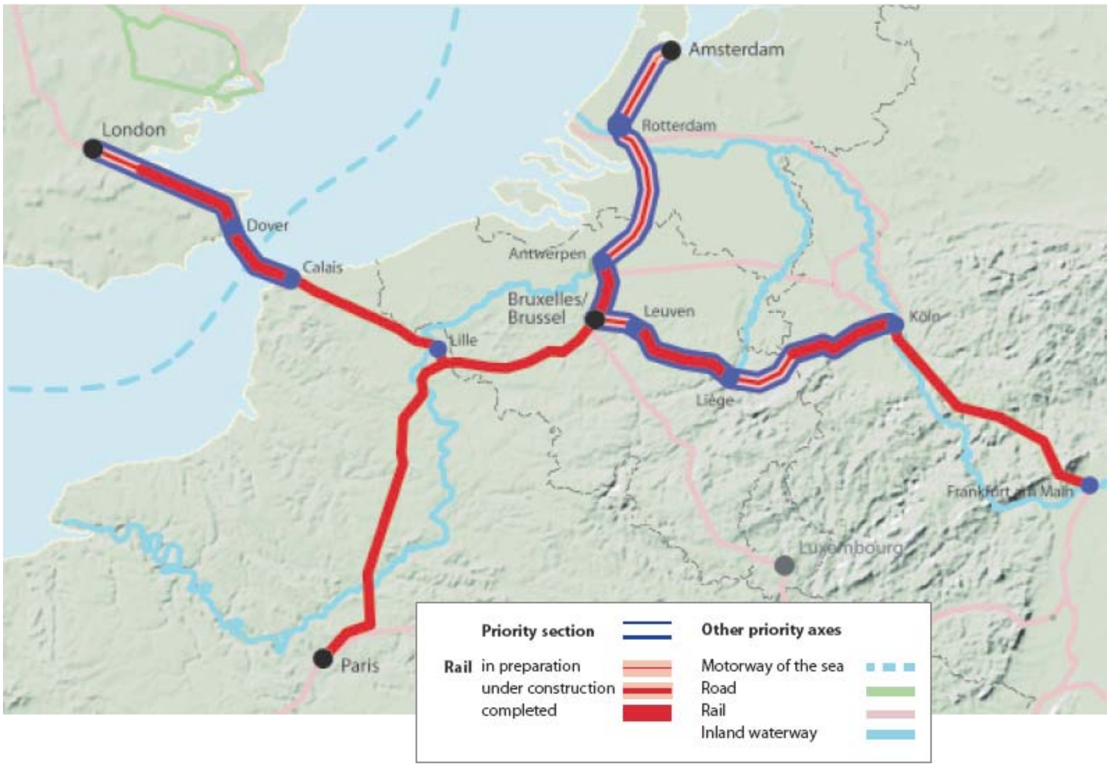

Figure 1 North-West European HSR Network (source: European Commission, 2005)

Excluding the French TGV links, Paris-Lille-Calais which were built prior to 1993 and thus not included as TENs priorities, the total cost of the remaining links is estimated at €24.9bn of which just under €0.9bn (to end 2004) was from the TEN budget (European Commission, 2005). The projects are being delivered in a number of ways with both pure public sector projects managed by the relevant national railway infrastructure authority and various models of public-private partnership. Services on the completed network will also be provided by a number of joint venture companies providing overlapping services between the main destinations. Thus Thalys services between Paris-Brussels-Köln-Amsterdam compete with SNCF TGV services and Eurostar (joint UK, French, Belgian services) between Lille and Brussels and with DB ICE services between Brussels and Köln and with SNCB/NS services between Brussels and Amsterdam. Tickets are not interchangeable and through booking (e.g. between London and Frankfurt) is not provided for.

This lack of easy booking and the lack of planning of reliable connections for through services limits the competitive edge of the network with airlines which is one of the major objectives of this development. Thus for example, on a direct competition between air and rail on the London-Paris segment, rail has captured almost 80% share of the combined market. Although rail will find it difficult to make similar inroads on the longest possible journeys (e.g. London-Frankfurt) even with through booking and easier connections, there is a considerable market for modal shift which would enable this network to fulfil one of its major objectives in terms of current EU transport policy. In late 1005 a joint venture between Eurostar and Thalys was established to further this aim and this was joined in 2006 by the various national rail companies and the Dutch High Speed Alliance (operator of the HSL Zuid) with the aim of delivering more seamless high speed travel over a wide area of northern Europe.

As will be clear from Figure 1, the development of the network has required a number of compromises in terms of route choice. For example the London-Paris route is significantly longer than the more direct route between the Channel Tunnel and Paris, made necessary by the economic considerations of combining the infrastructure with that between Paris and Brussels (which route is also longer than the more direct traditional route via Maubeuge and Mons. Here the commercial consideration of serving the Lille metropolitan area with a population of well over 1 million was critical. Less clear from the map, but also important was the decision to place the route through the main railway station of Antwerp, involving a very expensive tunnelling operation, but ensuring that rail penetrated the heart of the city. Similar decisions surrounded the location of stations in Lille and Rotterdam.

Perhaps some of the local impacts of new TGV routes are best seen in the context of the impacts on towns in the border regions which may either have new links created or old links removed. On the Franco-Belgian border, Lille has made the most of its position at the junction of the lines to the three main cities of London (under 2 hours), Paris (1 hour) and Brussels (40 minutes). On the other hand, the traditional (and more direct) Paris-Brussels route served the smaller town of Maubeuge and the Belgian city of Mons which have largely lost their international links. Maubeuge, has irregular direct traditional rail services to Paris taking 2 hours. Services to Brussels involve a change at Quévy, operate irregularly (essentially morning and evening services) and take between 1 hour 20 minutes and 2 hours. Belgian domestic services from Quévy operate every hour to Brussels. On the Belgian side of the border, in Mons, as in Maubeuge through international services were largely lost, except for one return Thalys service a day to Paris. This is however some 40 minutes faster than the direct traditional services from Maubeuge just over 20 km away across the border. Otherwise journeys to Paris involve a change in either Brussels or Lille adding at least one hour to the journey time.

In contrast to the Franco-Belgian border, the border between France and Britain is one where the completion of the Channel Tunnel and associated high-speed rail links introduced through international rail services where none had existed previously (except for rail connections to traditional ferry services). Through services by Eurostar between Ashford in Kent and Paris and Brussels take 2 hours and 1 hour 40 minutes respectively opening up new journey possibilities to destinations beyond Paris and Brussels with changes in Lille and Brussels respectively. In the other direction the coastal region of Nord-Pas de Calais gained direct services to London taking just 1 hour 20 minutes (reducing to little over 1 hour on the completion of the high-speed line all the way to London in 2007). There is an imbalance in these services however. Calais has only three weekday services to London (and four in the opposite direction). The stops in Calais, where the station Calais-Fréthun is actually some way out of the town) tend to serve the Calais-Paris passenger more than the Calais-London passenger. Ashford currently has 6 weekday services to Paris (7 on Mondays and Fridays) and 4 to Brussels with 6 in the reverse direction. Most Brussels services also stop in Lille. Oddly, Ashford-Calais has only three services and Calais-Ashford only two on a regular weekday making simple cross-border journeys by rail the least attractive option (the tariff also makes this journey very unattractive).

However, the completion of the UK Channel Tunnel Rail Link in 2007 and the opening of a new station at Ebbsfleet close to the London Orbital M25 Motorway will mean that many services currently stopping at Ashford will instead stop at Ebbsfleet (Figure 2). The Ashford-Paris service will be reduced by 50% to just three service per day and the Ashford-Brussels service withdrawn completely. This issue of competition between stations along a line is an often overlooked problem as cities campaign for a station rather than looking at the level of service provided.

Figure 2 Channel Tunnel Rail Link and stations.
(source: http://www.lcrhq.co.uk/content/downloads/ctrlroutemaps.pdf)

A third case is that of the Dutch-Belgian border. This case differs from the previous two in that it represents a still proposed development of the network rather than one which has already been brought into service. Nevertheless it can be seen from the planning of this that issues were being raised both over the precise routing of the new Brussels-Amsterdam high-speed line and the services provided on that link and to towns not on the link. Thus the agreed route passes through the Central Station in Antwerp and then via Rotterdam to Schiphol Airport and Amsterdam with stops just in these locations. This has the effect of by-passing the border town of Breda (and also The Hague) which are currently served not by direct international services, but by international trains stopping at appropriate junction stations (Roosendaal and Den Haag HS) with connecting services to these stations. This has led to connections being provided to the new high speed line so as to enable the development of services specifically for these cities. Thus Breda will have two services an hour to Amsterdam via the high speed line and there are proposed eight trains a day between The Hague, Rotterdam, Breda and Brussels with additional stops which will complement the main inter-capitals service. Such a regional service may be the obvious solution for Ashford and Calais, but currently Channel Tunnel safety regulations and access charges make such a proposition uneconomic.

This section highlights the key local issues which arise in the context of HSR development and shows how HSR services need to be conceived as part of an integrated network with local rail (and other connecting) services and not as a totally independent network if the real benefits are to be felt.

Conclusions

The development of HSR as a new mode of transport has accelerated in many European countries and become a key element in the priority TENs. The rationale for this has, however, been somewhat confused so it is not clear whether HSR is simply an updating of the rail system to deal with problems of capacity and thus help maintain rail's market share, whether it is a means of competing with the rapid growth of air travel for medium distance journeys in the 400 to 600 km range, or whether it is a more fundamental agent of economic change with impacts on both competitiveness and cohesion.

The analysis here suggests that whilst the wider economic effects of HSR could be very significant, they are not always obvious or predictable and can vary significantly between different HSR projects. The analysis needs, however, to go further. Most of the analysis does not yet deal adequately with the dynamic effects which the development of a completely new network could have on patterns of trip making and economic behaviour. These may go beyond the simple network effects as evidenced by the rapid growth of that other new network of low-cost airlines. The next stage in the development of HSR is the joining up of the major international networks with the developing national networks and this could imply a step-change in effects even greater than that experienced by the first HSR links. Such a step-change does however carry implications for pricing and interconnection with other modes, including local and regional rail which need careful consideration. This implies a need to go back to thinking about appropriate definitions of accessibility change in the light of our better understanding of the links between accessibility change and the indirect benefits stemming from HSR developments.

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