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Spatial Short and Long-Term Implications and Planning Challenges of High-speed Rail: a literature review framework for the Special Issue

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Abstract

This introduction to the Special Issue on the *Spatial Implications and Planning Criteria for High-speed Rail Cities and Regions* attempts to distinguish its short- and long-term impacts described in the literature, classifying them into regional and inter-urban effects, urban effects and wider economic impacts. Articles composing this Special Issue are listed at the outset and referred to in the relevant subsections. This literature review highlights the need to distinguish between short- and long-term effects and shows that cases are context-specific. Planning challenges appear at two major points: 1) during the initial planning stage that includes the route and location of stations; 2) during the development process that follows.

Key words: high-speed rail; spatial impacts; wider economic impacts; long-term; planning challenges

1.-Introduction

This introduction to the Special Issue on the **Spatial Implications and Planning Criteria for High-speed Rail Cities and Regions: a long-term perspective** distinguishes between short- and long-term impacts from high-speed rail (HSR), recognising that some of them will only become clear after many years. This is true of travel patterns, as some adjustments are easy to make as accessibility changes, whilst those requiring relocation or investments take longer. Likewise, the response of planning authorities seeking to capitalise on the new opportunities afforded by HSR involves complex power relations and coordination among different levels of governmental and private entities.

Much has been claimed about the ability of HSR to transform cities and regions. The hard evidence of success or the best way of achieving it is much less clear. With over fifty years of experience in Japan and almost forty years in Europe, it is timely to reflect on its long-term achievements.

Several literature reviews have been published previously with different objectives and frameworks. Givoni (2006) examined four kinds of HSR impacts finding clear evidence for direct transport-related impacts, but mixed evidence for indirect spatial, socio-economic, and environmental impacts. Bazin et al. (2011) compared academic and professional literatures in order to understand the expectation gap. Loukaitou-Sideris et al. (2013) reviewed literature through a dichotomy of prediction and empirical observation to explore implications useful for the California HSR. Yin et al. (2015) explored international lessons for China by examining direct transport impacts and indirect spatial development impacts at the regional, urban and station-area levels. Chen and Vickerman (2017) looked at the evolution of theory and practice on wider economic impacts of transport investment, focusing on HSR.

As these literature reviews indicate, there is no automatic and systematic relation between transport infrastructure and spatial and socio-economic development, and there is little evidence that enterprises change location exclusively due to HSR (Willigers and van Wee, 2011). Nevertheless, messages in the media tend to perpetuate the idea that HSR contributes to greater local dynamism (Bazin et al., 2011).

The paper is organised in three sections dealing with the regional and inter-urban effects, the impacts on individual cities and the wider economic impacts. These sections include references to the following articles comprising this Special Issue:

Three articles on methodologies to analyse the spatial implications of HSR:

-Short- and Long-Term Population and Project Implications of High-Speed Rail for Served Cities: Analysis of all served Spanish cities and re-evaluation of Ciudad Real and Puertollano. (Coronado et al., 2019)

-A methodological approach to analyze the territorial appropriation of high-speed rail from interactions between actions and representations of local actors. (Facchinetti-Manone, 2019)

-Measuring the Regional Economic Impacts of High-Speed Rail Using a Dynamic SCGE Model: the Case of China. (Chen, 2019)

Three articles about territorial/regional implications of HSR

-Has HSR improved territorial cohesion in Spain? An accessibility analysis of the first 25 years: 1990-2015. (Monzon et al., 2019)

-Business and tourism high-speed rail same-day trips: factors influencing the efficiency of high-speed rail links for Spanish cities. (Moyano et al., 2019)

-Regional Heterogeneity in Taiwan HSR Demand Developments: Station Accessibility and its Effect on Usage Adoption. (Kim et al., 2019)

Two articles on activities around stations

-Are the reasons for Companies to locate around Central versus Peripheral High-Speed Rail Stations different? The cases of Reims Central Station and Champagne-Ardenne Station. (Beckerich et al. , 2019)

-Assessing spatial planning strategy in High-speed Rail station areas in Spain (1992-2018): Towards a sustainable model. (Ribalaygua, and Perez del Caño, 2019),

One article about activities inside stations

-Designing Paris Gare-du-Nord for pedestrians or for shoppers? New retail patterns as flow optimisation strategies (Baron, 2019)

2.-Short and long term regional impacts and interurban opportunities

HSR has the potential to transform the interurban system, mostly in the long-term, by increasing accessibility and reducing time-space distances (Bonnafous, 1987; Blum et al., 1997; Sasaki et al., 1997; Horner, 2000; Garmendia et al., 2008), changing intercity relations in the short-term, and a city's relative position within the urban hierarchy. For this reason, Hall (2009) considered HSR as one of the principal forces reshaping spatial structure and the city-system in Europe.

A key question is whether HSR produces impacts only on major cities, but also on small ones. HSR facilitates, in most cases, polarization between first- and second-order cities; other cases show that some small and intermediate cities have experienced HSR-induced development (Hall, 2009; Garmendia et al., 2012a and 2012b). Yin et al. (2015) show that the disparity between HSR-connected and unconnected cities and regions tends to become larger, but that it is still not clear if HSR drives growth or if cities with comparative advantages for growth attract HSR. In this Special Issue, Coronado et al. (2019) compare the long-term population evolution of HSR cities with similar non-HSR ones, finding in which cases HSR induces greater/lesser growth.

Bruinsma and Rietveld (1993) argue that the differential increase in accessibility that accompanies HSR may lead to increased spatial inequality and centralization. Gutiérrez et al. (1996) argue that the contraction of space by HSR in Europe will not be uniform but unbalanced between first-tier cities and their hinterlands. Vickerman (1997) notes that preliminary evidence from Europe is favouring big cities. Vickerman et al. (1999) confirm the likely unevenness of space contraction in Europe, while Bazin et al. (2011) point out that served cities improve in the short-term their "notoriety" and "modernity" image.

Thus, there is a mixed picture whether HSR facilitates decentralization from large metropolitan centres or concentration to them. In this Special Issue, Monzón et al. (2019) evaluate accessibility impacts caused by the way in which HSR investment was developed in Spain between 1990 and 2015 and find a more balanced distribution of accessibility levels in 2015, implying a positive contribution to territorial cohesion.

As HSR networks develop further, a more complex change in accessibility emerges, which cannot only be viewed from first- and second-tier cities or centralization versus decentralization perspectives; a more nuanced examination is required as follows.

a) <u>Distant small cities</u>

Before HSR, same-day return travel was only possible between national major cities and between most small cities and major cities. Now HSR has also made day-return travel feasible between some isolated distant small cities. Coronado et al. (2013) studied the utility of HSR for same-day tourism in Spain, and Ureña and Coronado (2009) identified Spanish and French small distant cities (more than 350 km) where HSR has made possible day-return trips.

In this Special Issue, Moyano et al. (2019), using an efficiency analysis of all HSR Spanish connections, show that large cities located at the end of lines are more favoured for business connections, while intermediate cities achieve greater efficiency for tourism.

b) <u>Time-space distance by HSR from metropolitan centres</u>

Over and above local characteristics, the effects of HSR on cities differ with the travel time to major metropolitan centres, depending on a city's position in the HSR network and other

transportation networks. Travel time thresholds of ½, 1, 1-2, 2 and more than 2 hours have been considered (Ureña et. al., 2012a).

Chen and Hall (2011) compared the development in British cities served by trains operating at 200km/h and those served by slower conventional trains. Cities connected by rapid trains within 1 h of London showed a strong impact on private and knowledge-intensive activities and seemed to gain spillover effects of value-added activities from London. In cities not connected with rapid trains, urban development remained focused on local services and was less attractive to the knowledge economy. Some regional cities within 1-2 h travelling time by rapid trains, experienced some reversal of past decline, with improved rail services from London giving them economic advantages as transport hubs. On the contrary, cities not served by rapid trains were largely characterized by high unemployment, low office rents and public-oriented services. Beyond the 2-h ring, the effects of rapid trains appeared weaker.

Studies of small cities that experienced improved accessibility with HSR at one hour from a metropolitan centre, showed initial integration into the metropolitan region. Some Spanish tertiary cities with abundant cheap HSR services, public administration facilities, and centrally located HSR stations, have slowly increased their population and economic dynamics (Ureña et al., 2005; Garmendia et al., 2008; Ureña et al., 2012a). In the short term, these cities were expected to experience considerable population growth, as other suburban areas. But 10 years after the HSR, their growth rates had increased only slightly (Serrano et al., 2006), and 25 years later they show a small but persistent population growth (Mohino et al., 2018).

In France, DATAR (1992) hypothesised that Lille, one hour from Paris by HSR, would become part of the Parisian region, experiencing localisation of high-valued economic activities, whereas the larger French city, Lyon, two hours from Paris, would remain independent from Paris. In reality, the outcome is more complex, with both cities retaining a certain degree of independence from Paris, but at the expense of their surrounding hinterlands (Plassard and Cointet-Pinell, 1986; Burmeister and Colletis-Wahl, 1996; Chen and Hall, 2012).

Cities closer to metropolitan centres, up to 100 km, connected to HSR, present varied effects. Those up to 30 km have strengthened their role as metropolitan subcentres (Coto-Millán et al., 2007; Garmendia et al., 2012a; Ureña et al., 2012a, Mohino et al., 2014), while those slightly more distant, do not show relevant metropolitan activities (Romero et al., 2014; Preston and Wall, 2008).

c) Large and medium size intermediate cities

Intermediate cities, situated between large metropolitan centres, also present varied effects. Early studies argued that in countries like France, the impact on secondary cities is greater than on larger central cities (Cervero and Bernick, 1996), with HSR helping overcome their isolation and improve their location advantages.

Some studies with longer-term perspectives find that HSR has improved the metropolitan roles of medium-size or large cities at intermediate locations (Ureña et al., 2009), the benefits vary with the catchment areas from their intermediate location and the status of the city (Ureña et al., 2012b). However, although increased accessibility to the metropolitan centres may help large intermediate cities to attract business and leisure visitors to a greater extent than prior to HSR (Ureña et al., 2009), these benefits may not be shared by their hinterlands (Chen and Hall, 2012).

HSR may assist medium-size or large cities to improve their metropolitan roles and develop a knowledge economy. However, the uncertainties indicated above, together with the recent

economic crisis which has diminished the positive evolution of these cities, suggest that further research is needed.

d) Corridor effects

HSR connecting several distant metropolitan areas, linking together a chain of cities, may create an integrated corridor economy (Yin et al., 2015), facilitating linear conurbations. Blum et al. (1997) projected the advent of corridor regions with integrated but dispersed labour and consumption markets in the long-term. HSR has certainly played a role in the formation of such conurbations, such as in Japan's Tokaido. In China, the inter-city HSR connecting Shanghai to Nanjing and Hangzhou has immediately enhanced transport links between cities. But how the spatial-economic evolution brought about by HSR will unfold in the long term remains to be seen.

Perl and Goetz (2015) identify three strategic models of HSR development: exclusive corridors (e.g., Japan); hybrid national (e.g., France and Germany) and international (e.g., European Union) networks; and comprehensive national networks (e.g., China and Spain) and find corridor effects in the corridor and national hybrid models. It is challenging to extract definitive conclusions about the corridor effect, because of a lack of consistent research and dissimilar corridor definitions, and because linear conurbations have also formed without HSR, such as the north-east corridor of the USA.

Table 1 compares five HSR corridors. The Japanese one is the best to facilitate mega linear conurbations, since it serves the largest population numbers with small distances between stations/cities (Okada, 1994). The Italian and Californian ones may not be as conducive, since the Italian system leaves many intermediate small cities not served, while the California system concentrates stations within its four metropolitan regions, with only 4 stations in the central part of the corridor. The systems in France and Spain are more complex and have long distances with no stations.

Table 1 Five HSR corridors

HSR Line	Length (km by road)	Number Stations	Population served (1000 inhabitants)	Population served by km	Station-Station Distance km		City/Station Size (1000 Inhabitants)		
					Average	Maximum and Station names	Maximum	Average	Minimum
Morioka-Tokyo-Fukuoka	1.636	52	89.000	54.401	31	60 Kokura-Hakata	37.832	1.710	25
Lille-Paris-Marseille	991	11	18.000	18.163	90	295 Eurodisney-LeCreusot	12.300	1.655	2
Seville-Madrid-Barcelona	1.145	12*	15.000	13.100	95	180 Madrid-Ciudad Real	6.138	1.218	9
Milan-Rome-Naples-Salerno	813	6	12.000	14.760	136	260 Florence-Rome	4.107	2.000	382
San Francisco-Los Angeles-San Diego	807	18	16.000	19.827	45	155 Gilroy-Madera	12.829	898	59

* Including the recent Villanueva de Córdoba HSR station and Madrid, although HSR Seville-Barcelona services cannot stop at Madrid without entering the Atocha station and existing again.

Source: Authors' calculations

3.-The short and long term urban form impacts of HSR

The impacts of railways on urban form typically appear in the long-term (Boarnet and Compin, 1999; Cervero and Landis, 1997). This is particularly true in market economies, where relocation of private investments and real estate development often require long approval processes. Opposition to large infrastructure projects often arises, involving litigation and further delays. Where the public sector does not own much land around stations, the process of compiling large lots is also time-consuming and may present a hurdle to station-area development. In cases of joint development projects and public-private partnerships, additional delays may arise because of the time taken in negotiating agreements.

There is a growing realisation that the impact of HSR on cities could only be maximised when the HSR is part of a larger urban development vision. Therefore, it is difficult to separate the specific HSR impacts from other factors influencing spatial-economic outcomes. Research has evolved from isolating impacts of HSR towards understanding how the socio-spatial dynamics and opportunities opened by HSR are in synergy with other factors, and this is particularly relevant for long-term impacts. In this Special Issue, Facchinetti-Mannone (2019) proposes a new methodology to analyse territorial appropriation of the HSR from the perspective of local actions and actors. Urban and HSR dynamics should reinforce each other (Ribalaygua and Garcia Sanchez, 2010) for HSR to become a catalyst for restructuring cities and urban economies. Still, the role of HSR stations as important new infrastructure nodes will vary according to their specific context and characteristics of cities and station areas.

In general, the more decentralized the planning process, the more likely that the urban form impacts of HSR will be long-term. The short-term impacts are frequently negative, due to disruptions in the built environment for the building or refurbishing of the station and its tracks. In contrast, state-controlled economies, where the public sector owns the land and is the sole and undisputed regulator of land development, are often able to encourage and dictate the pace of development around stations, thus witnessing short-term impacts. Two extreme examples are California and China.

There is no consistent pattern of long-term urban form impacts of HSR. Significant variations exist between countries, cities and stations. In some cities, new HSR stations have acted as catalysts for urban regeneration (Hall, 2009). In others, the improvement of traditional stations to include HSR has stimulated development in their vicinity (Bellet, 2009). Finally, some stations/cities have not experienced any catalytic effects or witnessed new development or regeneration of their surrounding areas (Peters, 2009).

The impacts of HSR on urban form depend on a variety of locational and economic factors. Cities should not expect that an HSR station will necessarily be accompanied by anticipatory or post-station construction development. The relevant factors relate to a) the spatial characteristics of the station and its station-area; b) the transportation characteristics of the station; and c) the type and extent of government/planning intervention.

a) Spatial Characteristics of the Station and Station-Area

Location

Hall (2009) identified three kinds of urban impacts of HSR based on the location of the stations within metropolitan areas, namely extended CBDs, new CBDs and edge-cities. HSR stations

located near or within the Central Business District (CBD) improve its attraction for investment. HSR stations created in new centres can help develop complementary sub-centres, as was the case with Lyon-Part Dieu and London Stratford International. Finally, new stations may be used as the basis for new commercial ''edge cities'' on the urban periphery, such as Ebbsfleet in the UK.

Indeed, the location of the station within a city determines potential station-area development (Kim et al., 2018). In general, HSR stations at city centres develop synergies and facilitate urban regeneration (Bellet et al., 2012). Some suburban stations in close proximity to central areas may also witness new development, while plans to develop peripheral stations, using HSR as an attraction for further development, have often been unsuccessful (Facchinetti-Mannone, 2009).

In Japan, the New Yokohama station, 7 km from the city centre, has developed over 50 years into a prosperous sub-centre specialized on IT industries. This station has been widely regarded as a good model for Chinese HSR development (Li et al., 2016). In China, the rapid expansion of HSR has been embraced enthusiastically by local governments, assuming that HSR will facilitate urbanization processes, especially in out-of-town locations. Zhao and Chen (2015) found that the larger the urban scale and the smaller the distance from the city centre, the larger the development capacity around the station. Securing a shorter distance between city centre and HSR station requires strong local power, but the practice suggests an unbalanced bargaining power with central government between small and large cities over the politics of route planning (Wei, 2011).

The idea of HSR transit-oriented development (HSR-TOD) (Li, 2012; Dai et al., 2011) was translated in China to a popular HSR new town planning model. However, these overly ambitious plans have generated unsustainable urban expansion and are counter to the TOD principles of walkability, livability, vitality, connectivity, and mixed use (Chen and Wei, 2013; Dai, 2015).

In this Special Issue, Breckerich et al. (2019) study through surveys the different reasons for companies to locate around central and peripheral HSR stations and find that types of companies around each station are not the same.

Station-area characteristics

The physical characteristics of the station-area may also influence development. In market economies, the mere introduction of a new HSR station can rarely catalyse further growth and development, especially in second-tier cities and peripheral locations, unless strategically complemented by other factors. The availability of affordable land for development is critical (Mohino et al., 2014). Large railway tracks disrupt urban coherence and create a barrier which can complicate or deter development.

Other major attractors close to the station, such as airports, large scale leisure facilities or science parks and research facilities, may act synergistically with the HSR and help attract more development. This is the case with some French HSR stations near the Charles de Gaulle airport, Disneyland or the Massy technopole at the outskirts of Paris (ibid.).

There were also expectations, but no convincing evidence, that HSR would increase property values in served cities (Bazin et al., 2011). HSR has had some long-term effects on land prices in certain small cities but no effects in bigger ones (Mohino et al., 2018). There is also evidence that stations, including HSR, affect land prices around them, and Yin et al. (2015) synthesise literature that identifies the most relevant factors influencing real estate development in station areas: regional-city economy and role in the global economy, station location and physical conditions, image, mixed uses and public support, and good rail and road accessibility.

Place quality

Bertolini's (1996) "node-place" model is widely used to categorise the transport and place functions of station areas. Kloosterman and Trip (2006) discuss the importance of "quality of place", emphasizing that HSR stations should function as transportation hubs, and also as places attracting passengers and non-passengers. An equilibrium between place and node characteristics, along with synergy between municipal and HSR strategies become crucial for long-term vitality (Bellet et al., 2012). Trip (2008) offers insights into the quality of place from various perspectives (urban structure, functional diversity, quality of functions, public space, and architectural expression).

Creating a station area that is full of vitality is not automatic. Cascetta and Pagliara (2008) emphasize the importance of coordinating land use around stations through densification, location of major "traffic attractors," and distinctive station architecture. Willigers and van Wee (2011) find that architectural and aesthetic images of the station-neighbourhood influence locational decisions of firms and contribute to vitality. Dovey (1998) discusses the architecture and urban design of Euralille, geared toward a new sense of interacting at a global scale and desiring to travel everywhere fast. Bishop and Williams (2016) illustrate the complex politics of planning and design for the regeneration around King's Cross/St. Pancras station in London.

b) Transportation Characteristics of the Station

Station connectivity and intermodality

HSR services compress time and space and can make some cities much more accessible. But this also depends on good urban accessibility to/from the station (Bazin et al., 2011) and the level of station connectivity and intermodality, including the presence of other transportation modes in proximity (Loukaitou-Sideris and Peters, 2015; Cascetta et al., 2011; Tapiador et al., 2009). Good connections with other transportation modes help increase HSR ridership and also attract station area development (Cervero and Bernick, 1996).

In this Special Issue, Kim et al. (2019) investigate the relationship between accessibility to HSR stations and region-specific long-term demand in Taiwan, finding that regional heterogeneity of demand and improving access modes to the HSR station have positive impacts to short- as well as long-term HSR demand.

Level-of-service

The level-of-service at HSR stations and international connections are important in influencing decisions of firms to locate offices near HSR stations (Willigers and van Wee, 2011). Moyano and Dobruszkes (2017) argue that the poor HSR services in some European cities have prevented them from gaining full advantage from their location on the HSR network. This problem is even more severe in smaller intermediate cities (Vickerman, 2015).

In this Special Issue, Baron (2019) explores the relation between flow management and retail development in mixed (metro, suburban and HSR) railway stations and concludes that strategies can transform movement and consumption and turn them into fertile commercial streams.

c) Planning and local government intervention

Cervero and Bernick (1996) argue that development around HSR has been more remarkable in cities with significant public-sector interventions. An example, of local government partnership with the private sector is the establishment of Euralille-Metropole to guide the development of the new HSR station and the mixed-use projects around it (Loukaitou-Sideris and Peters, 2017). However, Lille may be a unique case, because its strategic location (between London, Paris, and

Brussels) has contributed to its exceptional growth after the inauguration of HSR (Bertolini et al., 2012). Murakami and Cervero (2010) emphasize that without proactive public agencies and local champions pushing for investment around stations, the effects of HSR on development are likely to be small.

By examining HSR station-areas around mid-size Spanish cities, Ribalaygua and García-Sánchez (2010) and Bellet (2009) found that local governments were instrumental in promoting urban regeneration by different intervention strategies (promoting intermodality, mitigating barriers, providing land, and boosting the station's urban image). Moreover, Chen and Hall (2015) illustrate that the relative impact of HSR in Britain and France reflects the varied interaction between national and local factors.

In this Special Issue, Ribalaygua and Perez-del-Caño (2019) study land uses of HSR station areas spatial plans in Spain and find a mixed urban common pattern and a progressive minimization of the barrier effect.

There can also be negative social effects from HSR. In China, station locations have often been determined without sufficient integration and cooperation with local planning actors (Wei, 2011; Dai, 2015). Chen and Wei (2013) highlight three social issues that have appeared across China: high HSR fares leading to social segregation; rapid land conversion to high-density urban around HSR stations resulting in the demolition of rural villages; landless farmers with mismatched employment skills creating latent social unease. In California, a study of transit-oriented-development (TOD) with conventional rail services found that it may produce gentrification and displacement effects in station-neighbourhoods (Chapple and Loukaitou-Sideris, 2019). Peters and Novy (2012) point to the decline of lesser stations and their station-areas in Europe after the opening of new HSR stations.

4.-The wider economic impacts of HSR

Claims have been made about the ability of HSR to change the economic fortunes of cities and regions and rebalance the economy.

The primary focus of early HSR projects was on their direct economic return in terms of revenues and costs. The early pressure for such lines in Japan and France was to overcome the capacity constraints on the conventional railway network. Cost-benefit analyses focused on the direct benefits to users from the extra speed and the value of time savings. The attraction of being connected to the emerging new HSR networks led regions to press for new HSR lines, and the successive extensions of HSR networks produced lower benefit-cost ratios, leading to a search for additional benefits that could justify the investment. The social rate of return (based primarily on changes in employment resulting from the new line) of French HSR lines was expected to be between 50 and 100 per cent higher than the economic rate of return (based on the revenues from the direct user benefits). Ex-post measurements showed that both values were much lower than expected, except for the Paris-Lyon line (RFF, 2005 and Crozet, 2013). Kurosaki (2013) showed similarly how extensions of the Japanese Shinkansen have been less viable than the first section of the Tokaido line.

a) wider impacts of transport

The economic justification for wider impacts of transport relates to the analysis of the impact of agglomeration on productivity, with agglomeration being a product of increasing accessibility. Aschauer (1989) argued that infrastructures could raise the productivity of private investments. In addition, relaxing the assumption of perfect competition in the markets affected by transport

improvements could generate additional impacts. Instead of changes in the cost of access between locations working through relevant markets for goods and labour, through a process of self-balance, imperfect competition in such markets could lead to a cumulative causation in which some regions continued to get richer (more productive), while others continued to lose resources (Krugman, 1991). Importantly, there was no a priori prediction that this would lead to either greater or lesser inequality between locations. SACTRA (1999) suggested that extending the traditional transport cost-benefit-analysis to include wider impacts might not be appropriate in all circumstances, given the cost and complexity of the exercise; only where substantial changes to accessibility/connectivity or clear indications of imperfections in the local markets were present, it would be beneficial to undertake additional appraisal (see Vickerman, 2017a, b).

The changes discussed in sections 2 and 3 have largely been measured in terms of changes in labour markets, commuting flows and land use leading to changes in relative aggregate growth rates and income levels. Wider economic impacts, however, include also impacts on productivity and competitiveness. Laird and Venables (2017) have identified three processes by which changes in accessibility impact the wider economy: proximity and productivity effects, investment and land use impacts, and employment effects.

Proximity and productivity effects relate changes in accessibility to agglomeration, the external economies of scale that occur as a product of urbanisation. Glaeser and Gottlieb (2009) recognised that larger cities are generally more productive than smaller cities due to localisation and urbanisation economies. Increased market size leads to greater specialisation, and in labour markets, more efficient transport effectively raises the real wage for workers over a wider area. Rosenthal and Strange (2004) suggest a doubling of city size raises productivity by 3 to 8 percent. Melo et al. (2009) report significant variation across sectors, countries, and methods. This suggests there is a measurable, but variable, impact on economic mass (or density), which aggregates the economic opportunities for a location relative to all other accessible locations.

The effects on investment and land use are more complex. Improvements in accessibility lead firms to increase investment, and this produces a rise in output. This effect is greater where firms operate in imperfectly competitive markets, such that the benefits from the increased output outweigh the costs. Where this requires firms to use more or more intensively land, new developments can take place that increase rents and generate new employment.

Employment effects arise first through possible changes in participation rates. As the transport improvement leads to a rise in the real wage, labour markets expand to encourage more workers to seek employment and from a wider area. This potentially benefits the public sector through increased tax revenues. As the labour market expands, workers may also move to more productive jobs.

However, the theoretical models do not have simple analytical solutions, and hence demonstration of these has relied on numerical simulations (Fujita et al., 1999). There have been some attempts to develop empirical models (see Lafourcade and Thisse, 2011; Combes and Gobillon, 2015, for useful reviews). Graham (2007) used firm level data to assess the agglomeration impacts from the development of a new commuter rail line in Greater London. The main conclusion from this and subsequent studies (e.g. Graham, 2009) is that such measures are highly sector- and location-specific.

b) evaluating wider economic impacts of HSR

HSR presents particular challenges for evaluating wider economic impacts. First, most empirical studies have been undertaken about single urban or metropolitan areas, in which the expansion of local labour markets and consequent impacts on agglomeration and productivity can be defined more easily. These tend to show a fairly rapid spatial decay with little or no impact beyond a few kilometres from a station (Graham et al, 2010). Applying such methods directly to an HSR project suggests relatively small potential wider impacts (Graham and Melo, 2011). Secondly, empirical estimates are based on traditional economic models that estimate marginal impacts, whereas most HSR projects lead to step changes in accessibility. Non-marginal changes are more likely to lead to behavioural changes, in which firms (and individuals) alter their mode of working (Vickerman, 2017b).

Moreover, with a strategic vision of HSR for regional development and urban regeneration, the changes in both patterns of travel and in city and regional plans to embrace HSR led to a belief that traditional cost-benefit-analysis does not capture the entire impact of HSR. The debate over HS2 in the UK identifies the difficulty of existing transport appraisals to capture wider economic benefits (Hall, 2013). The case for such mega transport infrastructure has therefore become critically dependent on having identifiable wider economic benefits of rebalancing regional economies. This raises the more general question: whether HSR can or should be used as an instrument of regional economic planning?

Whether cost-benefit-analysis can be modified as suggested by SACTRA (1999) to extend beyond the narrow analysis of direct costs and benefits is open to debate. Hickman and Dean (2017) stress the problems of incomplete benefits and costs. Given that transport appraisal has traditionally adopted a demand-driven approach, deprived places find it difficult to justify their transport needs. As Worsley (2014, p.21) comments “CBA is well suited for analysing marginal land use change, but is not capable of calculating all the costs and the benefits of transformational schemes which start from a vision of the economic activity and social provision to which the planner aspires. Nor is it capable of demonstrating the part played by transport in delivering that vision”. Alternative methods, such as those by KPMG (2013) for the HS2 HSR project and PwC (2013, a, b) for airport expansion in the UK need to make heroic assumptions to obtain numerical forecasts. These have been open to serious methodological criticism (e.g. Overman, 2013).

In this Special Issue, Chen (2019) evaluates regional economic impacts of HSR in China through a dynamic and spatial general equilibrium-modelling framework and concludes that the real GDP growth rate stimulated by HSR investment was particularly substantial in less developed regions and relatively small in developed ones, although the real GDP level change was relatively large in developed regions.

Recent ex-post evidence suggests that a more nuanced examination is needed of impacts on economic sectors more likely to be directly affected by HSR. Using examples from the UK and China, Chen and Vickerman (2017) examined the employment impacts on knowledge intensive sectors. Before the HSR, the pattern of economic structural change was rather mixed and the largest increases in the knowledge economy appeared in relatively small cities, while, after HSR, the largest increases in knowledge economy employment (and greatest reduction in secondary industries) have been in the large cities, suggesting that HSR has promoted structural change. The effect is much less pronounced in the case of Kent, with the greatest concentrations of knowledge intensive industries being in traditional centres although the largest proportional growth occurred in Ashford, the main beneficiary of HSR.

This ex-post evidence of wider economic impacts indicates how the effects of HSR vary in different contexts. This difference illustrates further the argument of Cheng et al. (2015) on

convergence and divergence at different stages of economic development. As Vickerman (2018) concludes, there is no a priori reason to presume that HSR will have a transformational effect, but with careful selection of supporting measures and policies, it can make a difference to regional performance. This echoes findings in earlier studies, such as Chen and Hall (2011, 2012) on major cities, and Vickerman (2015) on HSR impacts on intermediate cities.

5.-Conclusion

This analysis of the regional, urban and economic impacts of HSR has highlighted the need to distinguish between short- and long-term effects. It has shown that there is no standard one-size-fits-all outcome; each case is different. HSR alone cannot explain the variations between places fully; some cities are more successful than others in exploiting and adapting themselves to the arrival of HSR. Innovation depends on a complex response to existing systems highlighting the gap between technological and socio-institutional innovation (Perez, 1983). The precise effects on cities depend on strategic planning and active intervention with "entrepreneurial adaptation" (Hall, 1995).

Successful adaptation, however, depends on the existence of supporting policy measures such as innovative funding, devolved planning power to a local level, institutional leadership and coordinated governance at different spatial levels. Planning challenges appear at two major stages. One is the initial stage of planning that includes the route and location of stations; the other is the development process that follows, which requires tenacity in resolving the uncertainty and problems encountered in line with a pre-existing strategic vision. But it remains clear that whilst there are great potential gains from access to HSR, these are not automatic, and impacts are not always positive.

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